A UNIFIED APPROACH TO NASALITY AND VOICING

Kuniya Nasukawa

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For Michiko
Abstract

This thesis proposes a merger of voicing and nasality under a single phonological feature. One main focus of this approach is a paradoxical phenomenon involving a nasal-voice affinity in Yamato Japanese. In postnasal voicing assimilation, nasals appear to be specified for voice (e.g. \( \hat{\text{si}} \text{n} + \text{ta} \rightarrow \hat{\text{s}i} \text{n} \text{da} \) 'died'). On the other hand, in Lyman's Law, which allows only a single voiced obstruent in a particular domain, nasals behave as if they have no voice feature (e.g. \( \hat{\text{s}i} \text{n} \text{do-i} \) 'tired', \( ^*\hat{\text{z}i} \text{n} \text{do-i} \)).

In order to resolve this paradox, I propose that nasal and voice are phonetic manifestations of the same phonological category. The different phonetic interpretations can be accommodated within a geometry-based element theory which incorporates the notion of a complement tier (Backley 1998, Backley & Takahashi 1998). When the complement of the nasal-voice element is licensed, the realisation is one of voicing. An unlicensed complement tier results in nasality. By adopting this analysis, postnasal voicing assimilation can be treated as the extension of the nasal-voice element across both positions of an NC cluster, where only the element in the second position licenses its complement tier. In addition, the transparency of nasal stops to Lyman's Law is made to follow from the element failing to license its complement tier.

The validity of the proposed representations finds further support in the analysis of spontaneous prenasalisation and spontaneous velar nasalisation found in several dialects of Japanese. In accordance with the principle of Licensing Inheritance (Harris 1994, 1997), both processes are regarded as lenition of the complement tier in a prosodically weak position. This avoids the need to rely on arbitrary notions such as lexically floating nasality or nasal insertion rules which have been proposed elsewhere in the literature.

Furthermore, in conjunction with the predictions of phonological licensing (Kaye 1990; Harris 1994, 1997), the representations successfully accommodate recurrent assimilatory phenomena such as nasal harmony and voicing assimilation.
I wish to express my gratitude to the following people who have contributed their time and concern and have assisted me in the writing of this work.

My greatest intellectual debt is to my thesis supervisor, John Harris. Without his professional guidance and unending support, little progress in this research would have been achieved. To him I also owe a debt of gratitude for his encouragement, patience and the time he spent going over this project in painstaking detail.

This work also owes much to Phillip Backley for reading the entire text in its original form and providing helpful suggestions. During my years of study, he has always provided his valuable time for discussing any aspect of phonology with me. My gratitude also goes to him for encouragement, friendship and enjoyment.

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# Abbreviations and symbols

## 1 Abbreviations

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>alt.</td>
<td>alternative</td>
</tr>
<tr>
<td>ATR</td>
<td>advanced tongue root</td>
</tr>
<tr>
<td>C</td>
<td>oral consonant</td>
</tr>
<tr>
<td>comp</td>
<td>complement tier</td>
</tr>
<tr>
<td>CTJ</td>
<td>conservative Tokyo Japanese</td>
</tr>
<tr>
<td>DP</td>
<td>Dependency Phonology</td>
</tr>
<tr>
<td>DR</td>
<td>derivational rule</td>
</tr>
<tr>
<td>ET</td>
<td>element theory</td>
</tr>
<tr>
<td>F</td>
<td>formant</td>
</tr>
<tr>
<td>Ft</td>
<td>foot</td>
</tr>
<tr>
<td>gen.</td>
<td>genitive</td>
</tr>
<tr>
<td>GLP</td>
<td>government/licensing-based approach</td>
</tr>
<tr>
<td>indic.</td>
<td>indicative</td>
</tr>
<tr>
<td>ISP</td>
<td>Inherent Structure Preservation</td>
</tr>
<tr>
<td>loc.</td>
<td>locative</td>
</tr>
<tr>
<td>N/Nas/nas</td>
<td>nasal consonant</td>
</tr>
<tr>
<td>NC</td>
<td>nasal-obstruent</td>
</tr>
<tr>
<td>nom.</td>
<td>nominative</td>
</tr>
<tr>
<td>Non-nuc</td>
<td>non-nucleus</td>
</tr>
<tr>
<td>NTJ</td>
<td>Northern Tohoku Japanese</td>
</tr>
<tr>
<td>Nuc</td>
<td>nucleus</td>
</tr>
<tr>
<td>Obs</td>
<td>obstruent</td>
</tr>
<tr>
<td>OCP</td>
<td>OBLIGATORY CONTOUR PRINCIPLE</td>
</tr>
<tr>
<td>ODT</td>
<td>Optimality Domain Theory</td>
</tr>
</tbody>
</table>
Abbreviations and symbols

Ons    onset
OT     Optimality Theory
PEx    PRINCIPLE OF EXTENSION
pl.    plural
R      root
Res    resonance element
sg.    singular
SP     soft palate, Structure Preservation
SPE    The Sound Pattern of English (Chomsky & Halle 1968)
SPN    spontaneous prenasalisation
STJ    Southern Tohoku Japanese
SV     spontaneous voicing
SVN    spontaneous velar nasalisation
subj.  subjunctive
UPSID  UCLA Phonological Segment Inventory Database
UT     Underspecification Theory
V      vowel
VOT    voice onset time
WSA    WIDE SCOPE ALIGNMENT

2 Symbols

α variable feature coefficient ! fatal violation
σ syllable ♠ optimal candidate
x prosodic/skeletal position ⊘ phonetically uninterpreted nucleus
# word boundary ☐ empty nucleus
* ungrammatical, violation ⊹ impossible structure
1 Nasal-voice affinities

1.1 Introduction

Phonological studies reveal that nasals and voiced obstruents show some robust correlations. A typical instance of such a relation is postnasal voicing assimilation, found in many languages such as Quichua, Zoque and Yamato Japanese, where an obstruent preceded by a nasal is obligatorily voiced. In such systems, nasal sounds are thought to contain a voice feature and trigger an assimilatory process on to the following obstruent. Among them, however, Yamato Japanese presents a challenge to this assumption, since this system seems to recognize two types of nasals, differentiated according to phonological context: in postnasal voicing assimilation, nasals appear to be specified for voice; on the other hand, in Rendaku (which I shall describe in §1.2.1.2), nasals behave as if they have no voice feature.

Another example of the relation between nasal and voice is found in processes involving alternations between voiced obstruents and their nasal reflexes — such as fully-nasalised and prenasalised voiced cognates. This kind of process is often observed in intervocalic contexts. For example, voiced obstruent prenasalisation is witnessed in Northern Tohoku Japanese, languages of the Reef Island-Santa Cruz family, those in the Pacific area and several Bantu languages; in the same context, conservative Tokyo Japanese exhibits voiced-velar-obstruent nasalisation in intervocalic positions. Furthermore, in the verbal inflexion of Yamato Japanese, the stem-final $b$ in a verbal stem such as $tob$ 'to fly' is realised as a nasal that is homorganic with the suffix-initial obstruent of a suffix such as $-te$ (gerundive). In these cases, only truly voiced obstruents are subject to the processes associated with nasality. Another aspect to be noted is that we do not seem to find any apparent triggering property for prenasalisation and nasalisation because, on the face of it, nasality for the purposes of this process is not
lexically present in the target (voiced obstruents, are normally considered to be specified for voicing but not nasality) or the given environment.

In response to the nasal-voice paradox in Yamato Japanese, Itô & Mester (1986) propose a rule-ordered analysis based on representationally-oriented Underspecification Theory (UT: Kiparsky 1982, Archangeli 1984, 1988, Pulleyblank 1986), while Itô, Mester & Padgett (1995) discard the rule-based multistratal approach and utilise a theory of universal constraint interaction following Optimality Theory (OT: Prince & Smolensky 1993, McCarthy & Prince 1993). As for voiced-velar-obstruent nasalisation and voiced obstruent prenasalisation, they are generally analysed by a nasality insertion rule at a certain level of derivation (Kanai 1982 et passim). Voiced-velar-obstruent nasalisation is analysed in Itô & Mester (1997) within the context of OT, but, to my knowledge, no OT-based analysis of voiced obstruent prenasalisation has yet been provided in the literature.

In a break from previous approaches, I will present a phonological principles-and-parameters analysis which does not call for arbitrary language-specific rules and multistratal levels of representation. Within such a framework, this research sets two goals: (i) to incorporate directly into phonological representation the relatedness of nasality and voicing; and (ii) to provide a representation which can encode not only the interactive aspects of the two properties, but also the distinct facets of behaviour which the two properties present.

To begin, I shall review the relevant data and discuss the correlation between nasal and voice in §1.2. In the final part of this chapter (§1.3) I shall provide an overview of this whole work.
Chapter 1. Nasal-voice affinities

1.2 The relation between nasal and voice

1.2.1 Nasal-voice paradox

1.2.1.1 Voice in nasals

A nasal is sometimes — but significantly, not always — identified as a segment specified for voice. The choice is determined by the relevant phonological phenomena and the system of a given language. In this subsection, I shall review these two different types of behaviour, beginning with a consideration of nasal-obstruent clusters. In many languages, a nasal-obstruent cluster shows categorial voicing assimilation. For example, Campa (Arawak), spoken in southern Mexico (Dirks 1953, Herbert 1986), has a distributional restriction whereby an onset obstruent following a coda nasal must share voice with the nasal, as shown in (1).

(1) Campa

<table>
<thead>
<tr>
<th>Word</th>
<th>Meaning</th>
<th>Voiced</th>
</tr>
</thead>
<tbody>
<tr>
<td>kombiróši</td>
<td>'palm leaf'</td>
<td>*kompiróši</td>
</tr>
<tr>
<td>nišindo</td>
<td>'my daughter'</td>
<td>*nišindo</td>
</tr>
<tr>
<td>kirínga</td>
<td>'downstream'</td>
<td>*kirínga</td>
</tr>
</tbody>
</table>

In the same way, a nasal-obstruent cluster must be voiced in Yamato Japanese.

(2) Yamato Japanese

<table>
<thead>
<tr>
<th>Word</th>
<th>Meaning</th>
<th>Voiced</th>
</tr>
</thead>
<tbody>
<tr>
<td>šombori</td>
<td>'discouraged'</td>
<td>*šompori</td>
</tr>
<tr>
<td>šindo</td>
<td>'tired'</td>
<td>*šintoi</td>
</tr>
<tr>
<td>kaggae</td>
<td>'thought'</td>
<td>*kagkae</td>
</tr>
<tr>
<td>kaghari</td>
<td>'done to a golden brown'</td>
<td>*kopkari</td>
</tr>
</tbody>
</table>
Chapter 1. Nasal-voice affinities

This phenomenon is found not only within lexical items, but also across a morpheme boundary. For example, verbal suffixes such as -te, -ta, -tari, and -tara, when attached to a stem ending with a nasal, show voicing assimilation, as illustrated in (3).

(3)  (a)  $\tilde{\text{s}}\text{n} + \text{te}$ (gerundive)  $\rightarrow$  $\tilde{\text{s}}\text{inde}$  'die' (gerundive)
     $\text{kam} + \text{te}$  $\rightarrow$  $\text{kande}$  'chew' (gerundive)

(b)  $\tilde{\text{s}}\text{n} + \text{ta}$ (past indic.)  $\rightarrow$  $\tilde{\text{s}}\text{inda}$  'died'
     $\text{kam} + \text{ta}$  $\rightarrow$  $\text{kanda}$  'chewed'

(c)  $\tilde{\text{s}}\text{n} + \text{tari}$ (alt.)  $\rightarrow$  $\tilde{\text{s}}\text{indari}$  'die' (alternative)
     $\text{kam} + \text{tari}$  $\rightarrow$  $\text{kandari}$  'chew' (alternative)

(d)  $\tilde{\text{s}}\text{n} + \text{tara}$ (subj.)  $\rightarrow$  $\tilde{\text{s}}\text{indara}$  'die' (subjunctive)
     $\text{kam} + \text{tara}$  $\rightarrow$  $\text{kandara}$  'chew' (subjunctive)

Inflexion involving verbal stems in (3) is subject to systematic voicing if the stem-final consonant is nasal.

This kind of dynamic voicing alternation is widely attested in the world's languages. Some further examples are given below.¹

¹The languages in (4a) and (4b) are American Indian languages: Quichua in (4a) is mainly spoken in Peru, Bolivia and Ecuador (Gleason 1955, Orr 1962, Rice 1992); Zoque in (4b) is spoken in southern Mexico (Wonderly 1946, 1951; Gleason 1955; Padgett 1994). Kpelle (Niger-Congo) in (4c) is spoken in Liberia (Welmers 1973, Sagey 1986, Padgett 1994).

It may be noted that, in the case of Zoque, we observe the deletion — rather than the assimilation — of a nasal which precedes sonorants and fricatives. For example:

\[
\begin{align*}
N + \text{faha} & \rightarrow \text{faha} \quad 'my hat' \\
N + \text{ask} & \rightarrow \text{ask} \quad 'my beans' \\
N + \text{lawus} & \rightarrow \text{lawus} \quad 'my nail'
\end{align*}
\]
Chapter 1. Nasal-voice affinities

(4) (a) Quichua

wakin-da 'others-ta/da (object suffix)'
kan-ju 'you-ču/ju (question suffix)'
kam-ba 'you-pa/ba (genitive suffix)'
hatum-bi 'big one-pilbi (locative suffix)'

(b) Zoque

min-pa → mimba 'he comes'
min-ta → mindama 'compel (pl.)'
pan-čaki → pαnįjaki 'figure of a man'
pan-ksi → pαngasiti 'on a man'
N-pama → mbama 'my clothing'
N-tatah → ndatah 'my father'
N-čoŋgoya → njoŋgoya 'my rabbit'

(c) Kpelle

N + polu → mbolu 'my back'
N + tia → ndia 'my taboo'
N + koo → ygo 'my foot'
N + fela → mvela 'my wages'
N + sua → njua 'my nose'

All the above examples indicate that nasals act as a trigger for the assimilation of voicing to the immediately following obstruent. This has led many phonologists to posit the presence of a voicing feature in the internal structure of nasals, which spreads, whenever possible, onto the following obstruents.
In contrast to the voice specification in nasals in the context of postnasal voicing assimilation, Yamato Japanese also displays a complementary type of nasal which is apparently unspecified for voice. The existence of this kind of nasal is confirmed by the fact that nasals are invisible for Lyman’s Law, which places an upper limit of one voiced obstruent on any lexical form (i.e. any single free morpheme). Some examples are given below.

(5) (a)  
<table>
<thead>
<tr>
<th>Item</th>
<th>Meaning</th>
<th>Form(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>sabi</td>
<td>'rust'</td>
<td>*zabi</td>
</tr>
<tr>
<td>sabaki</td>
<td>'judgement'</td>
<td>*zabaki, *sabagi, *zabagi</td>
</tr>
<tr>
<td>tsubasa</td>
<td>'wing'</td>
<td>*dzubasa, *tsubaza, *dzubaza</td>
</tr>
<tr>
<td>sazī</td>
<td>'spoon'</td>
<td>*zazī</td>
</tr>
<tr>
<td>kazari</td>
<td>'decoration'</td>
<td>*gazari</td>
</tr>
<tr>
<td>toge</td>
<td>'thorn'</td>
<td>*doge</td>
</tr>
<tr>
<td>tokage</td>
<td>'lizard'</td>
<td>*dokage, *togage, *dogage</td>
</tr>
</tbody>
</table>

(b)  
<table>
<thead>
<tr>
<th>Item</th>
<th>Meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td>beni</td>
<td>'rouge'</td>
</tr>
<tr>
<td>nizī</td>
<td>'rainbow'</td>
</tr>
<tr>
<td>tsubame</td>
<td>'swallow'</td>
</tr>
<tr>
<td>nagisa</td>
<td>'beach, shore'</td>
</tr>
<tr>
<td>mikado</td>
<td>'emperor, emperor’s palace'</td>
</tr>
<tr>
<td>nezumi</td>
<td>'rat, mouse'</td>
</tr>
<tr>
<td>nokogiri</td>
<td>'saw'</td>
</tr>
</tbody>
</table>

The items in (5a) show that only a single voiced obstruent is allowed to appear in a morpheme. From the distinction of nasal consonants in (5b), we observe that these sounds are not regarded as voiced segments; they are invisible to the constraint.
Lyman's Law also functions in compounding, where the independent process of Rendaku is observed. Under Rendaku, an initial voiceless consonant of the second member of a compound is realised as its voiced counterpart, as shown in (6).

