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

(1)  

a.  

\[
\begin{array}{c}
\text{L} \\
\text{place}
\end{array}
\]

Nasalized sonorant

b.  

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

Nasalized laryngeal

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

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

### 3.1 Vowel nasalization

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

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

\begin{align*}
\text{(2) a. } & \quad \text{N} & \quad \text{b. } & \quad \text{N} \\
& \quad \text{L} & \quad \text{L} & \quad \text{L} \\
& \quad \text{A} & \quad \text{A} \\
/\text{a}/ & \quad /\tilde{\text{ã}}/
\end{align*}

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

---

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

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

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

(4) \[
\begin{array}{c|c|c|c|c}
| & N & C & N & (C) \\
\mid - - L & L & L & > & L & L \\
\mid | & | & | & | & | \\
A & ? & A & (?)
\end{array}
\]

/\textipa{am}/ \rightarrow [\textipa{ãm}] > /\textipa{ã}/

---

3 I will not be concerned with the relation between nasalization and vowel place. Maddieson (1984:131) notes that peripheral /ɪ û ʌ/ are most frequent, and that “nasalized vowel frequency is generally correlated with the frequency of the oral equivalent”.

The first stage of nasal effacement involves regressive vowel nasalization, as expressed by the leftward spreading of dependent [L]. The second stage involves the loss of the nasal manner component, leaving behind a nasalized vowel.

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

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

\[
\begin{align*}
\text{(5) a. } & \text{ le petit ami } [lɔpɔ̃tami] \quad \text{‘the little friend’} \\
& \text{l’ami est petit } [lɑmjêpɔ̃ti] \quad \text{‘the friend is little’} \\
& \text{le petit cheval } [lɔpɔ̃[əval]] \quad \text{‘the little horse’} \\
\text{b. } & \text{ le bon ami } [lɔbɔ̃nami] \quad \text{‘the good friend’} \\
& \text{l’ami est bon } [lɑmjêbɔ̃] \quad \text{‘the friend is good’} \\
& \text{le bon cheval } [lɔbɔ̃[əval]] \quad \text{‘the horse is good’}
\end{align*}
\]

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

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

\[
\begin{align*}
\text{(6) } & \text{ bon } [bɔ̃n \sim bɔ̃] \quad \text{‘good-MASC’} \\
& \text{ bonne } [bɔ̃n \sim bɔ̃] \quad \text{‘good-FEM’} \\
& \text{ vain } [vɛn \sim vɛ̃] \quad \text{‘vain-MASC’} \\
& \text{ vaine } [vɛn \sim vɛ̃] \quad \text{‘vain-FEM’}
\end{align*}
\]

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

---

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

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

<table>
<thead>
<tr>
<th>(7)</th>
<th>Proto-Bisoid</th>
<th>Bisu</th>
<th>Pyen</th>
<th>Phunoi</th>
</tr>
</thead>
<tbody>
<tr>
<td>m̥ŋ</td>
<td>?am̥ŋ</td>
<td>&lt;amawng&gt;</td>
<td>m̥</td>
<td>‘horse’</td>
</tr>
<tr>
<td>h̥n̥ k̥n̥ŋ</td>
<td>h̥n̥ k̥n̥ŋ</td>
<td>&lt;nakang&gt;</td>
<td>t̥h̥ŋ</td>
<td>‘nose’</td>
</tr>
<tr>
<td>b̥l̥ŋ/m̥l̥ŋ</td>
<td>?ən̥ b̥l̥ŋ</td>
<td>&lt;angplawng&gt;</td>
<td>?̥m̥ŋj̥</td>
<td>‘husband’</td>
</tr>
<tr>
<td>h̥m̥ŋ</td>
<td>?ən̥ h̥m̥ŋ</td>
<td>&lt;mawng&gt;</td>
<td>?̥m̥m̥û/mû</td>
<td>‘high’</td>
</tr>
</tbody>
</table>

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

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

<table>
<thead>
<tr>
<th>(8)</th>
<th>Lakkia</th>
<th>Thai</th>
<th>Sek</th>
<th>Sui</th>
<th>Kam</th>
</tr>
</thead>
<tbody>
<tr>
<td>khjóp</td>
<td>phrom</td>
<td>phrom</td>
<td>?γum</td>
<td>wum</td>
<td>‘slimmed’</td>
</tr>
<tr>
<td>kūi</td>
<td>mai</td>
<td>mi</td>
<td>...</td>
<td>...</td>
<td>‘thread’</td>
</tr>
<tr>
<td>kū</td>
<td>mu</td>
<td>mu</td>
<td>hmu/hû</td>
<td>ñu</td>
<td>‘pork’</td>
</tr>
<tr>
<td>khwō</td>
<td>ma</td>
<td>ma</td>
<td>hma</td>
<td>ñwa</td>
<td>‘dog’</td>
</tr>
<tr>
<td>kjē</td>
<td>na</td>
<td>na</td>
<td>ña</td>
<td>na</td>
<td>‘face’</td>
</tr>
<tr>
<td>kjûn</td>
<td>non</td>
<td>nol</td>
<td>...</td>
<td>nun</td>
<td>‘worm’</td>
</tr>
<tr>
<td>tsiē</td>
<td>...</td>
<td>...</td>
<td>ñja/nie</td>
<td>nga</td>
<td>‘river’</td>
</tr>
<tr>
<td>pha/hā</td>
<td>ma</td>
<td>ma</td>
<td>ma</td>
<td>ma</td>
<td>‘to return’</td>
</tr>
</tbody>
</table>

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

---

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

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

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

<table>
<thead>
<tr>
<th>Lakkia</th>
<th>Thai</th>
</tr>
</thead>
<tbody>
<tr>
<td>/tam/</td>
<td>/thom/</td>
</tr>
<tr>
<td>/ʧɛn/</td>
<td>/kiɛn/</td>
</tr>
<tr>
<td>/liŋ/</td>
<td>/liŋ/</td>
</tr>
</tbody>
</table>

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

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

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

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

---

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

(11)  

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

*kne > /kjê/

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

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

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

### 3.2 Nasal harmony

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

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

### 3.2.1 Typological overview

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

(12)  

Parameters of nasal harmony  

a. Domain of nasalization  
b. Trigger of nasalization  
c. Direction of nasalization  
d. Target range of nasalization  
e. Behaviour of non-targets

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

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

(13) a. m̀aʈaʔ ‘eye’
    himōh ‘to blow the nose’

b. ɡiham ‘rapids’
    avin ‘because’
    soŋ ‘rice mortar’

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

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

(14) a. nąʃān ‘wet-ACT’
    nąłur ‘say-ACT’
    kumāHā ‘how?’
    biŋHār ‘be rich-ACT’
    mìʔasih ‘love-ACT’

b. nąjak ‘sift-ACT’
    nąwih ‘sing-ACT’
    mąro ‘halve-ACT’
    mòlohok ‘stare-ACT’
    nątur ‘arrange-ACT’

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

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

---

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

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

(15)  a. mõɔùu /õãû 'give it to him'
     nõãûùùù /ãÜãHã 'summer'
     mõõúúûu /õãû 'give them to him'
     mêHõkohi /'shadow'  
     b. tewêke /'kind of bird'
     terê /'it broke'
     ja /'sun'
     jã /'walking'
     c. iõ /'turtle'
     õiHõro /'kind of tree'

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

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

---

9 I have been unable to find any Warao forms with vowel sequences whose second, but not first, member is nasalized. According to Osborn’s description, such forms should be possible.
NASALIZATION

(16) a. ñipôñi ‘down river’
    bìmi ‘fruit’
    Hāmawi ‘step on it’
    kînîf’ap ‘bowl’

b. pô ’ã(n) ‘arm’
    jîf’(n) ‘by fire’
    warâ(n) ‘squash’

The forms in (16a) indicate that nasal harmony proceeds leftwards from a nasal, targets vowels, laryngeals, and /w j/, and is blocked by other consonants. The forms in (16b) indicate that triggering nasals, when in word-final position, are themselves deleted. This suggests that Capanahua exhibits a process of final nasal effacement, with nasalization being retained by spreading it leftwards. We may think of this nasalization as being compensatory, in the sense that it compensates for effacement of the nasal. As we will see in §3.3, nasal lenition may also give rise to this type of nasalization.