(6)  
- oo + taiko → oodaiko ‘big drum’
- onna + kokoro → onnagokoro ‘woman’s heart’
- take + sao → takezao ‘bamboo pole’

However, Lyman’s Law blocks Rendaku if the second member of a compound includes a voiced obstruent in its lexical form, as seen in (7).

(7)  
- maru + hadaka → maruhadaka (*marubadaka) ‘completely naked’
- kami + kaze → kamikaze (*kamigaze) ‘divine wind’
- onna + kotoba → onnakotoba (*onnagotoba) ‘feminine speech’

In Rendaku, voicing in a nasal consonant is also invisible for the purposes of Lyman’s Law. Therefore, the first consonant of a compound’s second member which possesses a nasal becomes voiced, as shown in (8).

(8)  
- yaki + sakana → yakizakana ‘grilled fish’
- ori + kami → origami ‘paper folding’
- kami + tana → kamidana ‘a shelf for the family gods’

If Rendaku is to be accounted for with a voicing feature, then we must assume that a nasal does not contain any such unit.

From the observations above, it is apparent that we encounter a paradox, such that Japanese must recognize two different specifications for nasals under two different sets of circumstances (voicing assimilation and Lyman’s Law): nasals are specified for voice in postnasal voicing but unspecified for voice in Rendaku.
1.2.2 The appearance of nasality in voiced obstruents

1.2.2.1 Spontaneous prenasalisation

Further correlations between nasal and voice are observed in some dialects of Japanese. Northern Tohoku Japanese — spoken in the northern part of the Tohoku area of Mainland Japan — exhibits alternations between truly voiced obstruents and prenasalised voiced plosives with no lexical indication of nasality in either the target position or its environment. This type of phenomenon — let us call it spontaneous prenasalisation — is also witnessed in some other dialects of Japanese and some Western Indonesian languages and several Bantu languages. Examples are given below:

(9) Northern Tohoku Japanese

<table>
<thead>
<tr>
<th>Vowel</th>
<th>+ Obstruent</th>
<th>→ Prenasalised Obstruent</th>
</tr>
</thead>
<tbody>
<tr>
<td>( \text{ci} )</td>
<td>( \text{daruma} )</td>
<td>( \text{ci}^\text{n}\text{daruma} )</td>
</tr>
<tr>
<td>‘fire’</td>
<td>‘Dharma’</td>
<td>‘be covered with flames’</td>
</tr>
<tr>
<td>( \text{tsuu} )</td>
<td>( \text{gakko} )</td>
<td>( \text{tsu}^\text{n}\text{gakko} )</td>
</tr>
<tr>
<td>‘middle’</td>
<td>‘school’</td>
<td>‘junior high school’</td>
</tr>
<tr>
<td>( \text{o} )</td>
<td>( \text{baasan} )</td>
<td>( \text{o}^\text{n}\text{baasan} )</td>
</tr>
<tr>
<td>(polite prefix)</td>
<td>‘grandmother’</td>
<td>‘grandmother (polite form)’</td>
</tr>
<tr>
<td>( \text{niyu} )</td>
<td>( \text{ja}^\text{a}\text{ga} )</td>
<td>( \text{niyu}^\text{a}\text{ga} )</td>
</tr>
<tr>
<td>‘meet’</td>
<td>‘potato’</td>
<td>(name of a dish)</td>
</tr>
</tbody>
</table>

The examples in (9) illustrate the process of compounding in Northern Tohoku Japanese. Under this process, if the first segment of the second member of a compound is a voiced obstruent, then such a segment is interpreted as its prenasalised reflex. In this case, 

---

2 The status of the process varies from language to language: it is optional in Nea (Wurm 1972), some dialects of Malay (Hendon 1966) and many Melanesian languages (Ray 1926); but in Nambakaengo (Wurm 1972) and the northern Tohoku dialect of Japanese, it is obligatory.

3 Some exceptions exist. See Inoue (1967) and Iitoyo (1998) for discussion.
nasality does not exist lexically in either the target of the process or its environment; however, the target must be in an intervocalic environment.

In fact, this phenomenon is found not only in morpho-syntactic concatenation, but also in the lexical distribution of prenasalised plosives.\textsuperscript{4} Compare the Tokyo dialect forms in the left column of (10) with the corresponding northern Tohoku dialect forms to the right.

<table>
<thead>
<tr>
<th>(10)</th>
<th>Tokyo Japanese</th>
<th>Northern Tohoku Japanese</th>
</tr>
</thead>
<tbody>
<tr>
<td>(a)</td>
<td>saga</td>
<td>‘destiny’</td>
</tr>
<tr>
<td></td>
<td>kagi</td>
<td>‘key’</td>
</tr>
<tr>
<td></td>
<td>igaiga</td>
<td>‘thorny’</td>
</tr>
<tr>
<td>(b)</td>
<td>hada</td>
<td>‘skin’</td>
</tr>
<tr>
<td></td>
<td>kuda</td>
<td>‘pipe, tube’</td>
</tr>
<tr>
<td></td>
<td>ido</td>
<td>‘well’</td>
</tr>
<tr>
<td>(c)</td>
<td>kabu</td>
<td>‘turnip’</td>
</tr>
<tr>
<td></td>
<td>kiba</td>
<td>‘tusks’</td>
</tr>
<tr>
<td></td>
<td>sabi</td>
<td>‘rust’</td>
</tr>
</tbody>
</table>

\textsuperscript{4}It has been argued that prenasalised plosives in Northern Tohoku Japanese are derived from the prenasalisation of truly voiced oral plosives, in terms of both diachronic and synchronic perspectives (Inoue 1967, Ashworth 1976-77, Kanai 1982).
As seen in (10), all intervocalic plosives may exhibit prenasalisation.\(^5\)

In comparison, voiced oral plosives appearing in other positions\(^6\) neither nor voiceless cognates of plosives in intervocalic position undergo the process. This is illustrated below.

(11) Tokyo Japanese | Northern Tohoku Japanese
--- | ---
(a) gakkoo 'school' | gakkoo *gakko
daruma 'Dharma' | daruma *daruma
baku 'tapir' | bayu *baku
kaŋgeki 'impression' | kaŋgeyi *kaŋgeki
kandai 'generosity' | kandee *kan"dai
kambeN 'pardon' | kambeN *kam"beN
(b) kaki 'persimmon' | kayi *ka"gi *ka"ki
saka 'slope' | saya *sa"ga *sa"ka
hata 'flag' | hata *ha"da *ha"ta
kata 'shoulder' | kata *ka"da *ka"ta

\(^5\)This dialect exhibits other alternations involving alveolar: voiced alveolar obstruents are prenasalised and interpreted as prenasalised affricates before high vowels:
midzu 'water' \(\rightarrow\) mi"dzu
kuji 'lottery' \(\rightarrow\) ku"ji (regional)
Not only in cases involving prenasalisation but also in all other cases, alveolar obstruents become affricates when they are followed by high vowels:
tssumiki 'bricks' \(\rightarrow\) tsumiki
katsuo 'bonito' \(\rightarrow\) kadzuo
This kind of alternation can be analysed as local place assimilation, but it is beyond the scope of the present discussion to pursue its mechanism here.

\(^6\)The other possible positions where voiced plosives appear in Japanese are word/foot-initial and post-nasal sites (the C of NC). For a detailed discussion, see Vance (1987).
As shown in (11a), word-initial position and the C position of NC clusters do not allow voiced oral plosives to be prenasalised. In addition, the class of segments subject to prenasalisation is restricted to voiced plosives. The comparison in (11b) shows that intervocalic voiceless plosives never become prenasalised. Instead, they are potential targets for vocalisation.

1.2.2.2 Spontaneous velar nasalisation

A similar process has been reported for standard Japanese. In the same context as spontaneous prenasalisation, the conservative Tokyo and some northern Kanto dialects of Japanese exhibit spontaneous velar nasalisation, in which a voiced velar obstruent is fully nasalised. This is exemplified below.

---

7 In the consonantal inventory of modern Japanese (including the dialect in question), the distribution of the voiceless bilabial plosive is lexically restricted: it can appear only as a full geminate (e.g. kappa 'water imp') or as the second part of a NC cluster (sampo 'stroll'). Therefore, it is never found in the intervocalic environment in (11b).

8 The intervocalic reflexes of voiceless plosives in the Tohoku dialect in general have been regarded as voiced counterparts — g and d (Inoue 1967, Kanai 1982). However, my own research shows that the reflexes are not g and d, but the voiced velar approximant y and voiced alveolar tap respectively.
Chapter 1. Nasal-voice affinities

(12)  

<table>
<thead>
<tr>
<th>tsuu</th>
<th>+</th>
<th>gakko</th>
<th>→</th>
<th>tsuugakko</th>
</tr>
</thead>
<tbody>
<tr>
<td>'middle'</td>
<td>‘school’</td>
<td>‘junior high school’</td>
<td></td>
<td></td>
</tr>
<tr>
<td>tei</td>
<td>+</td>
<td>gi</td>
<td>→</td>
<td>tei gi</td>
</tr>
<tr>
<td>'to fix'</td>
<td>‘faithfulness’</td>
<td>‘definition’</td>
<td></td>
<td></td>
</tr>
<tr>
<td>kai</td>
<td>+</td>
<td>gun</td>
<td>→</td>
<td>kai gun</td>
</tr>
<tr>
<td>'sea'</td>
<td>‘army’</td>
<td>‘navy’</td>
<td></td>
<td></td>
</tr>
<tr>
<td>su</td>
<td>+</td>
<td>gei</td>
<td>→</td>
<td>su gei</td>
</tr>
<tr>
<td>'hand'</td>
<td>‘art’</td>
<td>‘handicraft’</td>
<td></td>
<td></td>
</tr>
<tr>
<td>kai</td>
<td>+</td>
<td>goo</td>
<td>→</td>
<td>kai goo</td>
</tr>
<tr>
<td>'to meet’</td>
<td>‘to assemble’</td>
<td>‘meeting’</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Under the morpho-syntactic concatenation in (12), if the first segment of the second member of a compound is a voiced velar obstruent, then such a segment is fully interpreted as its nasalised reflex. Similarly, this phenomenon does not require any lexical nasality in the given environment; the only essential thing for the process to apply successfully is that the target must be in an intervocalic context.⁹

This phenomenon is also found both in morpho-syntactic concatenation and in the lexical distribution of velar nasals, as seen in (13):

---

⁹Other examples below show that the process is triggered if a voiced velar plosive is sandwiched between a placeless nasal v and a vowel.

<table>
<thead>
<tr>
<th>man</th>
<th>‘full’</th>
<th>+</th>
<th>getsu ‘moon’</th>
<th>→</th>
<th>mangetsu ‘full moon’</th>
</tr>
</thead>
<tbody>
<tr>
<td>ken</td>
<td>‘prefecture’</td>
<td>+</td>
<td>gai ‘outside’</td>
<td>→</td>
<td>kegai ‘outside of prefecture’</td>
</tr>
</tbody>
</table>

In this case, spontaneous velar nasalisation is considered to be triggered by the intervocalic context, since v is syllabic/moraic and behaves like a vowel (Nasukawa 1998a).
Chapter 1. Nasal-voice affinities

<table>
<thead>
<tr>
<th>(13)</th>
<th>Non-conservative Tokyo Japanese</th>
<th>Conservative Tokyo Japanese</th>
</tr>
</thead>
<tbody>
<tr>
<td>saga</td>
<td>'destiny'</td>
<td>saŋa</td>
</tr>
<tr>
<td>kagi</td>
<td>'key'</td>
<td>kaŋi</td>
</tr>
<tr>
<td>igaiɡa</td>
<td>'thorny'</td>
<td>iŋaiŋa</td>
</tr>
<tr>
<td>kigu</td>
<td>'tool'</td>
<td>kigu</td>
</tr>
<tr>
<td>kage</td>
<td>'shadow'</td>
<td>kage</td>
</tr>
<tr>
<td>kago</td>
<td>'basket'</td>
<td>kaŋo</td>
</tr>
</tbody>
</table>

Compared with the non-conservative Tokyo Japanese forms in the left column, the conservative Tokyo Japanese forms to the right never exhibit a voiced velar plosive intervocally. Instead, the corresponding sounds are all nasal in such an environment.

In contrast, as mentioned in the discussion of spontaneous prenasalisation in §1.2.2.1, a voiced velar obstruent can occur only in word-initial position and the C position of NC clusters.

<table>
<thead>
<tr>
<th>(14)</th>
<th>Conservative Tokyo Japanese</th>
</tr>
</thead>
<tbody>
<tr>
<td>gaki</td>
<td>'urchin, bully'              *ŋaki</td>
</tr>
<tr>
<td>gin</td>
<td>'silver'                     *ŋiŋ</td>
</tr>
<tr>
<td>gun</td>
<td>'army'                       *ŋuŋ</td>
</tr>
<tr>
<td>geri</td>
<td>'diarrhoea'                  *ŋeri</td>
</tr>
<tr>
<td>gomi</td>
<td>'dust, trash'                *ŋomi</td>
</tr>
<tr>
<td>kanyeki</td>
<td>'impression'              *kanyeki</td>
</tr>
<tr>
<td>kanyeae</td>
<td>'thought'                 *kanyeae</td>
</tr>
</tbody>
</table>

This highlights the complementary status of ŋ and g in the given environments.
1.2.2.3 The appearance of nasality in verb-stem-final $b$

One more correlation between nasal and voice is observed in the verbal inflexion of Yamato Japanese, where the stem-final $b$ in a verbal stem such as tobi ‘to fly’ is interpreted as a nasal that is homorganic with the suffix-initial obstruent of a suffix such as -te (gerundive).^10

(15) tobi + te (gerundive) → tonde ‘fly’ (gerundive)
yobi + te (gerundive) → yonde ‘call’ (gerundive)
yorokobi + te (gerundive) → yorokonde ‘be glad, be pleased’ (gerundive)

This process involves not only alternation between nasality and voicing in the stem-final position, but also voicing assimilation to the suffix-initial obstruent and place assimilation to the stem-final $b$. In this process, as with spontaneous prenasalisation and spontaneous velar nasalisation, we cannot identify the apparent any local trigger for nasalisation.

In all three phenomena discussed here, nasality appears in voiced obstruents but not any other type of segment. In addition, the source of nasality is not encoded in the given context. The challenge is to account for this type of process without introducing any arbitrary mechanism such as a nasality insertion rule or floating nasality.

1.3 An overview of this work

As an introduction, this chapter has taken up the central issue of this study — the strong correlation between nasality and voicing, dealing with some data pertinent to the following discussion.

^10 This phenomenon has been analysed within many different theoretical approaches (McCawley 1968, Ashworth 1976-77, Poser 1986, Davis & Tsujimura 1991, Yoshida 1991). A detailed discussion will be given in §4.6.
The chapters to come are divided into two parts. Part I — Chapter 2 and 3 — concerns some fundamental issues associated with voice and nasality. In order to resolve the paradoxical behaviour of voice-nasal specification, Part II — Chapter 4, 5 and 6 — provides a melodic model which representationally encodes interactive aspects of the two properties and, using it, attempts to analyse both the correlations and the differences. The discussion is structured as follows.

In Chapter 2, I shall consider some typological aspects of nasality, voicing and prenasality. Special emphasis will be on universals and the dynamic behaviour of these properties.

Chapter 3 will discuss the nature of the phonological categories contributing to nasality, voicing and the structure of prenasalised segments in the context of element theory (Harris 1990, 1994; Harris & Lindsey 1995). I will consider how these properties contribute to the internal architecture of particular sounds, and how their behaviour reflects the typology argued for in the previous chapter.