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

(17) /wiran-wi/ [wirâ ã] ‘push it over’
/wiran-jañn-wi/ [wirâ ã’ã?] ‘push it over sometime’
/horînha-jañn-wi/ [horîñã’ã?] ‘make it red sometime’

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

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

---

10 Loos notes that nasal effacement also occurs before fricatives, but does not provide any examples.

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

(18)  

(a) /kunã/ ‘variety of tree’
    /hamõ/ ‘armadillo’
    /mêå/ ‘variety of ant’
    /nãšso/ ‘crayfish’

(b) /tõko/ ‘she is weaving’
    /jahi/ ‘sweet potato’
    /ãõ/ ‘bread’

(c) /ûûûé/ ‘variety of tree’
    /èè/ ‘arm band’

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

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

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

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

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

(20)

a. Ûfâ ‘to illuminate’
   Hôl ‘there’
   êml ‘howler monkey’
   Ûînl ‘wind’

b. mîp ‘badger’
   nît ‘coal’
   tîl ‘Yapara rapids’
   nôl ‘bird’
   sîfl ‘to kill’

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

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

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

(21)  a. Oral words  b. Nasal words

<p>| | | |</p>
<table>
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<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>bipí</td>
<td>míp</td>
<td>‘badger’</td>
</tr>
<tr>
<td>dití ‘to lose’</td>
<td>nít</td>
<td>‘coal’</td>
</tr>
<tr>
<td>siqé ‘follow’</td>
<td>tič</td>
<td>‘Yapara rapids’</td>
</tr>
<tr>
<td>osó ‘bat’</td>
<td>pós</td>
<td>‘bird’</td>
</tr>
<tr>
<td>peé ‘to bend’</td>
<td>pêu</td>
<td>‘to prepare soup’</td>
</tr>
<tr>
<td>siá ‘to tie’</td>
<td>sifl</td>
<td>‘to kill’</td>
</tr>
</tbody>
</table>

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

(22)  Desano  Spanish/Portuguese

<p>| | |</p>
<table>
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</thead>
<tbody>
<tr>
<td>a. [bária]</td>
<td>Maria [maria]</td>
</tr>
<tr>
<td></td>
<td>[barateru]</td>
</tr>
<tr>
<td>b. [sabô]</td>
<td>sabão [sabô]</td>
</tr>
</tbody>
</table>

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

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14 A more precise term would be “Eastern Tucano-type harmony”, since some Western Tucanoan languages, such as Secoya, have syllable nasalization but no obstruent transparency. Tucano-type harmony is equivalent to what Piggott (1992) terms “type B harmony”.

nasal denasalized to a voiced stop, as in (22a). Note that vowel nasalization in loans is retained in some forms, as in (22b), and lost in others, as in (22c). In forms where vowel nasalization is retained, any sonorant which precedes the nasalized vowel is also realized as nasalized.

Different interpretations of the complementary distribution between nasals and voiced oral stops have been offered. According to one approach, Tucano-type nasalization targets all voiced segment types, nasalizing sonorants and turning voiced oral stops into nasals (see e.g. Pulleyblank 1989, Noske 1995, Walker 1998).\footnote{Pulleyblank assumes that nasalization is regulated by a “nasal/voicing condition”. This condition sanctions the feature combination [+nasal,+voice] and rules out the feature combination [+nasal,–voice].}

An alternative approach is to analyze Tucano-type harmony as targeting sonorants only (see e.g. Piggott 1992, Rice 1993, Piggott & Van der Hulst 1997); this implies that the voiced oral stops function as sonorants, parallel to other nasalization targets. The latter view is also adopted here, since it is in accordance with the Element-based Dependency claim that nasalization is restricted to sonorant segment types. I return to this issue in §3.2.1.

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

\begin{align*}
\text{(23) a. } & \text{kāmōkā} \quad \text{‘rattle’} \\
& \text{māsā} \quad \text{‘people’} \\
& \text{mānō} \quad \text{‘none’} \\
& \text{ūātī} \quad \text{‘demon’} \\
\text{b. } & \text{eōnō} \quad \text{‘mirror’} \\
& \text{rimā} \quad \text{‘poison’} \\
& \text{romīdō} \quad \text{‘woman’} \\
& \text{hati-amī} \quad \text{‘he sneezes’} \\
& \text{hīāmākōnō} \quad \text{‘ten’}
\end{align*}

The form [hīāmākōnō] in (23b) shows that nasalization is lexically associated to a vowel, from which it spreads rightwards, skipping any intervening obstruents. Based on forms of this type, Piggott & Van der Hulst argue that the harmonic domains in (22a,b) can be unified if it is assumed that Southern Barasano has underlyingly nasalized vowels and syllable nasalization. The latter assumption is
required to account for forms like [romiØ] (cf. (23a)) and [Ūātī] (cf. (23b)): if nasalization spreads rightwards from the leftmost nasalized vowel, then syllable nasalization is necessary to account for the fact that any sonorant preceding the leftmost nasalized vowel is also nasalized. Tucano-type systems differ in this respect from the pattern displayed by Secoya; while syllable nasalization is optional in Secoya, it is required in Southern Barasano. I will examine the role of the syllable in nasal harmony systems in more detail in §3.2.3.

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

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

### 3.2.2 Sonorant nasalization

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

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

$$\begin{align*}
&O \quad O \\
&\quad \mid \quad \mid \\
&L \quad \rightarrow \quad L \quad L \\
&\quad \mid \quad \mid \\
&? \quad ? 
\end{align*}$$

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

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

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

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

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

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

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

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

(27) Fixed oral               Fixed nasal
   a. -a recent past         j. -Hã emphatic
   b. -ja evidential         k. -Ü9 singularizer
   c. -ri inanimate-SG-NOM   l. -í time(s)
   d. -ba classifier         m. -má classifier
   e. -da classifier         n. -nã at that instant
   f. -ga classifier         o. -ŋã diminutive
   g. -pi too much           p. -pí classifier
   h. -to classifier         q. -tõ classifier
   i. -sa classifier         r. -sã continue action

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

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

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

(28)  a. /ʔoːa/-maba ‘let me write’ ʔʔa-ʔa ‘let me see’
    b. /ʔoːa-/wi ‘I wrote’ ʔʔa-ʔã ‘I saw’
    c. ʔaʔa-pi ‘I ate’ niʔ-ʔã ‘I was’
    ʔote-se ‘seeds’ ʔã ʔã-se ‘pretty thing’

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

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

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

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

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

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

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

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

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19 Walker speculates that the nasalization of /ɡ/ may be due to the relative difficulty of maintaining voicing during a posterior oral closure. This interpretation is in line with Itô & Mester’s (1997) analysis of [ɡ-ŋ] allophony in Tokyo Japanese.

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

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

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

(30) Oral series: b d-r j y w l-r ŋ
Nasal series: m n ŋ-n ŋ-n ŋ- ŋ- ŋ- ŋ-

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

(31) a. fá ‘to be quiet’  b. ffl ‘to embrace’
s+ ‘to hear’  sU ‘to worship’
sû ‘to be enough’  sfi ‘to plug’
- Vil ‘small’  zU ‘lean against’

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

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

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

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

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

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

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

Nevertheless, the fact that Capo is unable to find a shared phonetic property of the alternating oral series does not imply that such a property does not exist—as Capo (1981:31) himself is quick to acknowledge. Indeed, an instrumental study in Ladefoged & Maddieson (1996) indicates that Gbe [p] and [b] differ not only in terms of voicing, but also in what may be loosely termed “articulatory strength”. In their comparison of Gbe [p] and [b], Ladefoged & Maddieson (1996:96) observe that [t]he closing movements of the upper and lower lips are markedly faster for p than they are for b, and the peak of the p is flatter, indicating more compression of the lips.

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

A final argument for interpreting the nasal series as derived concerns the phonetically heterogeneous nature of the oral series. This argument is further supported by comparative evidence. Compare the following correspondences between a number of Gbe dialects (cf. Capo 1981:20):
These correspondences suggest that the nasal series is historically derived from the oral series. Consider in this respect the phonetic variation that is observed in the oral series: where the nasal series consists of [m n ŋ] (with [n] described as dental by Capo), the oral series includes a voiced bilabial stop, an apical retroflexed stop, and a palatal and labiovelar approximant. If the oral series was historically derived from the nasal series, we would expect a phonetically more homogeneous set, say, [b d j g].

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

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

### 3.2.3 Syllable nasalization

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

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

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

(33)  

According to this account, the fact that the first syllable of [Ŭã] surfaces as nasalized is epiphenomenal: it is the result of association of dependent |L| to |L|-headed manner types, and the first syllable happens to consist of |L|-headed manner types only.

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

(34)  

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

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

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

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

(35)  
eonõ     ‘mirror’  
rimã     ‘poison’  
romõõ    ‘woman’  
hati-amõ    ‘he sneezes’  
hiâmãkõõõõõ    ‘ten’

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

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

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

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

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

$$
\begin{array}{c}
\text{(36)} \\
\text{F} \\
\mid
\text{\ldots V\ldots}_\sigma \\
\mid
\text{\ldots V\ldots}_\sigma
\end{array}
\quad
\begin{array}{c}
\text{f} \\
\mid
\text{\ldots V\ldots}_\sigma \\
\mid
\text{\ldots V\ldots}_\sigma
\end{array}
$$

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

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

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

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

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

(38)  

\[ \text{a. Nasalized sonorant} \quad \quad \text{b. Nasalized obstruent} \]

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

(39)  

\[ \text{Consistency of Dependency Relations (CDR)} \]

\[ \text{Every occurrence of an inherited feature must manifest the same dependency relation.} \]

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

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

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

(40)

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

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

(41)

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

---

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

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

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

\[(42)\]

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

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

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

In a domain \(X^0\), where \(X^0\) is a projection of \(X^0\) and \(X^0\) is specified for \(Y\), \(Y\) is a property of all structures that are of the same type as \(X^0\).

With respect to syllable nasализation, “of the same type as \(X^0\)” should be interpreted as “being compatible with nasализation”. That is, (43) states that all tautosyllabic manner types in which dependent [L] denotes nasализation—i.e. all sonorant and laryngeal manner types—surface as nasализed.\(^{31}\) An important

\[31\] As far as sonorants are concerned, “of the same type as \(X^0\)” can be taken to mean “having [L] as part of the manner component”. Note, however, that this interpretation fails to
prediction of (43) is that syllable nasalization can only trigger nasalization, and never both nasalization and voicing. This observation plays an important role in distinguishing segmental instantiations from syllabic instantiations of nasal harmony, as we will see in §3.2.4.