Chapter 4 will focus on the apparently paradoxical behaviour of nasals in Yamato Japanese, where voice is active for nasals in postnasal voicing assimilation (e.g. ʂin + ta → ʂinda ‘died’) but inactive with respect to Lyman’s Law, which allows only a single voiced obstruent in a particular domain (e.g. ŝindo-i ‘tired’, *zindo-i). In order to explain this paradox, I propose that the two features conventionally used to denote nasality and voicing are identical, and that the difference is determined by the presence of a complement tier (for an outline of the geometry-based element theory, see Backley 1998, Backley & Takahashi 1998): the nasal-voice element licensing its complement tier contributes voicing, while its counterpart, without a licensed complement tier, manifests itself as nasality. By adopting this analysis, postnasal voicing assimilation can be treated as the extension of the nasal-voice element across both positions of an NC cluster, where only the element in the second position licenses its complement tier. In addition, the transparency of nasal stops to Lyman’s Law follows from the element failing to license its complement tier.

Chapter 5 will reinforce the validity of the proposed structures of nasality and voicing by analysing spontaneous prenasalisation and spontaneous velar nasalisation.
Chapter 1. Nasal-voice affinities

found in several dialects of Japanese. Within the proposed structures, unlike previous analyses, we can identify as a lexical property the unit which is the source of the processes: a nasal-voice element. It is lexically present in the targets of the processes — truly voiced obstruents, in which voicing is interpreted by a complex expression containing a nasal-voice element and its complement tier. Coupled with the principle of Licensing Inheritance (Harris 1994, 1997), both processes involving nasality are regarded as lenition of the complement tier in intervocalic sites. There is thus no need to introduce arbitrary notions such as lexically floating nasality or rules like nasal insertion (Kanai 1982).

Chapter 6 will be devoted to analysing how the proposed structures for nasality and voicing can incorporate variation in the extent of assimilatory processes: nasality exhibits long-distance assimilation, while voicing assimilation is restricted to a short-distance domain. In conjunction with certain universal and parametric constraints, these different characteristics are all explained by the nature of the proposed structures.

Finally, Chapter 7 brings together the results of my study and explores some further consequences of the proposed model.
2 Typological aspects of nasality and voicing

2.1 Introduction

Before proceeding any further with the issue of the correlation between nasality and voicing, we need to consider some typological aspects of these properties. Principally, I focus on universals and the behaviour of the properties in question. These aspects provide us with a useful insight into the analyses presented in the following chapters.

§2.2 attempts to illustrate the universal properties of nasals and their phonologically dynamic alternations. §2.3 surveys the typological distribution and phonological behaviour of voicing, with special emphasis on its definition. §2.4 presents evidence of a typological relationship between nasality and voicing. §2.5 investigates the typology of prenasalisation, which exhibits the characteristics of both nasality and voicing. As a summary, §2.6 addresses the issue of implicational universals involving nasality, voicing and prenasalisation.

2.2 Nasality

2.2.1 The distribution of nasal-oral contrasts across different languages

cases, prove somewhat lacking in terms of descriptive precision for the purposes of phonological analysis. To solve this problem, Cohn (1993b) summarises all major works investigating nasal phenomena and provides a large number of accessible references to various studies of nasals in natural languages.

According to the literature on the typology of nasality (Trubetzkoy 1939; Hockett 1955; Ferguson 1963; Greenberg 1966, 1978; Ladefoged 1971; Crothers 1978; Maddieson 1984 and Cohn 1993b), this property is contrastive both in vowels and consonants. This fact entails the existence of four types of speech sound — 'oral vowels', 'nasal vowels', 'oral consonants' and 'nasal consonants' — in natural languages. Focusing on 'nasal vowels' and 'nasal consonants', and classifying natural languages in terms of the presence/absence of these two types, languages in the world may be divided into the following four systems:

(1) Typology of nasal systems

<table>
<thead>
<tr>
<th>Type</th>
<th>Nasal consonant</th>
<th>Nasal vowel</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>Quileute</td>
<td></td>
</tr>
<tr>
<td>II</td>
<td>Coast Salishan</td>
<td>✔</td>
</tr>
<tr>
<td>III</td>
<td>Most languages</td>
<td>✔</td>
</tr>
<tr>
<td>IV</td>
<td>Yoruba</td>
<td>✔</td>
</tr>
</tbody>
</table>

The data presented by Hocket, Nartey and Maddieson tell us that type I is fairly rare and only a small number of languages (eight in Nartey’s sample: e.g. Quileute, Rotokas and Apinayé) belong to this system. However, every language in type I contains voiced oral consonants which, historically, used to have nasal cognates. Some dialect systems like Rotokas display nasal characteristics in voiced oral plosives, which are generally regarded as dialectal surface variants (Herbert 1986). Languages corresponding to type II are equally rare (Coast Salishan: Hockett 1955, Cohn 1993b). In comparison, the majority of the world's languages belong to type III, exhibiting nasal consonants but no nasal vowels. Type IV is uncommon, although observable in Yoruba and Nupe, which
show both nasal consonants and nasal vowels. With this consideration, we may derive the following implicational statement in terms of universal preference:

(2) The existence of nasal vowels typically entails the existence of nasal consonants.

Other typological surveys found in the literature explore the frequency of nasal occurrence in lexical items in a given language system (Ferguson 1963, Lass 1984), and the markedness consideration with respect to the place of articulation in nasal consonants and constraints on nasal vowel production (Hockett 1955, Ferguson 1963, Narrey 1979, Lass 1984).

The former investigation states that the most preferred nasal consonant is an alveolar nasal \( n \). Regarding languages displaying two nasals, most of them are likely to have \( n \) and, in most cases, a bilabial nasal \( m \) (Ferguson 1963: 57). In contrast to this observation, Lass (1984: 156) reports that a velar nasal \( y \) also often occurs as the second preferred candidate in place of \( m \). Regarding nasal vowels, however, it is difficult to clarify the markedness status of their occurrence. At least one thing to note is that no nasal tense vowels have been witnessed in languages exhibiting an ATR contrast.

2.2.2 Phonological phenomena in nasality

Phonological phenomena involving contrastive nasality vary across different languages. One of the most widespread types of behaviour shown by nasality is assimilation. Cross-linguistically, assimilatory processes are divided into two types: short-distance (adjacent or local) assimilation and long-distance (prosodic) assimilation (nasal harmony). In the former type, a segment is nasalised by continuous nasalisation from its adjacent segment.

---

1 This is due to the fact that, in most of the languages possessing only a single nasal consonant, such a nasal is \( n \).

2 The fact that coronal/alveolar sounds are preferred throughout the languages of the world is not restricted to nasals. The same preference can be seen in obstruents (Nartey 1979, Lass 1984).
In the latter type, in contrast, nasalisation spreads across several or all segments in a given span. In terms of the presence/absence of these two types of nasalisation, natural languages may be divided into four systems, as follows:

(3) Typology of contrastive nasality assimilation

<table>
<thead>
<tr>
<th>Type</th>
<th>Short-distance</th>
<th>Long-distance</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td></td>
<td></td>
</tr>
<tr>
<td>II</td>
<td>✔</td>
<td></td>
</tr>
<tr>
<td>III</td>
<td></td>
<td>✔</td>
</tr>
<tr>
<td>IV</td>
<td>✔</td>
<td>✔</td>
</tr>
</tbody>
</table>

Some languages of the world do not exhibit phonologically contrastive nasalisation (Type I: e.g. English, Japanese). Others present contrastive nasalisation, and are divided into three types: Type II, III and IV. As shown in (3), languages belonging to Type II exhibit short-distance nasalisation (Hyman 1975). A typical example is found in diachronic sound change. It is widely accepted that nasal vowels derive from earlier states of oral vowels in proximity with nasal consonants (Hyman 1972: 171, cf. Ferguson 1963, Greenberg 1966, Schane 1968). For instance, a vowel before a nasal consonant preceding a word boundary or an oral consonant becomes nasalised at a stage before the nasal consonant is deleted. Chinese (Chen 1973), Indo-Aryan languages (Ohala & Ohala 1993), Romance languages (Hajek 1997) and many African languages (Hyman 1972) exhibit this historical development. (4) gives examples from the Romance languages Cremonese (Hajek 1997: 38) and Riminese (Hajek 1997, 140: cf. Schürr 1919), in which the following notational conventions apply: V = vowel, N = nasal consonant, C = oral consonant and # = word boundary.
Chapter 2. Typological aspects of nasality and voicing

(4) Diachronic short-distance (local) nasalisation

\[ VN\#(or \ C) \rightarrow \overline{V}N\#(or \ C) \]

e.g.

(a) Cremonese

\[ ka:n \rightarrow k\ddot{a}:n \]

(b) Riminese

\[ (pane \rightarrow) \hspace{1em} pa:n \rightarrow p\ddot{e}:n \]

According to Bibeau (1975) and Tranel (1981), in an underlying synchronic analysis of nasal vowels, such segments are considered to be derived by a similar trajectory in (4). French provides a typical example.

(5) Synchronic short-distance (local) nasalisation:

\[ VN\#(or \ C) \rightarrow \overline{V}N\#(or \ C) \rightarrow \overline{V}\#(or \ C) \]

French

\[ bon \rightarrow b\ddot{o}n \rightarrow b\ddot{a} \]

On the other hand, in the case of Type III exhibiting only long-distance nasalisation, the domain of assimilation is larger than that of the process in (5). Examples are provided from Southern Barasano (Smith & Smith 1971, Piggott 1992) and Guarani (Rivas 1974, van der Hulst & Smith 1982).
(6) Southern Barasano

<table>
<thead>
<tr>
<th>Nasal words</th>
<th>Oral words</th>
</tr>
</thead>
<tbody>
<tr>
<td>mānō</td>
<td>*diro</td>
</tr>
<tr>
<td>mīnī</td>
<td>wa*ba/waba</td>
</tr>
<tr>
<td>ṇāmōṭōṇī</td>
<td>ho*goro/hogoro</td>
</tr>
<tr>
<td>ēōnō</td>
<td>ta*bott/taboti</td>
</tr>
<tr>
<td>māhāγī</td>
<td><em>ba</em>go/*bago</td>
</tr>
<tr>
<td>māsā</td>
<td>yuka</td>
</tr>
<tr>
<td>pūkā</td>
<td>wati</td>
</tr>
<tr>
<td>wāfī</td>
<td>wesika</td>
</tr>
<tr>
<td>kāmōkā</td>
<td>hikoro</td>
</tr>
</tbody>
</table>

(7) Guaraní

<table>
<thead>
<tr>
<th>Nasal words</th>
<th>Oral words</th>
</tr>
</thead>
<tbody>
<tr>
<td>mēnā</td>
<td>&quot;ba?e</td>
</tr>
<tr>
<td>mā?ē</td>
<td>haihu</td>
</tr>
<tr>
<td>nūpā</td>
<td>puru?a</td>
</tr>
<tr>
<td>pūrī</td>
<td>piri</td>
</tr>
<tr>
<td>tūpā</td>
<td>tupa</td>
</tr>
</tbody>
</table>

These languages exhibit nasal harmony in words specified for nasal: all segments are nasal in nasal words. However, as seen in (6a) and (7a), languages exhibiting this type of phenomenon display an additional transparency effect in obstruents. As in (6b) and (7b), on the other hand, words unspecified for nasal never exhibit such an assimilatory effect.
process. This phenomenon is observed mainly in Amerindian languages of South America, including members of the Tupi and Tucanoan families.

Languages belonging to Type IV (e.g. a number of Malayo-Polynesian languages, Warao, Capanahua and Applecross Gaelic) exhibit both short-distance and long-distance nasalisation. Examples are given from Sundanese (Robins 1957; Cohn 1989, 1993a), Malay (Durand 1987, Onn 1980), Urhobo (Dunstan 1969, Sagey 1986) and Applecross Gaelic (Ternes 1973, van der Hulst & Smith 1982), as follows:

(8) (a) Sundanese

(i) \( \eta\acute{a}yak \) ‘sift (active)’

\( \eta\acute{a}laran \) ‘to forbid’

\( \eta\acute{a}s\acute{o}r \) ‘displace (active)’

\( \eta\acute{a}kan \) ‘to eat’

(ii) \( \eta\acute{a}\ddot{i}\acute{a}n \) ‘wet’

\( \eta\acute{a}\ddot{n}\ddot{\text{o}}m \) ‘to drink’

(iii) \( \eta\acute{a}\ddot{\text{u}}\ddot{\text{r}} \) ‘seek (active)’

\( \eta\acute{a}\ddot{\text{u}}\ddot{\text{r}} \) ‘say (active)’

(b) Malay

(i) \( \eta\acute{a}kan \) ‘to eat’

\( \eta\acute{a}laran \) ‘to forbid’

(ii) \( \eta\acute{a}\ddot{\text{y}}\ddot{\text{a}}n \) ‘stalk (palm)’

\( \eta\acute{a}\ddot{n}\ddot{\text{o}}m \) ‘to drink’

(iii) \( p\eta\acute{\text{g}}\acute{\text{a}}\ddot{\text{w}}\ddot{\text{a}}\ddot{\text{s}}\ddot{\text{a}}n \) ‘supervision’

\( m\acute{\text{e}}\ddot{\text{w}}\ddot{\text{a}}\ddot{\text{h}} \) ‘to be luxurious’

\(^{3}\)Tucano (West & Welch 1967) and Tatuyo (Gomez-Imbert 1978, Steriade 1993) are also often identified in the literature as systems describing the same type of nasal harmony.
Chapter 2. Typological aspects of nasality and voicing

(c) Urhobo (R and v are fricatives)

(i) evû (< evun) ‘belly’
(ii) ùýòûyì (< uyoBin) ‘head’
   ëwë (< ewen) ‘breath’
(iii) iRîrì (< iRirin) ‘nine’
   oRwë (< oRwen) ‘hunter’

(d) Applecross Gaelic

(i) tàv ‘ox, stag (pl.)’
   kʰ5āt ‘to look’
(ii) šènè vār ‘grandmother’
   ōrīànn ‘roots’
(iii) kʰ5iðpaxk ‘wasp’
   šìnà n’dan ‘thread’

All these languages display short-distance nasalisation and complete long-distance nasalisation as in (8ai), (8bi), (8ci) and (8di), and (8aii), (8bii), (8cii) and (8dii), respectively. Languages showing this type of nasalisation also exhibit nasalisation which spreads beyond an adjacent segment stopping short of whole-word assimilation. This is illustrated in (8aiii), (8biii), (8ciii) and (8diii) in each language.

These different kinds of nasalisation (each (i), (ii) and (iii) in (8)) result from opacity effects. According to Piggott (1992) and Piggott & van der Hulst (1997), in this type of language, nasalisation starts in a single direction (rightwards or leftwards) from a lexically assigned nasal segment up to a segment which blocks the process (opaque segments are bold in (8)). Depending on the position occupied by an opaque segment, the domain for nasalisation varies as in (8): nasalisation can end at an adjacent segment (8ai, 8bi and 8ci) or in the middle of a given word (8aii, 8bii and 8cii), or may apply throughout a word (8aii, 8bii and 8cii).
The type of opaque segment also varies from language to language. For instance, in Sundanese (8a), nasalisation spreads rightwards and glides, liquids, fricatives and plosives block the process. In Malay (8b) and Applecross Gaelic (8d), the directionality of the process is identical to Sundanese, but the kinds of opaque segment are different: liquids, fricatives and plosives behave as opaque segments in Malay; in Applecross Gaelic, only plosives block nasalisation. In contrast to these three kinds of languages, in Urhobo (8c), nasalisation spreads leftwards and opaque segments are fricatives and plosives. Piggott (1992) summaries these four different types of nasal opacity as in the following tableau.

(9)  Typology of languages belonging to Type IV

<table>
<thead>
<tr>
<th>Type</th>
<th>Glides</th>
<th>Liquids</th>
<th>Fricatives</th>
<th>Plosives</th>
</tr>
</thead>
<tbody>
<tr>
<td>IVA Sundanese</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>IVB Malay</td>
<td></td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>IVC Urhobo</td>
<td></td>
<td></td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>IVD Applecross Gaelic</td>
<td></td>
<td></td>
<td></td>
<td>✓</td>
</tr>
</tbody>
</table>

In contrast to Type IV, languages belonging to Type III exhibit only a single pattern of transparency: as already seen in (6) and (7), fricatives and plosives are transparent to nasal harmony, but other kinds of segments always undergo nasalisation.

(10)  Transparent segments in Type III

<table>
<thead>
<tr>
<th>Type</th>
<th>Glides</th>
<th>Liquids</th>
<th>Fricatives</th>
<th>Plosives</th>
</tr>
</thead>
<tbody>
<tr>
<td>III Southern Barasano</td>
<td></td>
<td></td>
<td>✓</td>
<td>✓</td>
</tr>
</tbody>
</table>

Observing transparency (9) and opacity (10) in nasalisation provides the fact that the less sonorant a segment, the more likely it is resist nasalisation. Piggott & van der Hulst (1997), Schourup (1972) and Cohn (1993b) depict this tendency as follows:
Chapter 2. Typological aspects of nasality and voicing

(11) The nasalisability hierarchy

Most likely to nasalise

| Vowels | Glides | Liquids | Fricatives | Plosives |

Least likely to nasalise

Another phenomenon relevant to nasal harmony is encountered in some Type IV languages, in which obstruents stopping long-distance nasalisation themselves appear as prenasalised. Examples are given from Terena⁴ and Guarani,⁵ as follows:

(12) (a) Terena (Tereno)

First person singular

<table>
<thead>
<tr>
<th>Word</th>
<th>Translation</th>
</tr>
</thead>
<tbody>
<tr>
<td>ayo</td>
<td>'my brother'</td>
</tr>
<tr>
<td>dwá^gu</td>
<td>'my house'</td>
</tr>
<tr>
<td>'biho</td>
<td>'I went'</td>
</tr>
<tr>
<td>ãa?ta^so</td>
<td>'I desire'</td>
</tr>
<tr>
<td>d^opiko</td>
<td>'I chopped'</td>
</tr>
</tbody>
</table>

Third person forms

<table>
<thead>
<tr>
<th>Word</th>
<th>Translation</th>
</tr>
</thead>
<tbody>
<tr>
<td>ayo</td>
<td>'his brother'</td>
</tr>
<tr>
<td>owoku</td>
<td>'his house'</td>
</tr>
<tr>
<td>pího</td>
<td>'he went'</td>
</tr>
<tr>
<td>ahya^ašo</td>
<td>'he desires'</td>
</tr>
<tr>
<td>otópiko</td>
<td>'he chopped'</td>
</tr>
</tbody>
</table>

(b) Guarani

<table>
<thead>
<tr>
<th>Word</th>
<th>Translation</th>
</tr>
</thead>
<tbody>
<tr>
<td>kūmá'da</td>
<td>'bean'</td>
</tr>
<tr>
<td>hé'du</td>
<td>'to hear'</td>
</tr>
<tr>
<td>nô-řô-hé'du-i</td>
<td>'I don't hear you'</td>
</tr>
</tbody>
</table>

As seen in (12a), in Terena, nasals appear in first person forms, but not in third person forms. If the first person forms possess an obstruent, nasals never appear to the right of this. Accordingly, Terena's nasal harmony is triggered at the left edge and extended up to the first obstruent. Then, the obstruent itself appears as prenasalised. In the case of

---

⁴Terena (Bendor-Samuel 1960: 350-1, Cole & Kissberth 1994b: 6) is spoken in southwestern Mato Grosso, Brazil and classified as Arawakan in the Andean Equatorial family.

⁵Guarani (Rivas 1974: 135-7, van der Hulst & Smith 1982: 322) belongs to the Tupi family, which is widely spoken in South America.
Guarani, as seen in (12b), the same mechanism is observed: prenasalized segments appear in obstruents which disharmonise sequential nasalisation. This type of prenasalisation as a by-product of nasal opacity is also found in languages such as Gbeya (Samarin 1966, Steriade 1993) and the Kolokuma dialect of Ijo (Williamson 1965). In §2.5 below, I consider some typological aspects of prenasality, since prenasalised sounds are strongly relevant, not only to the behaviour of nasality, but also to that of voicing.

2.3 'Voicing'

2.3.1 Introduction

Here I investigate some typological aspects of ‘voicing’. For the purposes of a universal description, following Harris (1994, 1998) I will use the term ‘long-lead’ (to refer to true ‘voicing’), together with the term ‘short-lag’ (to refer to plain) and ‘long lag’ (to refer to voiceless aspirated). This is due to the inadequacy in the use of the term ‘voicing’, which is discussed in the following subsection.

2.3.2 Laryngeal-source contrasts and VOT categories

Coupled with ‘voicelessness’, the term ‘voicing’ has been utilised to describe one state of the laryngeal-source contrasts observed in languages such as English and French. From a universal point of view, however, it has been acknowledged that the labels used for the description of laryngeal-source distinctions are inadequate for describing the different phonetic manifestations of the contrasts across languages (Harris 1998, also cf. Abramson & Lisker 1970, Ladefoged 1971). For example, the English plosives conventionally labelled ‘voiced’ are phonetically identical to so-called ‘voiceless’ plosives in French. Both the English ‘voiced’ and the French ‘voiceless’ plosives are articulated without vocal-cord vibration and are described phonetically as voiceless
unaspirated. On the other hand, members of the so-called ‘voiceless’ plosive series in English are not only articulated without vocal-cord vibration, but are also aspirated, while the ‘voiced’ plosive sounds in French involve vocal-cord vibration in their production.

As discussed in Harris (1998), these phonetic manifestations of laryngeal-source contrasts in plosives are typically reflected in voice onset time (VOT: the interval between the release of stop closure and the onset of vocal-fold vibration; Abramson & Lisker 1970, Ladefoged 1971) in word-initial prevocalic position. Truly voiced plosives, as found in French, are produced if there exists a relatively long lead time between the onset of voicing and stop release. In voiceless aspirated plosives (fortis), as found in English, there is a relatively long time lag between closure release and the onset of voicing. In voiceless unaspirated plosives (lenis or neutral), as commonly found not only in English and French but also in all other languages of the world, there exists either a relatively short or zero time lag between closure release and the onset of voicing.

In order to avoid using the cover terms ‘voiced’ and ‘voiceless’, Harris adopts VOT distinctions for describing laryngeal-source contrasts in obstruents, and utilises the labels long lead for truly voiced obstruents, long lag for aspirated voiceless obstruents, and short lag for plain obstruents.

2.3.3 The distribution of VOT contrasts across different languages

VOT contrasts vary from language to language. According to Harris (1994, 1998), with respect to VOT categories, languages are classified into at least four groups (there exists a fifth type which will be discussed in the next chapter). These are illustrated in the following tableau taken from Harris (1998):
Chapter 2. Typological aspects of nasality and voicing

(13) Partial typology of VOT systems

<table>
<thead>
<tr>
<th>Type</th>
<th>Short lag</th>
<th>Long lead</th>
<th>Long lag</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>Finnish</td>
<td></td>
<td></td>
</tr>
<tr>
<td>II</td>
<td>French</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td>III</td>
<td>English</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td>IV</td>
<td>Thai</td>
<td>✔</td>
<td>✔</td>
</tr>
</tbody>
</table>

All languages contain short-lag plosives. Some languages exhibit only short-lag plosives. Other languages also possess either long-lead (e.g. French, Dutch and Standard Japanese) or long-lag plosives (e.g. English, Swedish and Standard German⁶). Some carry both long-lead and long-lag plosives (Thai, Korean and Sesotho). This distributional fact implies the following statement with respect to universals.

(14) The existence of either long-lead or long-lag plosives implies the existence of short-lag plosives.

In fact, all languages (Campa, Yamato Japanese, Quichua, Zoque, Kpelle and Kikuyu) exhibiting a correlation between nasality and 'voicing' (discussed in the previous chapter) belong to Type II: there are short-lag and long-lead plosives but no long-lag plosives. In the following discussion, I focus on the phonological regularities governing true voicing — long-lead properties.

⁶Although Standard German belongs to Type III, the system appears to display final obstruent devoicing which is, as we will see in §2.3.4, a process typically found in the Type II languages.
Chapter 2. Typological aspects of nasality and voicing

2.3.4 Phonological phenomena in long-lead plosives

All languages belonging to Type II allow long-lead plosives to be contrastive in word-initial and foot-initial position. With respect to word-final consonants, these languages are divided into two groups: languages permitting word-final obstruents (Dutch, Luo, German) and languages excluding any word-final obstruent (Zulu, Telugu, Japanese). In the majority of languages belonging to the latter group, long-lead plosives are contrastive not only in word-initial position but also in all other positions. In comparison, some members of the former type (Dutch, Polish, Russian, Northern German, Turkish and Wolof) lose laryngeal-source contrasts in word-final position: by the effect of obstruent devoicing, long-lead obstruents are excluded word-finally. This effect is also found in foot-final consonant position. The following examples are taken from Dutch (Kenstowicz 1994: 495), Polish (Bethin 1992: 162-3) and Northern German (Kenstowicz 1994: 494).

(15) (a) **Dutch**

  hui[s]  ‘house’
  hui[z]en  ‘houses’
  hui[s][ammer  ‘living room’

(b) **Polish**

  wó[r]  ‘water’ (gen pl.)
  wó[d]a  ‘water’ (nom sg.)
  brzy[z]a  ‘ugly’

(c) **Northern German**

  lô[s]  ‘loose’
  lô[z]en  ‘loosen’
  lô[s][ar  ‘solvable’
  lô[s]t  ‘dissolves’

Another widespread phenomenon in Type II is long voicing lead assimilation (henceforth voicing assimilation): a voiceless consonant becomes voiced under the influence of an adjacent voiced consonant. Among the languages exhibiting final
obstruent devoicing in (15), Dutch (Kenstowicz 1994: 495) and Polish (Lombardi 1995: 41) also display this process.

(16) (a) **Dutch**

<table>
<thead>
<tr>
<th>Dutch</th>
<th>Dutch</th>
</tr>
</thead>
<tbody>
<tr>
<td>hui[z6]aas</td>
<td>'landlord'</td>
</tr>
<tr>
<td>a[z6]ak</td>
<td>'ashtray'</td>
</tr>
<tr>
<td>hui[s]</td>
<td>'house'</td>
</tr>
<tr>
<td>a[s]</td>
<td>'ash'</td>
</tr>
</tbody>
</table>

(b) **Polish**

<table>
<thead>
<tr>
<th>Polish</th>
<th>Polish</th>
</tr>
</thead>
<tbody>
<tr>
<td>pro[Æ]a</td>
<td>'request' (noun)</td>
</tr>
<tr>
<td>pro[s]iê</td>
<td>'request' (noun)</td>
</tr>
<tr>
<td>li[d6]a</td>
<td>'numeral'</td>
</tr>
<tr>
<td>li[t6]yê</td>
<td>'count'</td>
</tr>
</tbody>
</table>

Other languages showing no final obstruent devoicing also demonstrate voicing assimilation. For example, as seen in (17), Serbo-Croatian (Cho 1990: 144-5, Partridge 1964) and Ukrainian (Kenstowicz 1994: 496) — which, as well as the languages discussed in (15) and (16) permit word-final obstruents — display the process of voicing assimilation without final obstruent devoicing.

(17) (a) **Serbo-Croatian**

<table>
<thead>
<tr>
<th>Serbo-Croatian</th>
<th>Serbo-Croatian</th>
</tr>
</thead>
<tbody>
<tr>
<td>to[bdz]ija</td>
<td>'gunner'</td>
</tr>
<tr>
<td>sva[db]a</td>
<td>'wedding'</td>
</tr>
<tr>
<td>rop[st]avo</td>
<td>'slavery'</td>
</tr>
<tr>
<td>to[p]</td>
<td>'gun'</td>
</tr>
<tr>
<td>sva[r]</td>
<td>'wedding guest'</td>
</tr>
<tr>
<td>ro[b]</td>
<td>'slave'</td>
</tr>
</tbody>
</table>

(b) **Ukrainian**

<table>
<thead>
<tr>
<th>Ukrainian</th>
<th>Ukrainian</th>
</tr>
</thead>
<tbody>
<tr>
<td>pro[z'b]a</td>
<td>'a request'</td>
</tr>
<tr>
<td>molo[d'b]a</td>
<td>'milling'</td>
</tr>
<tr>
<td>ve[zr]y</td>
<td>'to drive'</td>
</tr>
<tr>
<td>pro[s 'ity']</td>
<td>'to request'</td>
</tr>
<tr>
<td>molo[r 't']</td>
<td>'to mill'</td>
</tr>
<tr>
<td>vi[z]</td>
<td>'cart'</td>
</tr>
</tbody>
</table>

With respect to the directionality of the process in question, it is observed that, unlike nasalisation in §2.2.2, voicing assimilation typically proceeds **leftwards**, as in (16) and (17).
As for the distance of voicing assimilation, as just shown in the above, the voicing of an adjacent segment (short-distance assimilation) is widely observed in languages of Type II. However, in contrast to nasalisation discussed in (3), no languages displaying long-distance voicing harmony have been identified.

(18) Typology of long voicing lead assimilation in Type II

<table>
<thead>
<tr>
<th>Type</th>
<th>Short-distance</th>
<th>Long-distance</th>
</tr>
</thead>
<tbody>
<tr>
<td>IIA Sino-Japanese</td>
<td></td>
<td></td>
</tr>
<tr>
<td>IIB Dutch, Yamato-Japanese</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>✓</td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
</tbody>
</table>

2.3.5 Postnasal voicing

The voicing of an obstruent comes about not only under the influence of an adjacent long-lead voiced obstruent, but also in the context of a nasal too. As already discussed in §1.2.1.1, this assimilatory process is typically observed in a nasal-obstruent cluster. The examples below are from Yamato Japanese and Zoque (repeated from (3) and (4) in Chapter 1).

(19) (a) Yamato Japanese

\[
\begin{align*}
\hat{\text{sin}} + \text{te} \text{ (gerundive)} & \rightarrow \hat{\text{sin}}\text{de} & \text{‘die’ (gerundive)} \\
\text{kam} + \text{te} & \rightarrow \text{kande} & \text{‘chew’ (gerundive)} \\
\hat{\text{sin}} + \text{ta} \text{ (past indic.)} & \rightarrow \hat{\text{inda}} & \text{‘died’} \\
\text{kam} + \text{ta} & \rightarrow \text{kanda} & \text{‘chewed’}
\end{align*}
\]
Chapter 2. Typological aspects of nasality and voicing

(b) Zoque

\[ \begin{align*}
\text{min-pa} & \rightarrow \text{mimba} \quad \text{'he comes'} \\
\text{min-ta} & \rightarrow \text{mindama} \quad \text{'compel (pl.)'} \\
\text{pan-čaki} & \rightarrow \text{panjaki} \quad \text{'figure of a man'} \\
\text{pan ksi} & \rightarrow \text{panjasj} \quad \text{‘on a man’}
\end{align*} \]

As illustrated in (19), an obstruent adjacent to a nasal becomes voiced. This type of voicing is restricted to a nasal-obstruent sequence: the reverse sequence never triggers the process. This prompts the assumption that, in contrast to the assimilatory process discussed above, nasal voicing assimilation occurs only rightwards.

(20) Typology of voicing assimilation

<table>
<thead>
<tr>
<th>Directionality</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Triggering segments</strong></td>
</tr>
<tr>
<td>Long-lead voiced obstruent</td>
</tr>
<tr>
<td>Nasal</td>
</tr>
</tbody>
</table>

The melodic structures to be proposed in Chapter 4 provide a basis for accounting for these directionalities.

2.4 Implicational universals between nasality and long voicing lead

Now let us consider the relational typology between nasality and long voicing lead. In terms of the presence/absence of nasal and long-lead sounds, languages in the world may be divided into four systems as follows.
(21) Typology of nasal and long voicing lead

<table>
<thead>
<tr>
<th>Language</th>
<th>Nasal</th>
<th>Long lead</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quileute</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Finnish, English</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Dutch, French, Thai</td>
<td>✓</td>
<td>✓</td>
</tr>
</tbody>
</table>

Languages in Type I nasal systems (e.g. Quileute) — which have no nasal sounds — display no long-lead cognate. As discussed in (13), languages belonging to VOT systems Type I (e.g. Finnish) and III (e.g. English) also disallow long voicing lead, but unlike Quileute, they exhibit nasals. Likewise, languages in Type II (e.g. Dutch) and IV (e.g. Thai) — which exploit long voicing lead — display nasals. However, we never encounter a system which displays no nasals but only long-lead plosives. This observation leads us to the following implication with respect to universals.