3.2.4 Case studies

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

3.2.4.1 Kpelle

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

Given that the evidence for syllable nasalization in Gbe-type languages is less strong, it might be proposed that in these languages nasalization is not a property of syllables but of vowels. According to this interpretation, syllable nasalization is a surface effect that results from leftward spreading of nasality from an underlyingly nasalized vowel to a preceding sonorant. This general scenario is illustrated in (44):

---

[Include laryngeals in the harmonic target range. The inclusion of laryngeals requires a more elaborate characterization. One way to achieve this is in terms of a negative formulation, e.g. “not having a place-specified obstruent manner component”. In any case, the important point is that it is possible to define “of the same type as X0” in structural terms.]
We may think of this approach as being a “dynamic” alternative to the “static” syllable-based approach. Nevertheless, there are a number of arguments against this alternative. To appreciate these, I consider the pattern of nasal harmony as displayed by Kpelle.

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

\[
\begin{align*}
\text{ma} & \text{ ‘where’} \quad (*\text{m}i) \\
\text{nīnā} & \text{ ‘new’} \quad (*\text{nīnāa}) \\
\text{pī ɛ} & \text{ ‘fish’} \quad (*\text{pī ɛ}) \\
\text{ŋīnā} & \text{ ‘rat’} \quad (*\text{ŋīnāa}) \\
\text{ŋēnīnā} & \text{ ‘bitter’} \quad (*\text{ŋēnīnāa})
\end{align*}
\]

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

\[
\begin{align*}
\text{ŋīnā} & \text{ ‘bag’} \quad (*\text{ŋīnāā}) \\
\text{lūlū} & \text{ ‘fog, mist’} \quad (*\text{lūlū}) \\
\text{jā} & \text{ ‘water’} \quad (*\text{jāfl}) \\
\text{yā} & \text{ ‘dog’} \quad (*\text{yāā}) \\
\text{wē} & \text{ ‘white clay’} \quad (*\text{wēūē})
\end{align*}
\]

This complementary distribution suggests that we are dealing with a single series of underlying sonorant stops, which surface as nasalized in case they are followed by a nasalized vowel. Observe that an analysis of the vowel—or, alternatively, of the syllable—as the source of nasalization is supported by the fact that nasalized vowels are also found after non-nasalizable segment types, as is illustrated by the forms in (47):

\[
\begin{align*}
\text{tē} & \text{ ‘catfish’} \quad \text{(cf. te} \text{ ‘black duiker’)} \\
\text{sī} & \text{ ‘spider’} \quad \text{(cf. sī} \text{ ‘tribe’)} \\
\text{kēpāa} & \text{ ‘species of tree’} \quad \text{(cf. kēpaa ‘cedar tree’)} \\
\text{pōja} & \text{ ‘a design, mark’} \quad \text{(cf. sōja ‘white clay’)}
\end{align*}
\]
From an output-oriented perspective, the facts considered so far can be accounted for by analyzing nasализation as being an underlying property of either vowels or entire syllables. In the former account, an output form such as [m̥] involves sharing of dependent [L] by the onset sonorant and the vowel:

\[
(48) \quad \begin{array}{c}
O \\
N \\
L \\
L \\
? \\
I \\
U
\end{array}
\]

\[ [m̥] \leftarrow \overset{h\partial}{/} \]

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

\[
(49) \quad \begin{array}{c}
N'' \\
N' \\
L_i \\
O \\
N \\
L \\
L \\
? \\
I \\
U
\end{array}
\]

\[ [m̥] \leftarrow \overset{i{/i\delta}^*}{/} \]

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

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

\[
(50) \quad \begin{array}{l}
\text{INDEF} \\
\text{DEF}
\end{array}
\]

\begin{align*}
a. \quad \text{pili} & \quad \text{bili} & \text{'jump'} \\
\text{kpala} & \quad \text{gba} & \text{'dry out'} \\
\text{se} & \quad \text{ze} & \text{'thing'}
\end{align*}
The alternations in (50) indicate that the definite marker has three phonological effects on a root-initial consonant: the addition of a low tone if the consonant is a sonorant, the addition of voicing if the consonant is a voiceless obstruent, and the addition of nasalization and low tone if the initial consonant is a sonorant stop. For present purposes, the point to note is that the derived nasals in (50c) are followed by an oral vowel.

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

(51) N’
    O
  N
    L L
  L L
  A
  A
/DEF + jâ/  → [lå]

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

(52)

```
N'   
\  
\  
| O N
| H L L
| I A I
```

\[/\text{DEF} + \text{sen}/ \rightarrow [\text{zen}]\]

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

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

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

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

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

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

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

### 3.2.4.2 Zoque

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

(53) a. /tæntæn/ [tændæn] ‘mariposa’
    /tsæŋka/ [tsæŋga] ‘gordo’

b. /tukun-tæn/ [tukundæn] ‘arete-PL’
    /kiʔm-pa/ [kiʔmba] ‘subir-IMPERF’
    /min-pa/ [minba] ‘viene’
    /saŋ-kowi/ [saŋgowi] ‘muy sordo’

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

(54)  
```
    C  O
   /\   /
  L   L
 |   ?
?   U
 \   I
```

/n-p/ → [nb]
I examine this type of process in more detail in §4.1. Furthermore, we will see in §4.3.1 that the presence of dependent |L| in Zoque nasals is also supported by a process of denasalization, which turns nasals into voiced obstruent stops.

Nasals in Zoque trigger voicing, but they do not trigger any nasalization. The latter process is triggered instead by prefixation of the 1/2-SG-POSS morpheme. The pattern of nasalization is illustrated by the forms in (55):

(55) a. /N-waje/ [Üåã] ‘mi masa’
   /N-wiškuj/ [Üîškuj] ‘mi peine’
   /N-juwi/ ['āû] ‘mi rosadura’
   /N-johskuj/ ['āõškuj] ‘mi trabajo’
   /N-haja/ ['hɔ] ‘mi esposo’
   /N-heʔpe/ [Hɛʔpe] ‘mi ixtlé’
   /N-weʔke/ [Üẽʔke] ‘mi ceto’

   b. /N-poki/ [mboki] ‘mi rodilla’
   /N-tihk/ [ndihk] ‘mi casa’
   /N-burco/ [mburco] ‘mi burro’
   /N-disko/ [ndisko] ‘mi disco’

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

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

(56) /N-ʔane/ [ʔanê] ‘mi tortilla’
   /N-ʔamohk/ [ʔamõh] ‘mi elote’
   /N-ʔeʔni/ [ʔẽʔni] ‘mi avispa’
   /N-ʔaša/ [ʔaša] ‘mi estrella’
   /N-ʔoʔot/ [ʔoʔot] ‘mi suegro’
   /N-niwi/ [niʔi] ‘mi chile’
   /N-niji/ [niʔ] ‘mi nombre’

The observation that nasals do not block nasal spreading might initially suggest that nasals are underlyingly unspecified for dependent |L| (i.e. are “bare” sonorant stops). According to this view, nasals would be targeted by harmonic |L|, parallel to other harmonic targets. This view would be corroborated by the fact that Zoque nasals do not trigger root-internal nasalization.
The problem with the above approach is the presence of postnasal voicing, which indicates that Zoque nasals must be underlingly specified for dependent [L]. We are therefore left with a puzzle: if nasals in Zoque have dependent [L], and if nasals do not trigger nasalization, then how do we account for the fact that vowels following these nasals are a target for harmonic nasalization? Note that this specific question raises a more general typological problem. As was noted in §3.2.1, segmental transparency effects in nasal harmony processes appear to be universally restricted to obstruents. The Zoque facts, on the other hand, seem to suggest that nasals can also be included in the range of transparent segment types.

The solution that I would like to propose is that nasal harmony in Zoque is regulated by the syllable, similar to what we find in Tucano-type systems. However, the crucial difference between Tucano-type systems and Zoque is that in Zoque each tautosyllabic nasalizable manner type is required to surface with dependent [L]. To appreciate this point, consider the surface representation of the hypothetical form /N-\(L_i\)g119/g97/g109/g97/g107/g97:

\begin{align}
\text{(57)} & \\
& \begin{array}{c}
N'' \quad N'' \quad N'' \\
\mid \quad \mid \quad \mid \\
N' \quad L_i \quad N' \quad N'
\end{array} \\
& \begin{array}{c}
O \quad N \quad O \quad N \quad O \quad N \\
\mid \quad \mid \quad \mid \quad \mid \quad \mid \quad \mid \\
L \quad L_i \quad L \quad L \quad L \quad L \quad L_i \quad ? \quad L
\end{array} \\
& \begin{array}{c}
U \quad A \quad ? \quad I \quad A \quad A \\
\mid \quad \mid \quad \mid \quad \mid \quad \mid \quad \mid \\
\breve{U} \quad \breve{a} \quad m \quad \breve{a} \quad k \quad a
\end{array}
\end{align}

In (57), association of dependent [L] to the initial syllable results in nasalization of all segments within the syllable; hence the condition that each segment within the syllable must be realized as nasalized is satisfied. This condition is also satisfied in the second syllable, although here not all instantiations of nasalization have the same origin: while the vowel surfaces as nasalized as the result of syllable nasalization, the preceding nasal is already underlingly nasalized. This leaves us with the third syllable. Here the vowel is a potential nasalization target, but the preceding obstruent is not. Since the requirement in Zoque is that all segments within a syllable must be either oral or nasalized, no nasalization takes place. I assume that in such cases spreading of dependent [L] to the syllable head is blocked.