(22) The existence of long-lead implies the existence of nasal.

In the light of typical active phenomena involving nasality and long-lead — nasality and voicing assimilation, the typological behaviour of these two properties are summarised in (23):

(23) Typology of nasal and voicing assimilation

<table>
<thead>
<tr>
<th>Nasality</th>
<th>Short-distance</th>
<th>Long-distance</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>✓</td>
<td>✓</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Voicing</th>
<th>✓</th>
</tr>
</thead>
</table>

In the light of typical active phenomena involving nasality and long-lead — nasality and voicing assimilation, the typological behaviour of these two properties are summarised in (23):
As discussed in (3) and (18), both nasality and long voicing lead give rise to short-distance assimilatory processes. However, in the case of long-distance assimilation, the behaviour of these properties is distinguished: nasalisation is observable in a long-distance span, but voicing assimilation is never found in such a domain. This difference will be reviewed in Chapter 6 and the mechanism producing it will be revealed.

2.5 Prenasalised ‘voiced’ plosives

2.5.1 The distribution of prenasalised ‘voiced’ plosives across languages

This part of the discussion investigates some typological aspects of prenasalised ‘voiced’ plosives, which will prove decisive in determining the characterising properties of nasality and long voicing lead in Chapter 5. With respect to universal generalisations, this kind of plosive is not preferred. According to the expanded UCLA Phonological Segment Inventory Database (UPSID), about 12% of the world’s languages have prenasalised plosives (Maddieson 1991, Maddieson & Ladefoged 1993). Within this set, it is prenasalised ‘voiced’ cognates are typically preferred.

This kind of segment has a strong correlation with nasals and long-lead plosives. As for the relation between nasals and prenasalised segments, the following relational typology is observed.

(24) Typology of prenasalised plosives

<table>
<thead>
<tr>
<th></th>
<th>Nasal</th>
<th>Prenasal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Most languages</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Wolof, Fijian</td>
<td>✓</td>
<td>✓</td>
</tr>
</tbody>
</table>
Like the relation between nasals and long-lead plosives, there appears to be no system which exploits prenasalised segments without nasals, as seen in (24). This can be expressed in the following way.

(25) The existence of prenasalised segments implies the existence of nasals.

Regarding the relation with long-lead plosives, languages exploiting prenasalised segments have two options: either long-lead plosives or not.

(26) Systems of prenasalised segments

<table>
<thead>
<tr>
<th>Type</th>
<th>Nasal</th>
<th>Prenasal</th>
<th>Long-lead</th>
</tr>
</thead>
<tbody>
<tr>
<td>I Fijian</td>
<td>✓</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>II Wolof</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
</tbody>
</table>

Type I of the prenasal system in (26) — found in Eastern Oceanic languages such as Fijian (Scott 1947-48: 738), Samoan, Ñua⁷ and Nambakaengo⁸ — never exploits long-lead plosives (obstruents). Examples are illustrated by the following consonantal arrangements (the sounds in each first row are lenis).

---

⁷Ñua (Haudricourt 1971: 364, cf. Leenhardt 1946) is a New Caledonian language spoken by the tribe of Gomen. The name of this language is pronounced nuaña.

Languages of this type allow prenasalised plosives to occur in any position (i.e. word-initial and intervocalic).
However, in Fijian, the nasal phase of prenasalised plosives is not always easily distinguished from the following voicing phase in initial position (Scott 1947-48: 739): voiced plosives appear as variants of prenasalised plosives word-initially, but not word-internally. Herbert (1986: 18) notes that this phenomenon has also been reported in languages such as Javanese (Horne 1961), Delaware (Voegelin 1946), Reyesano (Key 1968), and Holoholo (Coupez 1955).⁹

In contrast to Type I, languages in Type II exploit not only prenasalised plosives but also long-lead plosives. The consonant systems of Wolof,¹⁰ Njebi¹¹ and the northern Tohoku dialect of Japanese provide suitable examples.

(28) (a) **Wolof**

<table>
<thead>
<tr>
<th>p</th>
<th>t</th>
<th>c</th>
<th>k</th>
</tr>
</thead>
<tbody>
<tr>
<td>b</td>
<td>d</td>
<td>f</td>
<td>g</td>
</tr>
<tr>
<td>&quot;b</td>
<td>&quot;d</td>
<td>&quot;f</td>
<td>&quot;g</td>
</tr>
<tr>
<td>m</td>
<td>n</td>
<td>f</td>
<td>η</td>
</tr>
<tr>
<td>f</td>
<td>s</td>
<td></td>
<td>x</td>
</tr>
<tr>
<td>w</td>
<td>r</td>
<td>l</td>
<td>y</td>
</tr>
</tbody>
</table>

---
⁹Herbert concludes that this is due to some inherent physiological or perceptual difficulty regarding prenasalised plosives in the position in question.

¹⁰Wolof is spoken in Senegal and belongs to West Atlantic branch of the Niger-Congo family. See Ka (1994).

¹¹This language is spoken in Gabon and belongs to the South Central Niger-Congo branch of the Niger-Kordofanian family. See Guthrie (1968).
Languages of this type are divided into two groups, based on the lexical distribution of prenasalised segments: (i) free distribution and (ii) restricted distribution. In the former case, prenasalised plosives are found in all positions and this language type, as exemplified by Wolof and Sinhalese (Herbert 1977), displays no free variants between
prenasalised and voiced plosives. However, like languages in Type I, some dialects of the Austronesian languages of New Guinea (Capell 1969: 29) — which belong to this group — also exhibit the free variation in question. In such cases, unlike Type I, this phenomenon is not restricted to word-initial position: it is observed in all positions.

In the case of (ii), on the other hand, the appearance of prenasalised plosives is normally restricted to intervocalic position, and such segments are considered to be variants of long-lead plosives. This is found in Njebi (Guthrie 1968), some dialects of Japanese (Inoue 1967, Kanai 1982, Itoyoi 1998) and some Western Indonesian languages (Milner 1965: 428)\(^\text{12}\). Among these languages, several Tohoku and Shikoku dialects of Japanese exhibit no free variation between prenasalised and long-lead plosives. In these dialects, long-lead plosives are excluded from intervocalic environments; instead, prenasalised cognates are regularly found in such a position.\(^\text{13}\) This is a historical consequence of a development from long-lead plosives to prenasalised cognates in intervocalic position (Ashworth 1976-77).

\[\text{(29) Northern Tohoku Japanese}\]

\[
\begin{array}{lll}
ka^\text{m}bu & \text{‘turnip’} & (< kabu) \\
ha^\text{k}da & \text{‘skin’} & (< hada) \\
ka^\text{g}i & \text{‘key’} & (< kagi) \\
\end{array}
\]

\(^{12}\text{Apinayé (Anderson 1975, 1976; cf. Callow 1962), a language of Brazil, may also be regarded as a language allowing prenasalised plosives only in intervocalic position. In this language, vowels creating an intervocalic environment must be nasal and oral respectively (i.e. } v^\text{n}d_v. \text{ In such a case, prenasalised plosives may be deemed to be voiced cognates which take on the phonetic characteristics of their environment (i.e. } v^\text{d}v \rightarrow v^\text{n}d_v).}\]

\(^{13}\text{Some exceptions exist. See Inoue (1967) and Itoyoi (1998) for discussion.}\]
2.5.2 Prenasalised plosives as a result of dynamic alternation

In addition to the static distributional patterning just reviewed, prenasalised plosives also enter into dynamic processes, both diachronically and synchronically.

A diachronic example is found in certain dialects of Japanese already mentioned in (29). As already discussed, long-lead plosives in intervocalic position developed historically into prenasalised reflexes before the eighth century (Ashworth 1976-77, Tsujimura 1996). The process occurs in the absence of any local source of lexical nasality (see examples in (29)). Processes of this type — spontaneous prenasalisation — are witnessed not only in Japanese but also in some Western Indonesian languages and several Bantu languages.

Within the context of prenasalisation, on the other hand, where morpho-syntactic concatenation results in the nasal phase of prenasalised sounds, nasality exists lexically in either the target of the process or its given environment. This is illustrated in the following examples taken from Tonga-Inhambane,⁴⁴ Fe?Fe?-Bamileke,⁵ Wolof and Ndali.⁶⁶

(30) (a) Tonga-Inhambane

\(N = \) nasal noun class

\[N + \text{banyis} + i \rightarrow ^{\text{h}}\text{banyisi} \quad \text{'saviour'}\]
\[N + \text{lay} + i \rightarrow ^{\text{d}}\text{doyi} \quad \text{'witch'}\]
\[N + \text{yuyu} \rightarrow ^{\text{g}}\text{guyu} \quad \text{'fig tree'}\]


(b) Fe?Fe?-Bamileke

\( N^- = \) non-complete and consecutive

\[
\begin{align*}
N^- + \text{pen} & \rightarrow "\text{ben}" \quad \text{‘to accept’} \\
N^- + \text{len} & \rightarrow "\text{den}" \quad \text{‘to say’} \\
N^- + \text{yen} & \rightarrow "\text{gen}" \quad \text{‘to go’}
\end{align*}
\]

(c) Wolof

\( N^- = \) a prefix deriving nouns

\[
\begin{align*}
N^- + \text{baax} & \quad \text{‘to be good’} \rightarrow "\text{baax}" \quad \text{‘goodness’} \\
N^- + \text{dugg} & \quad \text{‘to shop’} \rightarrow "\text{dugg}" \quad \text{‘shopping items’} \\
N^- + \text{jam} & \quad \text{‘to tattoo’} \rightarrow "\text{jam}" \quad \text{‘tattoo’} \\
N^- + \text{gas} & \quad \text{‘to dig’} \rightarrow "\text{gas}" \quad \text{‘digging’}
\end{align*}
\]

(d) Ndali

\[
\begin{align*}
iN^- + \text{puno} & \rightarrow i"\text{buno}" \quad \text{‘nose’} \\
iN^- + \text{tunye} & \rightarrow i"\text{dunye}" \quad \text{‘banana’} \\
iN^- + \text{ku"da} & \rightarrow i"\text{gu"da}" \quad \text{‘dove’}
\end{align*}
\]

Prefixes in (30a), (30b) and (30c) consist solely of nasality, while the prefix of Ndali in (30d) contains nasality at its right edge. In each case, nasality generates the nasal phase of a prenasalised expression, which attaches to a verb stem.

In Chapter 5, rather than identifying this straightforward process, I shall investigate the mechanism of spontaneous prenasalisation in the given environment, focusing on the phenomenon discussed in (29).
Chapter 2. Typological aspects of nasality and voicing

2.6 Summary

In this chapter, we have discussed some typological aspects of nasality, long voicing lead and prenasality. In terms of cross-linguistic distribution, languages typically contain nasal segments in their sound systems.

(31) Relational typology among nasality, long voicing lead and prenasality

<table>
<thead>
<tr>
<th>Type</th>
<th>Nasal</th>
<th>long-lead</th>
<th>Prenasal</th>
</tr>
</thead>
<tbody>
<tr>
<td>I Quileute</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>II Finnish</td>
<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td>III Dutch</td>
<td>✓</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>IV Fijian</td>
<td>✓</td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>V N. Tohoku Japanese</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>*</td>
<td></td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>*</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>*</td>
<td></td>
<td>✓</td>
<td></td>
</tr>
</tbody>
</table>

The other two properties — long voicing lead and prenasalisation — are not obligatorily encoded in all systems: some languages (e.g. Quileute and Finnish in Type I and II respectively) furnish neither long-lead nor prenasalised segments; some languages utilise either long-lead (e.g. Dutch in Type III) or prenasalised segments (e.g. Fijian in Type IV); some other languages exploit both components (e.g. the northern Tohoku dialect of Japanese in Type V).

However, as illustrated in (31), no language contains long-lead and prenasalised segments without nasals: the existence of nasal is a prerequisite for the presence of long-lead and prenasalised cognates, but not vice versa.
Chapter 2. Typological aspects of nasality and voicing

(32) Implicational universals from (31)
   (a) nasality c long voicing lead
   (b) nasality c prenasalisation

Regarding the assimilatory processes arising from these three properties, they behave quite distinctly, as follows:

(33) Typology of nasalisation, voicing and prenasalisation

<table>
<thead>
<tr>
<th></th>
<th>Short-distance</th>
<th>Long-distance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nasalisation</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Voicing</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>Prenasalisation</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Nasal assimilation manifests itself both locally and at a distance. In the case of voicing assimilation, the span of the process is restricted to an adjacent position; a phenomenon like voicing harmony is never encountered in any language.

Unlike nasality and long voicing lead, prenasalisation is not involved in assimilatory processes: prenasalisation is never manifested in any adjacent position by means of assimilation. As discussed in §2.2.2 and §2.5, the process of prenasalisation mainly occurs in three distinctive ways: (i) it is found in obstruents which block nasal harmony (e.g. Tereno); (ii) in obstruents which are concatenated with suffixes containing nasality (e.g. \(N + yuyu \rightarrow ^{g}guyu\) ‘fig tree’ in Tonga-Inhambane) and morphemes containing nasality at the right edge juncture (e.g. \(iN + tunye \rightarrow i^{d}unye\) ‘banana’ in Ndali); and (iii) in voiced obstruents in intervocalic position in dialectal and diachronic sound change (e.g. \(kabu > kau^{b}bu\) ‘turnip’ in Northern Tohoku Japanese).

In the following chapter, I shall present arguments to explain how these typological issues reflect the representational nature of nasality, long voicing lead and prenasality.
3 The melodic architecture of nasality, voicing and prenasality

3.1 Introduction

Most phonological theories are united in the assumption that sounds (transcribable by phonemic-alphabetic symbols) are decomposable into smaller units. These units are regarded as universal primes in phonological representation and are referred to by such terms as distinctive features (Chomsky & Halle 1968, et passim), elements (Kaye, Lowenstamm & Vergnaud 1985; Harris 1990, 1994; Harris & Lindsey 1995), gestures (Anderson & Ewen 1987, Durand 1990), particles (Schane 1984, 1995) and components (van der Hulst 1989).

Following the tenets of one particular sub-segmental theory — element theory — this chapter will consider (i) how the phonological primes contributing to nasality, true voicing and prenasalisation participate in the internal composition of a sound and (ii) how these primes representationally incorporate implicational universals.

3.2 Defining melodic primes

Phonological studies have generally assumed that the melodic content of speech sounds can be reduced to primes. These properties of melodic representation are convincingly evidenced by the notion of natural classes. Each natural class is formed by sounds which participate in an identical phonological process. The number of natural classes to which a particular sound is affiliated reveals the number of distinct properties by which the sound is structured (cf. Hyman 1975, Lass 1984, Davenport & Hannahs 1998).

The majority of phonologists agree that melodic primes are part of the linguistic aspects of the human genetic endowment and receive relatively stable interpretation by
sensorimotor systems. Apart from this area of agreement, however, other defining aspects of such primes are controversial in (at least) the following respects:

(1) A melodic prime is

(a) (i) the minimal unit of phonological contrast or (ii) not;

(b) (i) the minimal unit of phonetic interpretation or (ii) not; and

(c) (i) privative or (ii) equipollent in terms of phonological oppositions.

Regarding the issue in (1a), classical phoneme theory (Trubetzkoy 1939, et passim) stands in a position where primes are no more than taxonomic properties to categorize segments. Accordingly, segments are reckoned to be the minimal units of phonological contrast. However, recent phonological theories — especially those based on the doctrine of generative grammar — reject such a position and rest on the assumption that it is primes that are the minimal units of phonological contrast.

As for the second issue (1b), in standard feature theories, each prime is reckoned to have its own stable phonetic signature, yet it cannot be interpreted by the sensorimotor systems unless it is harnessed to the signatures of other primes. On the other hand, in Harris & Lindsey (1995), which pursues the monostratal view of phonology, any phonological representation (whether lexical or post-lexical) is available to the outer facilities of the cognitive system. Such an approach totally excludes redundancy constraints like feature-value filling rules, and forces each prime at any level of representation to be interpretable without support from other primes within the same segment. Furthermore, in contrast to the SPE notion of full feature specification, they consider primes to be ‘small’ enough to fit inside a segment and yet ‘big’ enough to enjoy stand-alone phonetic interpretability. This view is widely adopted among theories employing privative primes (discussed below).

The concern in (1c) affects the melodic expressive power in different theories. Within any melodic model, each prime defines the binary nature of phonological oppositions. Such a bifurcation is generally captured in one of the two distinct ways: equipollent and privative oppositions. On the one hand, under the concept of
equipollence, a phonological opposition is created by assigning values such as plus and minus to a given prime. For example, as typically found in the SPE model (The Sound Pattern of English: Chomsky & Halle 1968), the nasal-oral contrast is derived from, say, the prime [nasal] to which a plus or minus value is assigned. On the other hand, under the notion of privativeness, as adopted in the theories utilising elements, gestures or particles, the phonological opposition stems from the presence or absence of a given prime. For example, an expression including the property [nasal] contrasts with an otherwise identical expression that excludes [nasal].

These two theoretical views of melodic opposition make different empirical predictions. Consider a model employing privativeness where the nasal-oral opposition is captured by the presence or absence of [nasal]. In this case, only the prime which is present in a given context can be active for processes such as nasalisation: its absence means a failure to participate in phonological processes. In contrast, equipollence derives at least three types of system: [+nasal] is active; [-nasal] is active; and both [+nasal] and [-nasal] are active in processes. However, in the case of nasalisation, only the first prediction is attested, whereas the others fail to be observed in any natural language. To make matters worse, the equipollent format substantially over-generates the number of unattested processes when coupled to rule-based multistratal theories of phonology.

In the following discussion, I will adopt phonologically contrastive melodic primes (1ai) named elements, which are not only independently interpretable and redundancy-free (1bi) but also privative in their nature (1ci).

3.3 Elements

Nasukawa 1997, 1998ab; Harrison 1999). Without discussing any details of theoretical diversity, most of the basics recognised throughout this thesis rely on the model developed in Harris (1994) and Harris & Lindsey (1995). First let us consider the primes utilised in ET. The following list contains the resonance and ‘manner’ elements given in Harris (1994, in prep.) and Harris & Lindsey (1995), with specifications of their acoustic signal interpretation and articulatory execution.

<table>
<thead>
<tr>
<th>Elements Pattern</th>
<th>Acoustic Pattern</th>
<th>Articulatory Execution</th>
</tr>
</thead>
<tbody>
<tr>
<td>(a) Resonance</td>
<td></td>
<td></td>
</tr>
<tr>
<td>[A] mAss</td>
<td>Central spectral energy mass (Convergence of F1 and F2)</td>
<td>Maximal expansion of oral tube; maximal constriction of pharyngeal tube</td>
</tr>
<tr>
<td>[I] dIp</td>
<td>Low F1 coupled with high spectral peak (Convergence of F2 and F3)</td>
<td>Maximal constriction of oral tube; maximal expansion of pharyngeal tube</td>
</tr>
<tr>
<td>[U] rUmp</td>
<td>Low spectral peak (Convergence of F1 and F2)</td>
<td>Trade-off between expansion of oral and pharyngeal tubes</td>
</tr>
<tr>
<td>[R] rise</td>
<td>High spectral peak</td>
<td>Articulation with the tip or the blade of the tongue (coronality)</td>
</tr>
<tr>
<td>@ neutral</td>
<td>No salient spectral peak</td>
<td>Neutral expansion of oral tube; neutral constriction of pharyngeal tube (centrality and velarity)</td>
</tr>
</tbody>
</table>
(b) 'Manner'

<table>
<thead>
<tr>
<th>Manner</th>
<th>Edge</th>
<th>Abrupt and sustained Occlusion in oral cavity drop in overall amplitude</th>
</tr>
</thead>
<tbody>
<tr>
<td>[?]</td>
<td>edge</td>
<td>Aperiodic energy Narrowed stricture producing turbulent airflow</td>
</tr>
<tr>
<td>[h]</td>
<td>noise</td>
<td></td>
</tr>
</tbody>
</table>

As discussed above, these elements are fully interpretable without support from other elements from the same segment. For instance, the independent manifestation of the resonance elements [I] and [U] in a nuclear context is i and u respectively (phonetic-alphabetic transcription), while their consonantal reflexes are y and w. In the case of 'manner' elements — which occur only in non-nuclear segments, [?] and [h] are interpreted as ? and h respectively.

It should be noted that, among the resonance elements in (2a), @ is not an element; instead it is considered as the base-line on which resonance elements are superimposed. It is also interpretable when other elements are absent or suppressed. Its independent manifestation can be a schwa-like vowel in a nuclear context and a velar approximant y in a non-nuclear context.

Besides being independently interpreted, elements can also combine to form melodic compounds, each of which exhibits an asymmetric relation expressed by the preponderance of one of its constituent elements over the other(s): one element stands as the head of the expression while any other elements behave as dependents (operators). For example, consider the fusion of [I] with [A], which produces the following two kinds of compound (heads underlined and transcriptions of the phonetic interpretation given next to each bracketed compound expression):

(3) [I, A] e [I, A] æ

One expression headed by [I] is interpreted as a mid-high front unrounded vowel, while the other headed by [A] manifests itself as a mid-low front unrounded vowel. There is
a third expression composed of [I] and [A], where both elements occur as dependents of @, the head of the compound.

(4) [@, I, A] ε

Thus, @ only manifests itself when it assumes the head status of a given melodic expression, although it is latently present in all resonant expressions.

By the same token, consonantal compounds exhibit this structural asymmetry between elements too. An example is given by combining [U] and [h] as in (5).

(5) [U, h] m [U, h] f [@, U, h] Ø

An [U]-[h] compound is interpreted as a less strident labial fricative if [U] dominates [h], while a reverse of the head-dependent relation yields a strident labial fricative. In the third option, the expression represents a neutral labial fricative.

This notion of melodic headedness is also found in expressions consisting of a single resonance element. In such cases, the asymmetry exists between a given element and its base-line @ and provides the contrast between ATR and non-ATR. Take, for example, two expressions identified by a sole [I]. If [I] is headed, it manifests itself as tense i; on the other hand, if [I] is headless, it is interpreted as its lax counterpart.

(6) [I] i [@, I] i

In the ET literature, @-headed expressions like [@, I] in (6) are typically written as [I].

This brief overview outlines the way in which melodic structure is created within ET. Although there are other sub-segmental mechanisms and combinatorial restrictions among elements, still to be introduced, I postpone any discussion of these until the relevant time. I will finish by describing the intra-segmental architecture of universally preferred obstruents, which will be relevant to the discussion in later parts of this work.
Here, affricates are excepted since they are treated in the same manner as prenasalised obstruents in §3.6.

(7) (a) Plosives (b) Fricatives

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>[R, ?, h]</td>
<td>t</td>
<td>[R, h]</td>
</tr>
<tr>
<td>[U, ?, h]</td>
<td>p</td>
<td>[U, h]</td>
</tr>
<tr>
<td>[@, ?, h]</td>
<td>k</td>
<td>[@, h]</td>
</tr>
<tr>
<td></td>
<td></td>
<td>[I, h]</td>
</tr>
</tbody>
</table>

In ET, as shown in (7), plosives contain both 'manner' elements [?] and [h] in their structures, whereas fricatives have only [h].

The kind of melodic asymmetry expressed by the preponderance of one prime over another is also employed in other phonological theories too, such as Dependency Phonology (Anderson & Ewen 1987) and Particle Phonology (Schane 1984). Within the framework of ET, the head-dependent relation is expressed by different kinds of representation. One such other proposals are found in Backley (1998) and Backley & Takahashi (1998), where the notion of headship as depicted above is rejected in favour of the notion of complement tier. This is not an additional element, but when licensed, derives the predominance of its licensor element over other constituent elements. Coupled with the assumptions of orthodox ET, this approach, called tier geometry, will be involved in the analysis of the nasal-voice paradox in Chapter 4.

In the rest of this chapter, I will discuss elements which contribute nasality, voicing contrasts and prenasalisation.
3.4 Nasality

3.4.1 The characterisation of nasality


However, some approaches must specify more than one way of representing nasal properties. In standard Dependency Phonology (DP: Anderson & Ewen 1987), for example, nasality is represented by {\{V;C\}} (which is read as 'vocalicness governs a consonantality') under the phonic sub-gesture of the categorial gesture (for nasal consonants) and by a component \(|n|\) under the oro-nasal sub-gesture of the articulatory gesture (for all kinds of nasals). Without an accompanying \(|n|\) component in the oro-nasal sub-gesture, the phonic expression \{{\{V;C\}}\} cannot be formed. A similar situation is found in the relation between the Soft Palate (SP) node and the feature [nasal] within some versions of feature geometry (Sagey 1986, Halle 1992, Piggott 1992, Rice 1993): the appearance of [nasal] always depends on the SP node.

3.4.2 Problems associated with dual representations

Davenport (1994) claims that the dual representation of nasality leads to unsatisfactory results in DP. For example, standard DP provides no explanation why only \{{\{C;\sqrt{\cdot}\}}\} (rather than the other possibilities for combining \(\sqrt{\cdot}\) and \(C\) where \(C\) is always inclusive) is represented without \(|n|\). In addition, the structure of nasal stops (\{{\{V;C\}}\};\{|n|\}) has

\[\text{A similar problem is found in the relation between the SP node and the feature [nasal] in the framework of feature geometry (see Chapter 6).}\]
little in common with that of oral stops (\{|C|\} for voiceless stops, \{|V;C|\} for voiced stops), although both segment types may well form a natural class.

Also, both representations (\{\{V;C\}\} and \{|n|\}) are problematic in their own right. According to Davenport, the phonatory \{\{V;C\}\} predicts unattested lenition processes like below.

\[(8) \text{ A voiced fricative becomes its nasal reflex ('\rightarrow' indicates that |V| is dependent on |V:C|).} \]

\[
\{[V:C\rightarrow V]\} \rightarrow \{[V;C]\}
\]

\{[V;C]\} must be located between a \{[V:C\rightarrow V]\} (voiced fricatives) and \{[V:C\rightarrow V]\} (liquids: '\rightarrow' indicates that |V:C| and |V| are mutually dependent) in terms of the lenition trajectories which are, in DP, defined by the addition of vowel properties in a overall phonatory structure (see the example in (9) taken from Anderson & Jones 1987: 175-6).

In order to include the expression \{[V;C]\} in the representation of nasals, DP must explain why only \{[V;C]\} is excluded from the lenition trajectory below.

\[(9) \]

\[
\{[V;C]\}
\]

\[
\{[V:C\rightarrow V]\} \rightarrow \{[V:C\rightarrow V]\} \rightarrow \{[V\rightarrow V;C]\} \rightarrow \{[V]\}
\]

\{[C\rightarrow V]\}

\{[C\rightarrow V]\}

In addition, we find insufficient motivation for siting the oro-nasal sub-gesture under the articulatory gesture exclusively for \{|n|\}. Nasality is phonologically independent
of place of articulation, since it constitutes a domain that is distinct from place for a wide variety of processes (e.g. Finnish, Anderson 1976; Desano, Kaye 1989).

In response to these issues, Davenport concludes that nasality should be represented by a sole category. Dispensing with problematic representations — \{\{V;C\}\} from the phonatory sub-gesture and \[n\] from the oro-nasal sub-gesture — he introduces a separate category \[N\] in the initiatory sub-gesture\(^2\) of the categorial gesture. Under his proposal, nasal stops are represented by \{\{C;V\}\} in the phonatory sub-gesture, which also applies to voiced stops. Unlike standard DP, this structure common to both nasal and voiced stops can express a natural class (a similar argument is followed in the Radical CV model of DP: van der Hulst 1995).

3.4.3 The nasal element

ET adopts an approach similar to that of Davenport. As an alternative to a dual representation, ET represents nasality using a sole melodic unit \[N\]. The existence of this element is supported by long-distance and short-distance nasal assimilatory processes which have already been discussed in §2.2.2 (and will be further exemplified below). Specifications of the acoustic interpretation and the articulatory execution of \[N\] are given in Harris (1994: 140) as follows:

\[
\begin{array}{cccc}
\text{Element} & \text{Pattern} & \text{Acoustic Pattern} & \text{Articulatory Execution} \\
\hline
\[N\] & \text{murmur} & \text{Broad resonant peak} & \text{Lowering of the velum at lower end of the frequency range} \\
\end{array}
\]

\(^2\)The initiatory sub-gesture also contains the melodic components relevant for airstream distinctions: \[G\] (glottal), \[K\] (velaric suction) and \[I\] (egressive airflow) (Davenport & Staun 1986).
As discussed in §2.2.1, since nasality can be contrastive both in vowels and consonants, we must assume that [N] can occur naturally in both kinds of segment. Below are four nasal stops — which are typologically the most prevalent nasals across different languages — and some nasal vowels with their intrasegmental structures. (For the present purposes of identifying the constituent elements of given segments, headship is omitted from the representations. Henceforth headship will only be displayed when it is relevant to the discussion.)

(11) (a) Nasal stops (b) Nasal vowels

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>[R, ?, N]</td>
<td>n</td>
<td>[A, N]</td>
</tr>
<tr>
<td>[U, ?, N]</td>
<td>m</td>
<td>[I, A, N]</td>
</tr>
<tr>
<td>[@, ?, N]</td>
<td>ŋ</td>
<td>[U, A, N]</td>
</tr>
<tr>
<td>[I, ?, N]</td>
<td>ñ</td>
<td>[I, U, A, N]</td>
</tr>
</tbody>
</table>

With some of the subsegmental representations described so far, some morphological alternations resulting from nasal harmony in Tucano\(^3\) provide evidence that [N] behaves as an independent phonological category. In this language, depending on the quality of the given stems, all the segments from a set of inflectional suffixes alternate between oral and nasal reflexes. Some examples (West & Welch 1972, Bivin 1986, Noske 1993: 321) are shown in (12).

---

\(^3\)An Eastern Tucanoan language spoken in Colombia.
Chapter 3. The melodic architecture of nasality, voicing and prenasality

(12) Tucano

(a) \(-ri/-\bar{r}i\) (inanimate plural marker)

\[\begin{array}{ll}
\text{wi?i-ri} & \text{‘house, pl.’} \\
\text{pi?i-ri} & \text{‘basket, pl.’} \\
\text{kase-ri} & \text{‘skin; peel, pl.’}
\end{array}\]

\[\begin{array}{ll}
\text{māā-ři} & \text{‘river, pl.’} \\
\text{mā?ā-ři} & \text{‘path, pl.’} \\
\text{ōmōkā-ři} & \text{‘paca, pl.’}
\end{array}\]

(b) \(-a/-\bar{a}\) (animate plural marker)

\[\begin{array}{ll}
\text{yehse-a} & \text{‘pig, pl.’} \\
\text{"dase-a} & \text{‘Tucano, pl.’}
\end{array}\]

\[\begin{array}{ll}
\text{nūmī-ā} & \text{‘woman, pl.’} \\
\text{?mē-ā} & \text{‘man, pl.’} \\
\text{sēmē-ā} & \text{‘paca, pl.’}
\end{array}\]

It is widely accepted that the suffixes in (12) lexically contain only oral segments, which remain unchanged if preceded by an oral stem; on the other hand, they become interpreted as their nasal reflexes under the influence of a nasal stem. Within the general context of autosegmental representations, this process is illustrated as in (13) and (14).