Another complication that is posed by the Zoque facts concerns the mixed behaviour of obstruents. In root-internal context, obstruents block nasalization. However, the forms in (55b) illustrate that root-initial obstruents are targeted by
the harmony process. The relevant forms are repeated in (58) below, together with some additional examples (data from Padgett 1995):

(58) a. /N-pama/ [mbama] ‘my clothing’
    /N-tatah/ [ndatah] ‘my father’
    /N-kaju/ [nqaju] ‘my horse’
    /N-tsokoj/ [ndzokoj] ‘my heart’

b. /N-burco/ [mburco] ‘my donkey’
    /N-disko/ [ndisko] ‘my phonograph record’
    /N-qaju/ [ŋqaju] ‘my rooster’

The transcriptions in (58a,b), which are based on Herrera (1995), suggest that the prefix surfaces as a homorganic nasal in case the root is stop-initial. This is the interpretation in, for instance, Padgett (1995) and Ploch (1999).35 However, it is dubious whether this view is appropriate. The description in Herrera indicates that the nasal portion of these contours does not form an independent segment. This raises the question whether the nasality in such cases has the same status as that in harmonic forms of the kind in (56).

Following Iverson & Salmons (1996), who discuss the phonological status of nasal contours in a number of Mixtec dialects, I take the position that the prenasalization in the forms in (58a,b) does not reflect any phonologically relevant nasalization, but rather involves the phonetic manifestation of voice.36 According to this view, the voicing of the voiceless stops in (58a) can be attributed to the association of dependent [L], as is illustrated in (59) for the initial consonant of /N-pama/:

(59) 
\[
\begin{array}{c}
{\#} \quad O \\
L \quad ? \\
U \\
\end{array}
\]

/|L|+p /→ [b]

Essentially the same scenario can be proposed for the voiced stops in (58b), which, as Herrera notes, are found in Spanish loans only. I suggest that these stops function as inherently voiced stops (i.e. as manner structures in which [ʔ]

35 Both Padgett and Ploch are concerned only with the pattern of prefixation that is displayed by obstruent-initial and liquid-initial roots. The facts considered show that the nature of this pattern becomes clear only when sonorant-initial roots are taken into account.

36 Iverson & Salmons refer to this type of voicing as “hypervoicing”. Other potential examples of this type of voicing can be found in a number of Tucanoan languages, where the series of voiced oral stops that occur in oral words are phonetically realized as nasal contours. I discuss this issue in relation to Yuhup in §3.2.4.3.
dominates \(|L|\). As was argued in §2.2.4, the combination of such a stop and dependent \(|L|\) is phonetically interpreted as a voiced prenasal contour.\(^{37}\)

The problem that is posed by roots with initial stops is that the phonetic realization of the possessive morpheme in such roots cannot be attributed to syllable nasalization. If syllable nasalization was active, we would predict to find nasalization, and not voicing. I would like to suggest that the answer to this problem lies in another requirement on the pattern of Zoque nasalization, i.e. the condition that the possessive morpheme must be left-aligned with the root to which it is attached. I assume that in roots with initial stops, the condition on left-alignment blocks application of syllable-based harmony.\(^{38}\)

On a final point, a comment is in order with regard to roots with initial fricatives and liquids. The forms in (60), taken from Padgett (1995), show that prefixation of the 1/2-SG-POSS morpheme to such forms is not signalled at the surface level (note in (60b) that the liquids \(|/r/\) occur in Spanish loans only):

\[
(60) \quad \begin{align*}
\text{a. } /N-sak/ & \quad [sak] \quad 'my beans' \\
/N-/japun/ & \quad [japun] \quad 'my soap' \\
/N-afa/ & \quad [faha] \quad 'my belt' \\
\text{b. } /N-lawus/ & \quad [lawus] \quad 'my nail' \\
/N-ranfjo/ & \quad [ranfjo] \quad 'my rancho'
\end{align*}
\]

With regard to such forms, Padgett (1995) accounts for the non-occurrence of nasality in terms of a constraint that prohibits the cooccurrence of the features \([+\text{nasal}]\) and \([+\text{continuant}]\). From the point of view of the present approach, the question is rather what prohibits the occurrence of dependent \(|L|\) here. I suggest that the answer to this is that Zoque does not tolerate voiced fricatives and nasalized liquids. The combined effect of this restriction and the requirement of left-alignment is that the possessive morpheme is not phonetically realized. To sum up, the facts encountered suggest that the basic nasalization pattern in Zoque is syllable-based. The assumption that spreading of nasalization applies at the level of the syllable permits a straightforward interpretation of the transparency of nasals. This transparency is difficult to account for if the harmony process applies at the segmental level, given that there is independent evidence that Zoque nasals are specified for dependent \(|L|\). An additional argument for syllable nasalization is that, in root-internal contexts at least,

---

\(^{37}\) This interpretation implies that Zoque has two structures which are both interpreted as nasal contours. Given the assumption, made in §1.3.2, that a phonological representation does not necessarily have a unique phonetic interpretation, I do not regard this as problematic.

\(^{38}\) The notion of alignment is familiar from Optimality Theory. In Optimality Theoretic terms, left-alignment of the possessive morpheme can be ensured by the alignment constraint \(\text{ALIGN-LEFT(PFX,ROOT)}\). This constraint would be undominated in the phonology of Zoque (and would be vacuously satisfied by the forms in (60) below).
dependent \( |L| \) is never associated to an obstruent manner type, as is predicted by the (revised) CDR. The only context in which syllable nasalization does not apply is in roots which have an initial obstruent. In such roots, syllable nasalization is overridden by the requirement that the possessive morpheme be left-aligned with the root. Left-alignment is possible if the root-initial segment is a sonorant or obstruent stop, but not if it is a fricative or liquid. In the latter case, the possessive morpheme is not realized; as was argued, this is due to a cooccurrence restriction on fricative and liquid manner and dependent \( |L| \).

### 3.2.4.3 Yuhup

To conclude this section, I consider another type of evidence for analyzing nasalization as a syllable-level property. The evidence in question comes from a nasalization process in Yuhup, a Maku language which displays Tucano-type harmony. Inspection of the Yuhup harmony pattern suggests that syllable nasalization may, under certain specific circumstances, operate independently from segmental nasalization targets.

As was noted, Tucano-type systems are characterized by a complementary distribution between a series of nasals and a series of voiced oral stops, with the former occurring in nasal words and the latter in oral words. An added complexity that I have ignored so far concerns the observation that, in a number of Tucano-type languages, voiced oral stops are phonetically realized as nasal contours. Consider for instance the following “oral words” from Southern Barasano (cf. Piggott & Van der Hulst 1997:95):

(61)  
\[
\begin{align*}
\text{"diro} & \quad \text{‘grasshopper’} & (\text{"diro}) \\
\text{wa"ba} \sim \text{waba} & \quad \text{‘come!’} & (\text{*wa"ba}) \\
\text{"ba\text{"go} \sim \text{"bago} & \quad \text{‘eater’} & (\text{*\text{"b\text{"go}}) \\
\text{ta\text{"boti} \sim \text{taboti} & \quad \text{‘grass’} & (\text{*ta\text{"boti})
\end{align*}
\]

The forms in (61) show that voiced oral stops are phonetically realized as prenasalized stops; this prenasalization is required word-initially and optional word-externally. There are good grounds to interpret prenasalization as being phonologically irrelevant. Firstly, in word-internal position nasalization is not a required property of voiced stops.\(^{39}\) Second, and more importantly, prenasalized stops never trigger nasalization: a form like [\text{wa"ba}] is impossible in Southern Barasano.

Different interpretations of the nasalization of voiced stops have been offered. Noske (1995:153), for instance, observes that:

\(^{39}\) More generally, there are many languages with syllable nasalization in which voiced stops are realized as completely oral, such as Bear Lake Slavey (Rice 1993), Southern Min (Chung 1996) and Desano (Kaye 1971).
[in most Tucanoan languages] prenasalized stops occur only between a nasal and an oral vowel, and sometimes in word-initial position. Prenasalization is therefore predictable by rule, and should be accounted for by a spreading rule.

Piggott (1992:48) maintains that the variation between voiced stops and prenasals in languages like Southern Barasano must be treated as a phonetic effect (see Rice 1993 for a similar view):

The nasal property of … prenasalized stops is epiphenomenal; it is directly derivable from the articulatory adjustments required to realize spontaneous voicing.

Observe that both Noske and Piggott consider prenasalization to be predictable; the difference between the two views is that Noske accounts for their occurrence in terms of a (presumably postlexical) phonological process, whereas Piggott shifts the explanatory burden to phonetic implementation.

In all Tucano-type systems that I am familiar with, nasalization of voiced stops can be plausibly analyzed as being phonologically irrelevant. However, the nasal harmony pattern that is observed in Yuhup might at first sight seem to be a counterexample to this generalization. According to the description in Lopes & Parker (1999), Yuhup seems to display phonological prenasalization in contexts where other Tucano-type systems display phonetic prenasalization. Consider first the forms in (62), which illustrate that Yuhup exhibits sonorant nasalization and obstruent transparency:

(62) a. Oral forms
   pæːh  ‘rock, stone’
   wɔːχɔt  ‘striped mullet’
   õːdæ  ‘hole’
   õːdɔŋ  ‘species of fruit’
   õːtɪɾɪb  ‘foot’

   b. Nasal forms
   pæːŋ  ‘paternal uncle’
   ŵːŋːp  ‘to sleep’
   Hɔːŋ  ‘to vomit’
   nːŋ  ‘grease, fat, oil’
   kɔːtɪːm  ‘large potato (Xanthosoma)’

The forms in (62) suggest that the harmonic domain is that of the morpheme. This is corroborated by the forms in (63), which show that Yuhup compounds freely combine oral and nasal morphemes:

---

40 According to Noske, these languages include Northern Barasano, Tuyuca, Siriono, Carapana, Cubeo, and Piratapuyo.

41 Unfortunately, the data in Lopes & Parker is limited owing to “the sensitive political issues which arise in conjunction with studying indigenous groups in Brazil” (cf. Lopes & Parker 1999:324). Additional Yuhup data can be found in Del Vigna & Lopes (1987), Del Vigna (1991), and Lopes (1995), but I have not been able to consult these sources.
So far Yuhup reveals the contours of a typical Tucano-type system. The target range of nasalization includes all sonorants and laryngeals, while the range of non-targets is limited to supralaryngeal obstruents, which are transparent to the harmonic process. Voiced oral stops, which are in complementary distribution with nasals, are realized as prenasalized in initial position and as postnasalized stops in final position.