(13) (a) Lexical representation

\[\begin{array}{llllllll}
w & i & ? & i & r & i \\
x & x & x & x & + & x & x
\end{array}\]

\[\begin{array}{llllllll}
w & i & ? & i & r & i \\
x & x & x & x & x & x & x
\end{array}\]

(b) Output representation

\[\begin{array}{llllllll}
[U][I][?][I] & [R][I]
\end{array}\]

\[\begin{array}{llllllll}
[U][I][?][I] & [R][I]
\end{array}\]
3.5 VOX contrasts in ET

Here let us consider those elements which encode the laryngeal-source contrasts that are dependent on VOX distinctions. In ET, in order to derive VOT contrasts in obstruents, two autonomous melodic categories are utilised. They are the low source element labelled [L] and the high source element labelled [H], which represent long voicing lead (true voicing) and long voicing lag (aspiration) respectively. These source elements are described by Harris (1994, in prep.) as follows:

---

4 They are also involved in the specification of tonal contrasts in vowels.
On this basis, Harris (1998) motivates the following four source distinctions in obstruents:

(16) Element specification of VOT distinctions

<table>
<thead>
<tr>
<th>Source element</th>
<th>Manifestation in prevocalic plosive</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-specified</td>
<td>Zero or short voicing lag (neutral)</td>
</tr>
<tr>
<td>[L]</td>
<td>Long voicing lead (truly voiced)</td>
</tr>
<tr>
<td>[H]</td>
<td>Long voicing lag (voiceless aspirated)</td>
</tr>
<tr>
<td>[L, H]</td>
<td>Long voicing lead and lag, murmur (breathy)</td>
</tr>
</tbody>
</table>

Short voicing lag (neutral) — which is exhibited in all natural languages — is derived from the non-specification of both source elements. In contrast, a cooccurrence of [L] and [H] within the same segment yields breathy voicing or voiced aspiration. This combination is exploited in languages showing a four-way VOT contrast such as Gujarati.

This classification of source elements provides the VOT typology depicted below:
As pointed out by Harris (1994, 1998), this arrangement (i) straightforwardly captures implicational universals and (ii) allows us to pinpoint those segmental classes that are active in processes involving source.

As for (i), the relative markedness of VOT contrasts is captured in terms of complexity (i.e. the number of source elements specified). All natural languages employ a neutral series of plosives, the unmarked status of which is represented by the non-specification of source elements. This absence of source elements is viewed as the baseline on which source elements are superimposed. Exploiting either [L] or [H] yields a more complex system of contrast. More complex still is a system which can combine the appearance of the two elements [L] and [H] in a single segment. Languages like Gujarati exploit this possibility, which yields a four-way contrast (generated by the free combination of [L] and [H]).

In the context of (17), the active or inert state of a segmental class is directly represented by the presence or absence of a particular source element. For instance, laryngeal assimilation to the truly voiced obstruents and to the voiceless aspirated series can only be observed in languages employing [L] or [H] respectively. In these cases, members of the neutral series undergo the process in particular contexts, but can never participate in the process as a trigger. Examples are given below from a type II language, Polish (see (15b) and (16b) in §2.3.4):
(18) Source assimilation in Polish

(a) pro[żb]  
(b) brzy[tk]a

<table>
<thead>
<tr>
<th>pro</th>
<th>ż</th>
<th>b</th>
<th>brzy</th>
<th>t</th>
<th>k</th>
<th>a</th>
</tr>
</thead>
<tbody>
<tr>
<td>x</td>
<td>x</td>
<td></td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>l</td>
<td>l</td>
<td></td>
<td>l</td>
<td>l</td>
<td></td>
<td></td>
</tr>
<tr>
<td>[R]</td>
<td>[U]</td>
<td></td>
<td>[R]</td>
<td>[ 묀]</td>
<td></td>
<td></td>
</tr>
<tr>
<td>[h]</td>
<td>[h]</td>
<td></td>
<td>[h]</td>
<td>[h]</td>
<td></td>
<td></td>
</tr>
<tr>
<td>[ʔ]</td>
<td></td>
<td></td>
<td>[ʔ]</td>
<td>[ʔ]</td>
<td></td>
<td></td>
</tr>
<tr>
<td>[&lt;&lt; L]</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Polish displays another phenomenon related to laryngeal activity: final devoicing. The process is characterised by neutralisation of the laryngeal contrasts in obstruents showing short voicing lag; this occurs in domain-final position, which is widely considered a phonologically weak context (Lass 1984; Harris 1994, 1997; Brockhaus 1995). Employing the Type II system in (17) straightforwardly captures this mechanism (see (15b) in §2.3.4):

(19) Source neutralisation in Polish

(a) wó[t]  
(b) wo[d]a

<table>
<thead>
<tr>
<th>wó</th>
<th>t</th>
<th>wo</th>
<th>d</th>
<th>a</th>
</tr>
</thead>
<tbody>
<tr>
<td>x</td>
<td></td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>l</td>
<td></td>
<td>l</td>
<td></td>
<td></td>
</tr>
<tr>
<td>[R]</td>
<td></td>
<td>[R]</td>
<td></td>
<td></td>
</tr>
<tr>
<td>[h]</td>
<td></td>
<td>[h]</td>
<td></td>
<td></td>
</tr>
<tr>
<td>[ʔ]</td>
<td></td>
<td>[ʔ]</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;* [Ł] &gt;</td>
<td></td>
<td>[Ł]</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Chapter 3. The melodic architecture of nasality, voicing and prenasality

The low source element [L] must be excluded from a domain-final neutralising environment, thus leaving no source specification to derive the unmarked laryngeal series — neutral obstruents.

Other kinds of phenomena found in aphasia and child phonology are also correctly explained by adopting the representation of laryngeal-source contrasts in (15). Since they are not directly associated with the theme of this work, the reader may refer to Harris (1998) for the relevant discussion.

When the source elements [L] and [H] encode voice contrasts, they are specified only in obstruents, not in sonorants. This reflects the fact that the former display phonation-type contrasts, while the latter are characterised by spontaneous voicing that is considered to be a by-product of their manner characteristics (Harris 1994: 136). This distributional fact about source elements leads to the following constraint (provisional; reconsidered in Ch4).

\[(20) \quad [L]/[H] \leftarrow [h]\]

The presence of \([L]/[H]\) must be licensed by \([h]\) (in non-nuclear positions).

Here, \([h]\) is an element residing in most classes of obstruents, but never in sonorants. Due to this difference in the composition of the two sound types, the elements contributing phonation-type contrasts can only participate in a phonological expression under the condition that the noise element is also present in the same sound.

\[^3\text{According to the literature (Harris 1998), however, these source elements can also be specified in sonorants. In such cases, they contribute not to phonation-type contrasts, but to tonal distinctions in syllable nuclei.}\]
3.6 The melodic representation of prenasalised plosives

Aside from SPE, it is accepted in most of the literature that there exists no single element corresponding to prenasality. Within the framework of Feature Geometry, Sagey (1986) proposes the representation of prenasalised plosives as follows:

\[(21)\]

![Diagram of Feature Geometry representation of prenasalised plosives]

The two [nasal]s (each with a different value) are assumed to be ordered sequentially under the Soft-palate node: [+nasal] precedes [-nasal]. As Lombardi (1990) and Schafer (1995) claim in their discussion of the structure of affricates, this type of representation also predicts the reverse representation where [-nasal] precedes [+nasal]. However, this prediction is not borne out by phonological evidence. Postnasalised plosives — which appear phonetically (Ladefoged & Maddieson 1996) only in word-final position — are often considered to be the phonetic manifestation of prenasalised plosives; prenasalised plosives never occur word-finally and they never participate in any phonological events (van de Weijer 1994, Rennison 1998).

In frameworks employing privative primes (Mester 1986, McCarthy 1988, Kaye, Lowenstamm & Vergnaud 1990, Steriade 1993, Harris 1994, Lombardi 1995), 'contour' segments are also represented by a configuration in which one prime precedes another within the scope of a single position or root node. This is true of element theory, where the structure of a prenasalised alveolar plosive can be given as (22a). Clearly, an alternative representation where [ʔ], [h] and [ɾ] precede [n] is also a grammatical possibility, although this fails to find any empirical support.
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(22)  

\[ \text{ROOT} \rightarrow [N] [?] [h] [R] \]

Although the representation in (22a) utilizes no [+-] value, it predicts the possibility of finding the reverse representation where [?], [h] and [R] precede [N]. This configuration also fails to be borne out by phonological evidence.

Further criticism of (22a) is expressed in Takahashi (1993b), where it is noted that this structure is unable to encode any chronological distinction between the phonetic manifestation of the left melodic branch and that of the right branch. This follows from the generalisation that the sequential ordering of melodic units is determined exclusively by the prosodic structure, and manifest at the skeletal level. Any specific grouping of elements at the melodic level is rendered insignificant, under the assumption that each prime behaves autonomously and resides on its own autosegmental plane (Goldsmith 1976, 1990; Kaye, Lowenstamm & Vergnaud 1985). For this reason, the respective interpretations of the three structures in (22) will be identical. If intrasegmental components were to encode timing properties, then a great number of unattested ‘contour’ expressions would inevitably be generated — such as the segments in (22b) and (22c) that carry more than two timing differences (Scobbie 1997). Overgeneration of this sort would have immediate repercussions for generative restrictiveness.

Within a cognitive model of speech sounds, it should be expected that phonological representations accommodate only information that is lexically contrastive. Accordingly, the timing difference observed in the phonetic interpretation of prenasalised plosives should be deemed phonologically irrelevant for two reasons: first, the difference can never create a phonological opposition; and second, the two supposedly ‘phonetic’ phases of a prenasalised stop always behave as a single segment for contrastive purposes. This would appear to provide ample justification for treating timing differences of this kind as a product of the Articulatory-Perceptual system, and
I therefore omit these details from the representations of prenasalised plosives to be given below.\(^6\)

Given the inventory of elements introduced so far, as illustrated in (18) and (19), a voiced alveolar plosive comprises the components of a plain alveolar plosive ([R, ?, h]) and a voicing-bearing element ([L]) (Brockhaus 1992, 1995), as shown in (23a).

(23) Provisional representations of \(d\), \(n\) and \(\acute{d}\)

\[
\begin{align*}
\text{(a)} & \quad \text{\(d\)} & \quad \text{(b)} & \quad \text{\(n\)} & \quad \text{(c)} & \quad \text{\(\acute{d}\)} \\
\quad [R, ?, h, L] & \quad [R, ?, N] & \quad [R, ?, h, L, N]
\end{align*}
\]

(23b) gives the representation of an alveolar nasal, which is expressed by the set [R], [?] and [N] (Harris 1990, 1994). Regarding \(\acute{d}\), as seen in (23c), I tentatively assume that it consists of all the elements found in (23a) and (23b). This is the fact that \(\acute{d}\) is often consistent with the derived reflex of \(d\) in voiced plosive prenasalisation contexts, e.g. in Northern Tohoku Japanese — see §1.2.2.1.

The representations in (23) have the potential to mark phonological contrasts: the difference between \(d\) and \(\acute{d}\) is made by [N], and \(\acute{d}\) is distinguished from \(n\) by the presence of [h] and [L].

The elemental combinations in (23) further exemplify the typological difference between languages which employ nasalised segments and those which do not. Compare (23c) with the melodic expressions (23b), (7) and (11). Only the representation in (23c) allows [h] and [N] to cooccur within a single expression. No other consonantal category requires this combination, indicating that it is in some way marked. This is spelled out in (24).

---

\(^{6}\)For a similar reason, Rennison (1998) proposes a melodic representation for prenasalised alveolar plosives, that introduces a floating element — called a 'lazy' element — which contributes to the phonetic manifestation of the second part of the prenasalised segment. However, by applying the status of 'floating' to any kind of element, we can generate a massive number of 'contour' expressions, most of which are unattested (e.g. \(s'\) and \(\acute{f}\)).
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(24) TYPE ELEMENTAL COMBINATION MARKEDNESS STATUS
I Either [h] or [N] Unmarked
II Free combination of [h] and [N] Marked

Type I is observed in the majority of languages, where nasals, but not prenasalised segments, can occur: the cooccurrence of [h] and [N] is ruled out. In contrast, Type II languages (e.g. Fijian, Northern Tohoku Japanese) display all the sound types derived from the possible combinations of [h] and [N]: both nasals and prenasalised segments are allowed to occur.

3.7 Implicational universals and some problems

From the discussion provided so far, the typology involving nasality, long voicing lead and prenasality given in §2.6 can be re-drafted, as follows:

(25) Typology [N] and [L] (provisional)

<table>
<thead>
<tr>
<th>Type</th>
<th>[N]</th>
<th>[L]</th>
<th>[N, L]</th>
</tr>
</thead>
<tbody>
<tr>
<td>I Quileute</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>II Finnish</td>
<td>✔</td>
<td></td>
<td></td>
</tr>
<tr>
<td>III Dutch</td>
<td>✔</td>
<td>✔</td>
<td></td>
</tr>
<tr>
<td>IV Fijian</td>
<td>✔</td>
<td></td>
<td>✔</td>
</tr>
<tr>
<td>V N.Tohoku Japanese</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td>*</td>
<td></td>
<td></td>
<td></td>
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<td>*</td>
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<td>✔</td>
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<td>✔</td>
</tr>
<tr>
<td>*</td>
<td></td>
<td>✔</td>
<td>✔</td>
</tr>
</tbody>
</table>
As illustrated in (25), Type I languages do not exhibit any of the three kinds of segments — nasals, long-lead voiced and prenasalised voiced obstruents; so these systems never exploit [N] and [L]. All other types of language have nasals, however.

In contrast, exploiting long-lead voiced and/or prenasalised voiced obstruents is typologically marked: the existence of these kinds of segment implies the existence of nasals. The following is repeated from (32) in §2.6.

(26) Implicational universals

(a) nasality $\subset$ long voicing lead
(b) nasality $\subset$ prenasalisation

This is also consistent with the fact that the presence of a single [L] and/or a combination of [N] and [L] may be exploited by incorporating [N] in a given system. For example, Type III languages — showing long-lead voicing — can exploit [L] only if they employ [N]; Type IV languages — exhibiting prenasalised segments — can exploit the combination of [N] and [L] only if they employ [N]; Type V languages — displaying the free combination of [N] and [L] — also allow a single [N] to occur. These possibilities are illustrated in (25).

However, at least three problems arise with respect to (25). First, unlike the case of source contrasts in §3.5, relative markedness involving [N] and [L] is not correctly derived from complexity because [N]-specification and [L]-specification are equally complex in element terms. Second, the possibility of combining [N] and [L] within the same expression in a given system implies that each can appear independently. However this is not the case in Type IV languages where [L] does not exist in isolation. Ideally, the representation of prenasalisation should not include [L]. Third, if the elemental combination of prenasalisation is more complex than that of nasality, no explanation is provided for prenasalisation in Northern Tohoku Japanese, which is only observed in weak contexts and can be viewed as a type of lenition. According to Harris (1994, 1997), lenition is captured by a decrease in element complexity.
These three problematic issues arising from (25) will be considered in the following chapters and will be resolved by introducing an alternative representation for true voicing and prenasalisation.
4 An integrated approach to nasality and long-lead voicing

4.1 Introduction

In this chapter, I attempt to analyse the apparently paradoxical behaviour of nasals in Yamato Japanese, where voice is active for nasals in postnasal obstruent voicing assimilation but inactive under Lyman’s Law (which allows only a single voiced obstruent in a particular domain). The active status of nasality is widely attested both in dynamic alternations and in cases of static distribution (e.g. in Quichua, Zoque). The items in (1) are examples of Yamato Japanese, repeated from §1.2.1.

(1) (a) Dynamic postnasal voicing assimilation

\[
\begin{align*}
\text{\v{sin} + te (gerundive)} & \rightarrow \text{v\text{inde}} & \text{‘die’ (gerundive)} \\
\text{kam + te} & \rightarrow \text{kande} & \text{‘chew’ (gerundive)} \\
\text{\v{sin} + ta (past indic.)} & \rightarrow \text{\v{sinda}} & \text{‘died’} \\
\text{kam + ta} & \rightarrow \text{kanda} & \text{‘chewed’} \\
\text{\v{sin} + tari (alt.)} & \rightarrow \text{\v{sindari}} & \text{‘die’ (alternative)} \\
\text{kam + tari} & \rightarrow \text{kandari} & \text{‘chew’ (alternative)} \\
\text{\v{sin} + tara (subj.)} & \rightarrow \text{\v{sindara}} & \text{‘die’ (subjunctive)} \\
\text{kam + tara} & \rightarrow \text{kandara} & \text{‘chew’ (subjunctive)}
\end{align*}
\]

(b) Static postnasal voicing assimilation

\[
\begin{align*}
\text{\v{som}b\text{o}ri} & \quad \text{‘discouraged’} \\
\text{\v{si}ndo-i} & \quad \text{‘tired’} \\
\text{ka\text{\textipa{g}ae}} & \quad \text{‘thought’} \\
\text{ko\text{\textipa{g}ari}i} & \quad \text{‘done to a golden brown’}
\end{align*}
\]
Inflexion involving verbal stems in (1a) is subject to categorial voicing assimilation if the stem-final consonant is nasal. This phenomenon is found not only across a morpheme boundary, but also within lexical items as in (1b). In these cases, it is usually assumed that nasal sounds are specified for voice, thereby allowing them to trigger postnasal voicing assimilation.