As was noted, the standard interpretation of nasal contours in Tucano-type systems is to treat the nasalization of nasal contours as being phonologically irrelevant. But while this interpretation can be maintained in “standard” Tucano-type systems, it appears to be contradicted by Yuhup. This becomes apparent when we consider the pattern of allomorphy displayed by the progressive suffix /-ih/ (cf. Lopes & Parker 1999:333-4):

(64)  a. ñbiːʔ-ih    ‘working’
      ’dɔɾɔːh-ih    ‘getting married’
      ʃaːw-ih    ‘shouting’

b. ūm-ıH    ‘killing’
   ɲɛ:ɨH    ‘hearing’
   ɔHɛp-ıH    ‘sleeping’

c. tɔd̪-ıH    ‘beating’

The forms in (64a,b) illustrate that /-ih/ is an alternating suffix: it surfaces as oral after oral forms, as in (64a), and as nasalized after nasal forms, as in (64b). Strikingly, /-ih/ also surfaces as nasalized when added to an oral form that ends in a postnasalized stop, as in (64c). This is unexpected if the nasalization of the nasal contour is phonologically irrelevant. However, if the nasalization in final postnasals is phonologically active, then the question is why in such forms nasality does not surface as a property of the word as a whole (i.e. *[t@n-ıH]).

I would like to propose that the solution to the Yuhup conundrum lies in the syllabic status of stem-final consonants. Specifically, my claim is that these consonants occupy the onset position of an empty-headed syllable. 43 This

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42 Lopes & Parker maintain that /#/ is included in the set of transparent segments, which suggests that they equate nasalization with the presence of nasal airflow. As was argued in §3.2.1, this is not the only possible interpretation; if nasalization is equated with a lowered velum, there are good grounds to include /#/ in the target range. I discuss the issue of nasalized glottal stops in more detail in §6.1.

43 For general arguments in favour of this type of syllabification see, among others, Kaye et al. (1990), Harris (1994, 1997), and Harris & Gussmann (1998).
prosodic organization makes it possible to integrate the Yuhup facts on the basis of a shared trait of Tucano-type systems: syllable nasalization. According to this interpretation, I assume that the final syllable of [txdʰ] has the following shape (in (65) I ignore place; “º” denotes an empty position):

(65)  
```
    N''
    |   N'
    |   L
    O   N
    |   |º
    L   ?
```

Being a Tucano-type system, nasalization in Yuhup is distinctive at the syllable level. As was argued in §3.2.3, allocating nasalization at the level of the syllable implies that nasalization is a property of the syllable head. Note, however, that the head in (65) is empty. As a consequence, nasalization cannot surface as a property of any of the other segments dominated by the syllable. It follows, then, that any sonorant which occupies the onset of an empty-headed syllable is phonologically oral. The consequence of this interpretation is that the realization of nasal contours can be relegated to the level of phonetic implementation, similar to other Tucano-type systems.

The question that remains is why suffixation of /-ih/ to /txdʰ/ results in a nasalized allomorph. The answer that suggests itself is that /-ih/ is incorporated in the stem-final syllable. Given that this syllable now has a filled nucleus, nasalization is free to associate to all nasalization targets within its domain.44

Aside from nasalization, there is further support for analyzing word-final consonants in Yuhup as onsets of empty-headed syllables. According to the description in Lopes & Parker, Yuhup has the following canonical root shapes:

(66)  
```
  CV   /ke/  ‘wing’
  CVC  /pop/  ‘larva of bot fly (Dermatobia hominis)’
  VC   /sw/  ‘iguana lizard’
  CVCC /taj/  ‘to kick’
  VCC  /ujn/  ‘species of bat (Desmodus rotundus)’
```

The root shapes in (66) lead Lopes & Parker to conclude that each Yuhup morpheme corresponds precisely to a syllable. Given that the penultimate

44 This interpretation raises the question why the stem-final consonant in [txdʰ 'ih] is apparently realized as a postnasalized stop rather than a plain nasal. More Yuhup data are required to check whether this is indeed the way such forms are realized.
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A segment of a morpheme which ends in two consonants is predictably /j/, this implies that the maximal syllable template in Yuhup is /CVJc/ (cf. Lopes & Parker 1999:326). There is reason to doubt this view, however. The reason lies in the distribution of long vowels, which occur in stressed syllables only. As Lopes & Parker (1999:331-2) observe:

Primary stress in Yuhup regularly falls on the final vowel/syllable of the word … The physical correlates of primary stress are greater amplitude, higher pitch, and lengthening of the vowel … [S]uffixes are treated as extrametrical since they are normally unstressed.

The forms in (67) illustrate this process of metrical vowel lengthening:

(67)  a. /tju/    [tʻjuː]    ‘coati’
b. /tʃep/    [tʻʃeːp]    ‘clothes’
c. /te-tej/    [te-tej]    ‘species of snake’
d. /jo-joŋ/    [joŋoŋ]    ‘elbow’
e. /tajt/    [tʻaːt]    ‘to kick’

The forms in (67) suggest that metrical vowel lengthening takes place in three contexts: word-finally, as in (67a), before a single word-final consonant, as in (67b-d), and before a cluster of which the initial consonant is /j/, as in (67e). In Lopes & Parker’s model of syllable structure there is no shared property underlying these contexts. However, the contexts in which metrical lengthening occurs receive a unified treatment if we make two assumptions: firstly, that a word-final consonant occupies an onset position that is supported by an empty nucleus, and, secondly, that a preconsonantal glide /j/ occupies the dependent position of the nucleus.

There are a number of arguments that support this analysis. First of all, there seem to be no restrictions on the final consonant of Yuhup morphemes. This would be unexpected if this consonant occupies the coda position, since codas generally license only a subset of the contrasts that are licensed by onsets. Further support comes from the distribution of /j/. The available Yuhup data indicate that /j/ can cooccur with practically any kind of preceding vowel. Based on the forms given by Lopes & Parker, six of the nine Yuhup vowels can cooccur with a following /j/. The remaining three vowels are /i/, /iː/, and /oː/. It is quite possible that the absence of a form containing [oj] is accidental, nor is it unthinkable that the absence of forms with [ij] and [iːj] is due to a cooccurrence restriction on a high unrounded vowel and a following palatal glide. I tentatively conclude, then, that apart from this constraint there are no cooccurrence restrictions on nuclei containing /j/. In this view, the Yuhup syllable template is restricted to CV(V). This analysis of Yuhup syllable structure makes it possible

45 Yuhup has a nine-vowel system /i, u, e, o, æ, a, ɔ, ɔː/.
to provide a unified account of the metrical lengthening process as targeting final stressed open syllables.

In Botma (2001) I propose a similar analysis in order to account for metrical lengthening in Icelandic. Since, in comparison with Yuhup, there is no shortage of Icelandic data, it is useful to briefly consider the Icelandic facts here. The metrical lengthening contexts of Icelandic are given in (68):

(68)  a. bú     [pu:]    ‘estate’
vé     [ve:]    ‘shrine’
b. gulur  [kvlv]   ‘yellow’
slaemur  [slaizmy]  ‘bad’
c. is     [tis]    ‘ice’
lit    [lhot]    ‘colour’
d. sötra  [sotbʰra]  ‘slurp’
     snupra  [snvpʰra]  ‘rebuke’
e. sötr  [sotbʰ]  ‘slurping’
     snupr  [snvpʰ]  ‘rebuking’

Long vowels in Icelandic emerge in a number of contexts. They are found in stressed open syllables, as in (68a,b), before single word-final consonants, as in (68c), and before some word-medial and word-final consonant clusters, as in (68d). Crucial evidence in favour of a relation between vowel length and syllabification of word-final consonants comes from the forms in (68d,e). The clusters in (68e) cooccur with a preceding long vowel. As is shown by forms like sötra, it is precisely these clusters that are syllabified as onsets in word-internal position. An analysis of the final consonants in (68c) and of the clusters in (68e) as onsets of an empty-headed syllable permits a unified account of metrical lengthening as a process that targets initial open syllables. Essentially the same analysis can be advanced with respect to single word-final consonants in Yuhup.

The form [txdʰ-ʰ] is, unfortunately, the only example of a “phonologically active” postnasal that Lopes & Parker provide. However, there is some additional support for the exceptional status of Yuhup postnasals. The relevant evidence concerns the pattern of suffixation displayed by the locative suffix. Consider the forms in (69):

(69)  STEM          STEM+LOC
a. tiw  ‘path’    tiw-wit  ‘on the path’
b.  ámb  ‘village’  ámb-mát  ‘in the village’
c. judn  ‘clothes’  judn-nút  ‘on the clothes’

46 Specifically, before a cluster consisting of any obstructing stop or /s/ and any of /j v t/.
Lopes & Parker take the underlying form of the locative suffix to be /-CVu/, where the first consonant and the vowel are copied from the stem. Of importance is the form in (69c); this form indicates that in case the stem-final consonant is a postnasalized stop, the suffix-initial consonant is realized as a plain nasal. Again, this is unexpected if the nasality in the postnasal is merely a matter of phonetic implementation. Although here, too, data are very scant, one analysis suggests itself: the stem-final sonorant stop and its suffix-initial nasal variant form a single onset constituent which, being dominated by the second nasalized syllable, surfaces as nasalized.

The facts encountered, though fragmentary, initially suggest that Yuhup differs from other Tucano-type harmony systems in that in Yuhup postnasalized stops, which are in complementary distribution with nasals, display phonologically relevant nasalization. However, the nasalizing potential of these stops becomes less of a mystery when we analyze phonologically relevant nasalization as a property of the syllable in which these stops are contained. The advantage of this account is that the nasal portion of postnasalized stops can be regarded as phonologically irrelevant, parallel to what has been proposed for other Tucano-type systems.

### 3.2.5 Discussion

In the preceding sections, I have focused in some detail on two interrelated aspects of Tucano-type nasal harmony systems, i.e. the sonorant target range of nasalization and the syllable-level propagation of nasal harmony. Element-based Dependency accounts for both aspects in a straightforward fashion. As far as supralaryngeal articulations are concerned, nasalization targets are identified by the presence of |L| in their manner component. The transparency of obstruents is captured by formalizing the harmony process in terms of syllable-to-syllable spreading, while the association of dependent |L| within syllables is kept in bounds by the CDR principle. This principle ensures that dependent |L| is associated only to those segment types that are nasalizable. The approach developed in §3.2.2 therefore predicts that there are no Tucano-type languages which display simultaneous nasalization of sonorants and voicing of obstruents.

Additional support for the Element-based Dependency interpretation of Tucano-type nasal harmony comes from an inspection of glottal harmony in certain Salish languages, such as Spokane. As is noted by Carlson (1980), the repetitive morpheme in Spokane is signalled by the insertion of /e/ into a root, with concomitant glottalization of all root-internal sonorants. In Element-based Dependency, the harmonic element in this type of harmony process can be formalized as [ʔ], which is associated to the dependent position of all sonorants within the harmonic domain. A further similarity between the pattern of glottal harmony in Spokane and the pattern of nasal harmony in Tucano-type systems is

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47 See Walker (2002) for an Optimality Theoretic analysis of this pattern.
that in both processes obstruents are transparent. It would seem, therefore, that
syllable-based harmony is not restricted to |L|, but may also involve |?|.48

The identification of the syllable as the level at which nasal harmony is
active may also shed some light on those nasalization processes in which
fricatives are reportedly included in the target range of nasalization. The
database of nasal harmony systems in Walker (1998) contains a mere four
languages for which this has been argued, Applecross Gaelic, Inor, Itsekiri, and
Umbundu. The nasalizable fricatives in Inor, Itsekiri, and Umbundu are all
voiced, which suggests that these segments can be viewed as inherently voiced
fricatives (see also §2.2.4).49 The fact that inherent voicing involves the presence
of |L| in the manner component makes these fricatives potential nasalization
targets.

The Applecross dialect of Scottish Gaelic is the only language in Walker’s
database where voiceless fricatives are described as being part of the target
range of nasalization. Some examples of words containing nasalized fricatives
are given in (70) (cf. Ternes 1973; see also Walker 1998):

(70) /fr̩a’av/ [W̩ăn] ‘root’
/kʰʻispaxk/ [kʰˈispaxk] ‘wasp’
/str̩a’ɪ/ [stʰˈaɪ] ‘string’
/θˈhuʃk/ [tʰˈhuʃk] ‘senseless person, fool’
/θuč/ [θuC] ‘neck’

The status of these nasalized fricatives is not uncontroversial, however. More
recently, Ternes has concurred that acoustic measurements are required to
substantiate that these sounds are indeed nasalized (Elmar Ternes, cited by
Ohala & Ohala 1993). According to Ternes (1973), nasalization in Applecross
Gaelic spreads bidirectionally from a stressed vowel. This leads Van der Hulst
& Smith (1982) to equate the domain of nasalization with that of the foot. Given
this domain, it is not unexpected that the realization of voiceless fricatives in
nasalized feet involves some nasal airflow; but this should not be interpreted to
mean that this nasalization is phonologically relevant. I conclude, then, that the
pattern of nasal harmony displayed in Applecross Gaelic does not undermine the
claim that there is no phonological category of nasalized obstruents.

48 I am unaware of any examples of languages in which |H| could be argued to be a syllable-
level property. It might perhaps be suggested that this is the case in languages which
contrast “ballistic” and “controlled” syllables, such as some Chinantec, Chatino, and
Mazateco languages. Ballistic syllables are characterized by postvocalic aspiration and a
raised pitch.

49 I propose a similar analysis for the nasalized fricative of Waffa in §3.3 below.
3.3 Nasal lenition

One of the basic claims of the Element-based Dependency approach to nasalization is that nasals, in those languages in which nasality is phonologically active, are represented as nasalized sonorant stops. Support for this analysis comes from processes in which nasals trigger nasalization (see §3.1) and from processes in which sonorant stops are themselves nasalized (see §3.2). Additional support comes from processes in which nasals trigger voicing of obstruents, as we will see in §§4.1 and 4.2. In this section, I will adduce another type of evidence for the representation of nasals in terms of sonorant stops. The evidence in question comes from an inspection of the phenomenon of nasal lenition, the cover term for processes in which nasals shed their consonantal properties and surface as nasalized approximants.

The unifying characteristic of lenition processes is that they involve a change towards a more open stricture of articulation. Given that nasals involve a complete closure of the oral cavity (and given that the degree of velic lowering does not play a linguistically significant role), lenition of nasals is expected to produce approximants. Inspection of diachronic processes of nasal lenition suggests that such approximants are, at least initially, nasalized, although subsequent developments have in many cases resulted in either loss or transfer of nasalization.

The hypothesis that nasal lenition produces a nasalized approximant receives a natural interpretation in Element-based Dependency, where it can be expressed in terms of the deletion of \( |_{g} \) from the nasal manner component. This scenario is illustrated in (71):

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

Hence, nasal lenition provides a theory-internal argument for treating nasals—the input to nasal lenition—as nasalized sonorant stops. On the assumption that lenition affects manner, and thus targets head rather than dependent structure, the process involves the stability of dependent \( |_{L} \).

Before turning to some illustrations of nasal lenition, consider first some typological facts. Distinctively nasalized approximants are cross-linguistically rare. For instance, the UPSID database contains only four examples of this segment type:
Distinctively nasalized approximants (cf. Maddieson 1984)

Breton  Ù
Kharia  Ù
Yakut  Ù
Japanese  ÷

It seems reasonable to relate the rarity of this segment type to the fact that nasalized approximants are perceptually not sufficiently distinct from both their oral and their fully nasal congeners. This might be the reason why in many of the languages with underlyingly nasalized approximants, these approximants trigger nasalization of surrounding segments. Such nasalization can be regarded as compensatory, in the sense that the lack of perceptual salience of the nasalized approximant is compensated for by spreading nasalization across a larger domain. We will see some examples of this type of nasalization below.

In her discussion of consonant nasalization, Cohn (1993) distinguishes between three types of nasalized continuants. One type invariably occurs in nasal spans, and is found in for instance Igbo and Umbundu. Cohn argues that in these languages the occurrence of nasalized continuants can be attributed to nasal harmony; as a result, nasalization is not underlingly associated to these continuants, but is a property of a larger domain. In Umbundu, for instance, consonant nasalization is restricted to the final syllables of stems. Cohn observes that nasality can therefore be analyzed as a lexical property of stem-final syllables. Such an analysis is compatible with the Element-based Dependency approach to nasal harmony outlined in §3.2.

The second type of nasalized continuants are nasalized fricatives. Cohn mentions two languages that have been argued to possess such segments, Japanese and Waffa. In Japanese there are good grounds for treating the segment in question as being a derived nasalized approximant; in any case, there is no reason to assume that the sound is anything other than a sonorant. In Japanese, syllable-final nasals are homorganic with a following stop word-internally, as is illustrated by the forms in (73a). This suggests that syllable-final nasals do not license an independent place component. In word-final prepausal context, place-linking to a following stop is impossible, and the nasal surfaces as what may be termed a “nasal glide”. The description of this sound varies. Bloch (1950:102) terms it a “voiced frictionless nasalized mediovelar spirant” (which, as Yip 1991:69 points out, is a contradiction in terms). Maddieson (1984:246) calls it a “nasalized voiced velar approximant”. Yip (1991:69) observes that “prepausally, the nasal is unreleased, either uvular or velar, and oral closure may not be complete”. Finally, Trigo (1988), calls the sound a “nasal glide”; here I will refer to the sound as a “nasalized approximant”. For the sake of simplicity, I

---

50 This would hold a fortiori for nasalized fricatives, a segment type which I claim has no phonological status.
assume in (73b) that the realization of the segment in question varies between [ŋ] and [ŋ̃]:

      mo[nd]ai ‘problem’          ze[ŋ-M] ‘goodness’
      da[ŋg]o ‘dumpling’          a[ŋ-M] ‘idea’

In Botma & Van der Torre (2001), the realization of the nasals in (73b) is argued to involve deletion of the consonantal component. This analysis is essentially equivalent to what I interpret as nasal lenition here: in word-final prepausal position, Japanese nasals lose the manner element [ʔ], which turns them into nasalized approximants:

(74)  \[ C \backslash \\mid L \mid L \mid C \\mid \]

Support for this interpretation comes from the fact that all of the sources that I have consulted transcribe vowels preceding such nasalized approximants as nasalized; this suggests that the lenited nasals have dependent [L], which spreads leftwards to the preceding vowel. In line with the argumentation presented above, we may think of this vowel nasalization as being compensatory.

Waffa is described by Stringer & Holz (1973) as having a nasalized voiced fricative /$/. This segment contrasts with its non-nasalized counterpart and with /m/ and /ⁿ/b/ word-initially and word-medially, as is shown by the forms in (75):

(75)  "búume ‘stamens’  jaⁿᵇáa ‘banana’
      βaini ‘close by’      ţoβo ‘type of yam’
      $atá ‘ground’        jaⁿ$jø ‘reed skirt’
      mátee ‘now’          kámø ‘round taro’

Cohn observes that there is no clear evidence, neither phonetic nor phonological, that /$/is an obstruent. What is clear, however, is that the segment contrasts with /m/, and is therefore in all likelihood not the result of nasal lenition. For this reason, I suggest that /$/ constitutes what was termed an inherently voiced fricative in §2.2.4. Consider the representation in (76):
Since inherently voiced fricatives contain [L] as part of their manner component, they permit dependent nasalization.

The third type of nasalized continuant, nasalized approximants, is argued by Cohn to be the most frequent type. Cohn (1993:331-5) provides the following list of languages with distinctive nasalized approximants; following Cohn, I give the diachronic origin of each of these approximants:

<table>
<thead>
<tr>
<th>Nasalized approximant</th>
<th>Diachronic origin</th>
</tr>
</thead>
<tbody>
<tr>
<td>Paya</td>
<td>Û</td>
</tr>
<tr>
<td>Lele</td>
<td>Û, ñ</td>
</tr>
<tr>
<td>Yakut</td>
<td>n</td>
</tr>
<tr>
<td>Haitian Creole</td>
<td>n&gt;ñ</td>
</tr>
<tr>
<td>Lua</td>
<td>[Û~ñ]</td>
</tr>
<tr>
<td>Ile de Groix Breton</td>
<td>[Û~ñ]</td>
</tr>
</tbody>
</table>

The important observation is that each of the nasalized approximants in (77) appears to be the result of nasal lenition. This suggests that in those cases where nasalization is an underlying property of the approximant (and not the result of a nasalization process), the approximant is derived from a historical nasal. In the remainder of this section, I consider the status of a nasalized approximants in a number of languages not discussed by Cohn. We will see that in these languages, too, the available evidence suggests that these approximants are the result of synchronic or diachronic nasal lenition.

Consider first of all some examples of nasal lenition that can be observed in a process of morphologically conditioned consonant gradation, as found in a number of Mande and West Atlantic languages. The examples in (78) show that gradation involves the alternation of a labial stop, either oral or nasal, with nasalized or non-nasalized /w/:
On the assumption that the oral stops are sonorants, the change from the basic grade to the derived grade can be expressed in terms of the deletion of head [ʰ]. In the case of an oral stop, this yields an oral approximant, as in (79a); in the case of a nasal, this yields a nasalized approximant, as in (79b):

(79) a. Voiced stop lenition

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

/b/ \rightarrow [w]

b. Nasal lenition

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

/m/ \rightarrow [\dot{U}]

This interpretation of nasal lenition therefore supports a representation of nasals in terms of nasalized sonorant stops.

Nasal lenition can also be observed in the diachronic development of a number of North American languages. For instance, Taylor (1963:125) notes that Proto-Caddoan *n has developed into */l* in Wichita. Similarly, in the Uto-Aztecan language Shoshone /m/ lenite to [\dot{U}] in intervocalic and final contexts (cf. Miller 1996:696). According to Miller, these lenited nasals are in some cases realized as devoiced; there seems to be no clear conditioning factor for this realization.

(80) Underlying:

\[
\begin{array}{c}
m \\
\dot{U} \\
\end{array}
\]

Lenited:

\[
\begin{array}{c}
\dot{U} \\
\end{array}
\]

In those contexts where nasal lenition takes place, stops and affricates are spirantized. Spirantized stops and affricates are realized as either voiced or
voiceless fricatives; here, too, a clear conditioning factor for this variation appears to be lacking:

(81) Underlying: $p\ t\ \tilde{\theta}\ k\ kw$
Lenited: $\phi\ \beta\ \varsigma\ \theta\ \delta\ x\ y\ x^w\ y^w$

In feature-based theories, nasal lenition and stop spirantization can be given a unified account in terms of a change from [-continuant] to [+continuant]. If we assume that Shoshone stops have a manner component consisting of both $?$ and $[H]$, then a unified account is also available in Element-based Dependency in terms of the deletion of $[?]$. This is illustrated in (82):

(82) a. **Nasal lenition**

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

b. **Stop spirantization**

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

Lenition of intervocalic $*m$ to $\tilde{U}$ can also be observed in the Bishop dialect of Monachi, another Uto-Aztecan language. As is noted by Norval Smith (p.c.), the lenited variant of $/m/$ is $[w]$ in the North Fork dialect of Monachi:

(83) **Bishop dialect**

mija$\tilde{U}ai$ mijawai ‘will go’

ta$\tilde{U}ijawai$ tawijawai ‘our future going’

In diachronic terms, this suggests that lenition occurred in both Monachi dialects, with a subsequent process of denasalization occurring in the North Fork dialect. The North Folk development is represented in (84):

(84) \[
\begin{array}{c|c|c}
\text{O} & \text{O} \\
\text{L} & \text{L} > & \text{L} \\
\text{?} & > & \text{U} \\
\text{U} & & \\
\end{array}
\]

$/m/>$/\tilde{U}$/ > $/w/$

As I observed in §3.1 in relation to Lakkia, the denasalization of nasalized approximants is unsurprising, given the markedness of this segment type.
Nasal lenition with subsequent denasalization has also occurred in the development from Sanskrit to Hindi and Panjabi, where intervocalic *m lenited to /Ʉ/ or /ǚ/ (see Arun 1961). In Hindi, the nasalization was subsequently transferred to the preceding vowel, while in Panjabi the nasalized consonants underwent vocalization and, word-internally, denasalization. Some examples are given in (85):

(85) Sanskrit | Hindi | Panjabi
--- | --- | ---
/kəmala/ | kāval | kəl (< kaul) ‘lotus’
😊/ʃəmala/ | sāvla | səla (< saula) ‘dark’
/gəmɑma/ | gəw | grɑː (< grɑːu) ‘village’
/nɑmɑ/ | nəw | nəː (< nəu) ‘name’

I propose that the lenited nasal is phonologically a nasalized labial approximant, i.e. a segment which consists of head [L] and dependent [L]. While it is possible that this segment was realized as [Ʉ], it is not unlikely that other realizations included [ʃ], [ʃ], and perhaps [Ʉ].

As can be observed in (85), the final stage of the development from Sanskrit to Hindi involved the transfer of nasality from the nasalized approximant to the vowel. This process can be represented as in (86):

(86) N O
    /L L L\ A U

I assume that transfer of nasalization from an onset approximant to a nuclear vowel leads to a less marked structure. Observe once more that we can attribute this to the relative markedness of [L] in consonantal positions.

Denasalization and transfer are also observed in the history of the Goidelic languages (the various stages of Irish, Scottish Gaelic, and Manx). Goidelic exhibits the following synchronic lenition patterns (see e.g. Anderson 1975):51

| (87) m, m̱ → v, v̱ | N, Ṉ → n, ṉ |
| b, ḇ → v, v̱ | L, Ḻ → l, ḻ |
| p, p̱ → f, f̱ | R, Ṟ → r, ṟ |

51 Scottish Gaelic has only the non-palatalized labial nasal. The full set of coronal sonorants is not found in all dialects, at least not phonetically. In line with the tradition in Goidelic studies, the non-lenited sonorants are represented by capital letters; phonetically, these sonorants are distinguished from lenited sonorants in terms of their place of articulation and their geminate-like nature.
Note in (87) that the labial and coronal nasals display asymmetric behaviour. Whereas /N/ lenites to its lax counterpart [n] and retains its nasality, /m/ lenites to non-nasal /v/. The latter development becomes more natural when we take into account that /v/ derives from an earlier nasalized labial approximant. This approximant was obsolescent in certain dialects at the beginning of the 20th century. Consider for instance Sommerfelt's (1922:153) description of the dialect of Torr County Donegal:

The nasalization [of /tʃ/] is maintained in these cases with extreme fidelity by old people and it has seldom been troubled by analogy ... [For younger speakers] w, v and r are often nasalized, but as a general rule the nasalization has been displaced to the preceding or following vowel.

Some examples of this “displacement” are given in (88):

(88)  /dɪːʃ/  [dɪːʃ ~ dɪːvəs]  ‘disrespect’
      /kiːnəχ/  [kiːnəχ ~ kɪvənəχ]  ‘mindful’

Like Hindi, Goidelic thus displays transfer of nasalization from an approximant to a neighbouring vowel. This is corroborated by Oftedal (1956:42), who, in his discussion of nasalized approximants in Scottish Gaelic, observes that

[p]honetically, the v may still be nasal [tʰæːʃ], but the phonemically relevant nasality has been shifted from the consonant to the vowel.

While the facts considered make the development from /m/ to /v/ more natural, the question remains why /m/ and /n/ display asymmetric behaviour in Goidelic lenition. I offer a tentative solution to this asymmetry in §7.2.

There is also evidence to suggest that in some languages nasalized approximants are underlingly present even though they are never realized phonetically. For instance, Bright (1957:39-40) posits /tʃ/ in Karok on the basis of the alternations in (89a):

(89)  a. ʔấm-tih  ‘to be eating’     ʔấv-at  ‘ate’
      vû́n-tih  ‘to be flowing’     vû́r-unih  ‘to flow downhill’
    b.  vaθ̃v-tih  ‘to be fighting’   vaθ̃v  ‘to fight’

The forms in (89) suggest that Karok, at some point in its history, underwent a process of intervocalic nasal lenition which changed *VmV into [VːV] and *VnV into [VʰV]. These nasalized approximants subsequently disappeared from the surface level, but are still present underlingly. The fact that lenited /m/ is transcribed by Bright as /tʃ/ could be interpreted to mean that the segment has obstruent status. This is unlikely, however. The form in (89b) shows that not all
instances of /ν/ alternate with /m/. This suggests that the two types of /ν/ differ in their underlying representation. I suggest that the alternating /ν/ is a labial approximant. Support for this interpretation comes from the observation that Karok lacks a labial(-velar) approximant /ν/ or /w/; hence, the alternating /ν/ could be argued to fill this position in the consonant inventory.

It should further be noted that there is independent evidence for the presence of dependent |L| in Karok nasals. As Bright observes, /r/ surfaces as [n] in the context of preceding /m/ or /n/. This is shown by the forms in (90), where /-ri/ is the locative suffix:

(90)  a. /ɪkx'àram-ri/ [ɪkx'àramri] ‘in a dark place’
    b. /ɪθ'àram-ri/ [ɪθ'àramri] ‘among strangers’

This suggests that /r/ functions as a sonorant stop, and surfaces as nasalized after nasals as the result of spreading of dependent [L]. The alternation in (90a) can therefore be represented as follows:

(91)

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>L</td>
<td>L</td>
</tr>
<tr>
<td>?</td>
<td>?</td>
</tr>
<tr>
<td>U</td>
<td>I</td>
</tr>
</tbody>
</table>

/m-ri/ → [mn]

Summarizing, the Monachi, Hindi, Goidelic, and Karok facts illustrate the markedness of nasalized approximants. Unlike in Monachi, however, nasalization in Hindi, Goidelic, and Karok is not lost altogether, but is instead transferred to a neighbouring vowel, as in Hindi and some Goidelic languages, or remains underlyingly present, as in Karok.

As was observed at the beginning of this section, the relative instability of nasalized approximants is likely to be due to the relative lack of perceptual salience of nasalization in these segments. It is therefore not surprising that the nasalization of these approximants is transferred to a position in which it is perceptually more salient. The examples of this strategy that we have seen so far all involved transfer to a neighbouring vowel. Another, more drastic, strategy to ensure the perceptual salience of nasalization is to spread it across a larger domain. To conclude this section, I consider two languages in which nasal lenition sets, or has set, in motion a process of nasal harmony.

---

52 Bright (1957:8) notes that apparently all instances of what he transcribes as /ν/ are realized as unrounded bilabial spirants, i.e. a sound approximating [v].
Consider first a synchronic process of nasal lenition that is exhibited by Inor, a Semitic language of Ethiopia. Nasal lenition in Inor forms part of a more general process of lenition that affects stem-initial consonants in the context of a preceding prefix. Some examples involving nasals are given in (92); here the prefix that is involved is the imperfective marker /ji-/ (cf. Chamora & Hetzron 2000:16):

(92) \[\begin{array}{ll}
\text{PERF} & \text{IMPERF} \\
\hline
a. nádar & ḫ-rock' \\
b. mósáar & ḫ-s@ir 'resemble' \\
c. nátor & ḫ-s@ir 'bore a hole' \\
d. mákar & ḫ-s@ir 'come out' \\
e. domád & ji-domád 'put together' \\
f. fánd & ji-fánd 'cut in half' \\
\end{array}\]

(92) illustrates that prefixation of /ji-/ triggers lenition of /m/ to [ŋ]. The lenited nasals trigger bidirectional nasalization of vowels, approximants, liquids, and /n/. The form in (92b) shows that a voiceless fricative blocks rightward nasalization. The forms in (92c,d) indicate that nasalization is also arrested by voiceless stops, although these, unlike voiceless fricatives, surface as voiced. Finally, the forms in (92e,f) show that nasal lenition targets stem-initial nasals, but not stem-internal nasals.

Another illustration of nasal harmony that is triggered by nasal lenition can be found in Urhobo, a Kwa language of Nigeria. Consider in (93) a number of cognates from Urhobo and the closely related Ora (cf. Kelly 1969):

(93) \[\begin{array}{ll}
\text{Ora} & \text{Urhobo} \\
\hline
\text{Ome} & e^\text{e}s\text{ê} 'tongue' \\
\text{Omi} & ô{i}\text{ji} 'corpse' \\
\text{Uhumu} & u\text{u}s\text{û} 'tail' \\
\text{Emjami} & emjàs\text{ê} 'sickness' \\
\text{Ihumu} & uhûs\text{û} 'medicine' \\
\text{Ipo} & ônô 'honeybee' \\
\text{Eami} & ë^\text{e}s\text{ê} 'animal' \\
\text{Omehe} & ôs\text{ê}ô 'sleep' \\
\end{array}\]

These correspondences suggest that lenition of /m/ has resulted in a nasalized bilabial approximant in Urhobo. The lenition context appears to be intervocalic,

---

53 Chamora & Hetzron transcribe lenited /m/ as [ŋ]; their description indicates that the sound is phonetically nasalized [β].

54 It is also possible to say that /ř/ is included in the set of nasalizable segments, since there is nothing which prohibits the combination of glottal closure and velic lowering. I return to the relation between glottal stop and nasalization in §6.1.
as is suggested by forms like /emjami/, and targets /m/ only, as is shown by the form /ipo/. Nasal lenition triggers bidirectional harmony, which targets vowels and /ɪ/. Observe that it appears to leave /ɪ/ unaffected, which might be taken to suggest that this segment functions as an obstruent phonologically.

Interestingly, in both Inor and Urhobo lenited nasals trigger nasal harmony while non-lenited nasals do not. It is reasonable to relate this difference to the relative markedness of nasalization in both segment types. Dependent [L] as a property of an approximant is relatively marked, and triggers spreading of [L] across a larger domain. Dependent [L] as a property of a sonorant stop, on the other hand, is less marked, and does not trigger spreading of [L]. Thus, it appears to be the case that in both Inor and Urhobo the loss of perceptual salience of nasality that is caused by nasal lenition is compensated for by nasal harmony. This scenario might offer a plausible historical explanation for at least some types of nasal harmony processes.

The interpretation of nasal lenition that is proposed here provides a possible answer to a general problem that confronts a phonological characterization of nasality. According to traditional phonetics, consonants are classified into four manner types: stops, fricatives, approximants, and nasals. A complication here is that stops, fricatives, and approximants are typical manner classes, in the sense that they are distinguished from each other in terms of the degree of oral stricture. This cannot be said of nasals, since nasals, like stops, are characterized by complete oral closure of the oral cavity. An interpretation of nasals as being a separate manner type has unfortunate phonological repercussions. To illustrate this, consider a gradual process of consonant lenition in which the manner type of a stop is changed in the direction of a more open stricture. In (94), I give the changes that led from Pre-Old English āgan to Modern (RP) English own (cf. Ewen & Van der Hulst 2001:13).

(94) Pre-OE OE eME ME eMdE MdE

*āgan > āyan > āwān > ān > ōn > ōn

The gradual vocalization of *g that is observed in (94) involves a step-by-step increase in sonority. This raises the question why in the development from *g to /w/ there is no intermediate stage at which the outcome is a nasal. The reason is, presumably, that lenition takes account of the oral stricture properties of consonants, and as far as oral stricture properties are concerned, nasals do not form a separate class. A theory of segment structure must provide a principled explanation of why nasals are absent in lenition trajectories. However, this is not a straightforward affair if, as the traditional view has it, nasals are treated on a par with segment types that differ in terms of their oral stricture properties.

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55 In (94), OE is short for Old English, eME for early Middle English, ME for Middle English, eMdE for early Modern English, and MdE for Modern English.
The Element-based Dependency approach to nasality offers a potential explanation for the absence of nasals in lenition trajectories. In those languages in which nasality is phonologically active, nasal consonants consist of a combination of sonorant stop manner and dependent $|L|$. Hence, changes affecting manner—the key characteristic of lenition—can never have a nasal consonant as its output.

3.4 Summary

In this chapter, I have examined the interpretation of dependent $|L|$ as nasalization. One of the fundamental claims of Element-based Dependency is that dependent $|L|$ is interpreted as nasalization only in case $|L|$ is associated to a sonorant or laryngeal manner component. In some languages nasalization is a property of a subsyllabic constituents, such as an onset or a nucleus. In other languages nasalization may surface as a property of larger domains, such as syllables and words; I have argued that in some of these languages, in particular those that display sonorant nasalization and obstruent transparency, nasalization is best analyzed as an underlying property of the syllable. On the assumption that such syllables are $|L|$-headed, dependent $|L|$ surfaces as a property of all tautosyllabic $|L|$-headed segments while leaving other segment types unaffected. The distribution of dependent $|L|$ within syllables is regulated by the (revised) CDR. This principle ensures that syllable-level $|L|$ associates to nasalizible, i.e. $|L|$-headed—manner types only. The relevance of the syllable in nasal harmony is supported by a number of different manifestations of nasal harmony, such as those observed in Southern Barasano, Gbe, Kpelle, Zoque, and Yuhup.

A more specific focus of this chapter was the distinction between bare and nasalized sonorant stops. The latter segment type represents a phonologically active nasal. This interpretation of nasals is supported by processes of nasal effacement, by alternations between oral and nasal sonorants in nasal harmony processes, and by processes of nasal lenition.