However, Japanese presents a challenge to this assumption, since this system also seems to recognize another type of nasal segment — one which apparently contains no voice prime and is invisible to Lyman’s Law.

This effect is found in Rendaku, according to which the initial voiceless consonant of the second member of a compound is interpreted as its voiced counterpart, as shown in (2a).

(2)  Rendaku

(a)  \( \text{onna} + \text{koko} \rightarrow \text{onnagoko} \) \('\text{woman's heart}'\)
    \( \text{oo} + \text{taiko} \rightarrow \text{oodaiko} \) \('\text{big drum}'\)
    \( \text{take} + \text{sao} \rightarrow \text{takezao} \) \('\text{bamboo pole}'\)

(b)  \( \text{kami} + \text{kaze} \rightarrow \text{kamikaze (*kamigaze)} \) \('\text{divine wind}'\)
    \( \text{onna} + \text{kotoba} \rightarrow \text{onnakotoba (*onnagotoba)} \) \('\text{feminine speech}'\)
    \( \text{maru} + \text{hadaka} \rightarrow \text{maruhadaka (*marubadaka)} \) \('\text{completely naked}'\)

(c)  \( \text{ori} + \text{kami} \rightarrow \text{origami} \) \('\text{paper folding}'\)
    \( \text{yaki} + \text{sakana} \rightarrow \text{yakizakana} \) \('\text{grilled fish}'\)
    \( \text{kami} + \text{tana} \rightarrow \text{kamidana} \) \('\text{a shelf for the family gods}'\)

As illustrated in (2b), Lyman’s Law prevents Rendaku from operating if the second member of a compound includes a voiced obstruent in its lexical form. In this process, however, voicing in a nasal consonant is invisible for the purposes of Lyman’s Law. Consequently, as seen in (2c), the first obstruent of a compound’s second member which
contains a nasal is interpreted as its voiced reflex. Accordingly, if Rendaku is to be accounted for with a voicing prime, then we must assume that a nasal does not contain it.

Lyman's Law also functions in a single free morpheme:

(3) Single free morphemes

(a) sabi 'rust' *zabi
   sabaki 'judgement' *zabaki, *sabagi, *zabagi
   saži 'spoon' *žaži
   kazari 'decoration' *gazari
   toge 'thorn' *doge
   tokage 'lizard' *dokage, *togage, *dogage

(b) beni 'rouge'
    niži 'rainbow'
    tsubame 'swallow'
    nagisa 'beach, shore'
    mikado 'emperor, emperor's palace'
    nezumi 'rat, mouse'
    nokogiri 'saw'

The examples in (3b) confirm that nasals are also present in lexical forms and are considered to be unspecified for voice.

From the above examples, we encounter something of a paradox, such that Japanese must recognize two different specifications for nasals in different circumstances (voicing assimilation and Lyman's Law): voice is specified for a nasal in postnasal systematic voicing, whereas voice is unspecified for a nasal for in Rendaku.

This paradox is also observed within a single free morpheme, as seen in (4), where nasals are similarly unspecified for voice since they are invisible to Lyman's Law,
but need to be specified for voice for the purposes of static postnasal voicing assimilation.

(4) Two types of voice specification in nasals

<table>
<thead>
<tr>
<th>Word</th>
<th>Meaning</th>
<th>Transcription</th>
</tr>
</thead>
<tbody>
<tr>
<td>toombo</td>
<td>'dragonfly'</td>
<td>*dombo</td>
</tr>
<tr>
<td>šindo-i</td>
<td>'tired'</td>
<td>*žindo-i</td>
</tr>
<tr>
<td>kaŋgæ</td>
<td>'thought'</td>
<td>*gaŋgæ</td>
</tr>
</tbody>
</table>

How, then, do we account for this paradoxical behaviour? I shall propose that the phonological properties of nasality and voicing are expressed by the same object, and that a head/complement distinction determines its phonetic interpretation. This distinction is expressed through the introduction of a complement tier, which has the effect of enhancing the acoustic image of the element on its head tier: with an active complement tier, the nasal prime contributes voicing, while the same object manifests itself as nasality in the absence of such a complement. This notion of complement tier was first introduced in the geometry-based element theory developed in Backley (1998) and Backley & Takahashi (1998).

The structure of this chapter is as follows. §4.2 considers previous analyses of the paradoxical behaviour of nasals in Yamato Japanese and identifies the associated problems. In the remainder of this chapter I present my analysis of the facts, which accounts not only for the paradoxical behaviour of nasals observed in postnasal voicing and Rendaku, but also for b –nasal alternations in Japanese verbal inflexion. This will be achieved by assuming a unified structure for nasals within ET.
Chapter 4. An integrated approach to nasality and long-lead voicing

4.2 Previous analyses of the nasal-voice paradox

4.2.1 Underspecification and rules

To account for the paradox, Itô & Mester (1986) propose a model where default rules are ordered to apply at different levels of derivation — specifically, at the level of compounding and the level of verbal affixation, where the former level precedes the latter. At the level of compounding, nasals receive no [+voice] specification, and no application of the default rules given in (5) takes place. This is due to the fact that, in the course of compounding, nasals are invisible with respect to the operation of Lyman's Law.

(5) DR1 [+nasal] → [+voice]
    DR2 [-sonorant] → [-voice]

On the other hand, at the subsequent level of affixation, the default rules are assumed to apply, and consequently nasals are specified as [+voice]. This value then spreads to the following obstruent, according to the general operation of post-nasal voicing, as in *sinde (< *sin 'to die' + -te 'gerundive suffix').

As Itô & Mester (1986) themselves point out, however, their level-ordered solution is empirically unfavourable. From a morphological point of view, the level of verbal affixation should precede the level of compounding, giving an undesirable result from their analysis: if DR1 and DR2 apply in Rendaku, a nasal in the second member receives voice and the initial obstruent of the same member cannot receive voice, in accordance with Lyman's Law (*yakisakana); and if DR1 and DR2 do not apply in a nasal-obstruent cluster, then post-nasal voicing does not take place (*sinte).
4.2.2 Feature licensing and constraints

To approach the level-ordering paradox, Itô, Mester & Padgett (1995) shift their viewpoint from representationally-oriented Underspecification Theory (UT) position towards one based on constraint interaction following Optimality Theory (OT: Prince & Smolensky 1993, McCarthy & Prince 1993). Rather than being sequentially ordered, constraints in OT — which are ranked on a language-particular basis, all function simultaneously. The possibility of constraint violation provides another way in which this approach departs from that adopted within SPE (Chomsky & Halle 1968). In the latter, the violation of rules is excluded. In contrast, all constraints formulated in Optimality-theoretic terms are (in principle) violable, although constraint violation must be minimal.

Following the general theoretical stance adopted in Itô & Mester (1986), however, Itô et al (1995) believe they cannot abandon the representational advantages of underspecification which, by its nature, seems to require a level-ordering approach and, on the face of things, appears incompatible with constraint-based theory. To overcome the awkwardness of this blend of theoretical assumptions, they introduce a universal principle termed Licensing Cancellation, which is formalised as follows:

(6) Licensing cancellation

\[ \text{If } F \Rightarrow G, \text{ then } \neg (F \land G) \]  

"If the specification [F] implies the specification [G], then it is not the case that [F] licenses [G]."

The variables [F] and [G] are determined by segment-internal redundancy implications found in UT. In their analysis, the redundancy implication [sonorant] \( \Rightarrow \) [voice] is given without any apparent motivation, and the formula of Licensing Cancellation becomes 'If [sonorant] \( \Rightarrow \) [voice], then \( \neg ([\text{sonorant}] \Lambda [\text{voice}]) \)', which means that a segment including [sonorant] does not license [voice].

In addition to this principle, they introduce six constraints. One of these — a member of the family of licensing constraints — is LICENSE(Voice).
Chapter 4. An integrated approach to nasality and long-lead voicing

(7) **LICENSE(Voice)**

The phonological feature [voice] must be licensed.

This constraint requires that if there is a voice prime in the segment-internal structure, it must be licensed. Coupled with Licensing Cancellation, this constraint brings about the condition that, if there is an instance of voice, it can be licensed only in a non-sonorant segment. The feature-licensing constraint and Licensing Cancellation play a central role in their analysis, in the absence of feature cooccurrence formulations such as *[sonorant, voice]*.

The redundancy implication [sonorant] ≫ [voice], which is used to determine the variables in the principle in (6), is also treated as a constraint in their model, as shown in (8).

(8) **SONVOI**

[sonorant] ≫ [voice]

The constraint in (8) requires that all sonorants must possess voice in their internal structures. Unlike (7), however, there is no licensing relation involved here.

The other four constraints are given in (9). Their definitions are sufficiently self-explanatory for the purposes of the present discussion.
Chapter 4. An integrated approach to nasality and long-lead voicing

(9) (a) \textbf{NOGAP}:  
\[ *\alpha \beta \gamma \quad \text{where } \beta \text{ is a potential bearer of feature } F. \]

(b) \textbf{NO-VC-LINK}:  
Linkage of [voice] between sonorants and obstruents is prohibited.

(c) \textbf{NO-NC-LINK}:  
Linkage of [voice] between nasals and obstruents is prohibited.

(d) \textbf{FAITH} (Feature Faithfulness):  
This is a collective constraint covering the four constraints below.

(i) \textbf{PARSEFEAT}: All input features are parsed.
(ii) \textbf{FILLFEAT}: All features are part of the input.
(iii) \textbf{PARSELINK}: All input association relations are kept.
(iv) \textbf{FILLLINK}: All association relations are part of the input.

Itô \textit{et al} assume that these six constraints are hierarchically ranked in the grammar of Yamato Japanese. The hierarchy employs the three levels in (10).

(10) \begin{array}{ccc}
\text{LICENSE} & \text{NO-VC-LINK} & \text{NOGAP} \\
\text{SONVOI} & & \\
\text{FAITH} & \text{NO-NC-LINK} \\
\end{array}

(10) indicates that three of the constraints — LICENSE, NO-VC-LINK and NOGAP — are undominated. On the other hand, the two constraints comprising the bottom layer are both dominated by the other four constraints. In Itô \textit{et al}'s analysis, this ranking of constraints derives post-nasal voicing in words like \textit{tombo} 'dragonfly'; also, the affixal
form ṣin ‘to die’ plus -te ‘gerundive suffix’ becomes ṣinde. To illustrate their analysis, this second example is shown in the following tableau.

(11) Input: /sin+te/ ‘to die’ + gerundive suffix

<table>
<thead>
<tr>
<th>Candidate</th>
<th>NoGAP</th>
<th>Lic</th>
<th>No-VC-Link</th>
<th>SonVOI</th>
<th>No-NC-Link</th>
<th>Faith</th>
</tr>
</thead>
<tbody>
<tr>
<td>(a) ṣinte</td>
<td></td>
<td></td>
<td></td>
<td>***!</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(b) ṣinte</td>
<td></td>
<td>!</td>
<td></td>
<td>**</td>
<td></td>
<td>*</td>
</tr>
<tr>
<td>[Voi]</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(c) ṣinte</td>
<td></td>
<td></td>
<td></td>
<td>**</td>
<td></td>
<td>*</td>
</tr>
<tr>
<td>/</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>**</td>
</tr>
<tr>
<td>[Voi]</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The tableau format portrays the constraint hierarchy horizontally, where the constraints to the left are ranked higher than those to the right. Any fatal violations are marked by ‘!’, and the contender in the leftmost column marked with ‘!’ is deemed the optimal candidate within the set. A * under the relevant constraint indicates a single violation of that constraint. Multiply starred candidates are those in which the same constraint is violated more than once, giving well-formedness gradience.

The candidate in (11b) violates LICENSE — one of the undominated constraints. (11a) and (11c) are differentiated by their degree of compliance with SONVOI in the second layer: the degree of the violation in (11a) is greater than that in (11c). Therefore, the optimal output is the form in (11c), which most closely adheres to the higher-ranked constraints.

In the case of a monomorphemic word such as tombo, the same mechanism is at work and the optimal output structure is similar to that in (11c): m and b in tombo license a single feature [voice]. In (11c), as in tombo, only one [voice] exists in a single word domain, so we do not encounter any violation of Lyman’s Law (which bans any sequence of two [voice] features in a word domain). In other words, a violation of Lyman’s Law is not a necessary consequence of this analysis: it is not an independent constraint but a
Chapter 4. An integrated approach to nasality and long-lead voicing

The constraint ranking illustrated in (11) functions within a word domain (either a lexical word or a word derived from affixation), but not beyond. In the case of compounding, therefore, each member of a compound is subject to the evaluation, but the overall shape of the resulting compound is not. For example, a compound *midorigame* ‘green turtle’ (< *midori* ‘green’ + *kame* ‘turtle’) is not subject to the evaluation, although both individual members of the compound, *midori* and *game*, are independently evaluated by the hierarchy.

Thus, under the right constraint ranking conditions, Itô et al succeed in preserving the representational advantages of underspecification. In their framework, one particular constraint — Licensing Cancellation — appears to make a significant contribution to this overall aim. Below, we will re-evaluate the role of this constraint.

4.2.3 The major-class feature [sonorant]

In Itô et al’s analysis, the major-class feature [sonorant] is adopted as a variable in constraints such as Licensing Cancellation and SONVOI; this feature plays an important role in their analysis. However, the validity of [sonorant] has recently been called into question. The very low contrastive and derivational profile of major-class features such as this is summarised in Harris (in prep.) by the following points.

First, compared to non-major-class features, the distinctive burden that major-class features bear is extremely light. The lexical contrastive status of other features such as [continuant] and [nasal] enjoys much greater independent support. Second, major-class features, unlike those of a non-major-class, are rarely specified as either the target or trigger of processes. Third, major-class features have by far the lowest exchange value in the realm of phonetic implementation.

These arguments significantly undermine the representational status of the major-class feature [sonorant], which is indispensable for Itô et al’s analysis of the nasal-voice paradox in Yamato Japanese. Below, I will approach the question of this paradox without
making any reference to major-class features such as [sonorant].

4.3 An alternative analysis of the paradox

4.3.1 Dual phonetic interpretation of a single element

In the remainder of this chapter, I shall offer an alternative analysis in which output representations contain only privative primes, are redundancy-free, and are fully interpretable. For this purpose, as already discussed in §3.2, I adopt the version of element theory assumed in, for example, Harris (1990, 1994) and Harris & Lindsey (1995).

In this theory, the melodic prime most similar to the privative feature [voice] is the element pertaining to slack vocal cords, labelled [L]. This element is present in fully voiced obstruents. The acoustic characteristic of [L] is lowered fundamental frequency. The other element relevant to the present discussion is the nasality element [N], which is similar to privative [nasal] employed in distinctive feature models. This element manifests itself in the signal as a broad resonant peak at the lower end of the frequency range.¹

As discussed in §4.1, nasals and [L] show a strong correlation, as demonstrated by the phenomenon of postnasal assimilation found in many languages (Herbert 1986). In other words, while it is [N] that determines the nasality of a segment, it can be said that the elements [N] and [L] are clearly related. This is supported by cross-linguistic observation: voicing assimilation in an NC-cluster is relatively unmarked (Lass 1984, Itô, et al. 1995).

In order to capture the [N]-[L] relation, I assume that these elements are in fact two instantiations of the same object, [N] (cf. Harris & Lindsey 1995). This object manifests its properties without recourse to redundancy rules or markedness conventions

¹See §3.4 and §3.5 for discussion.
and without reference to the major-class feature [sonorant]. The idea of the \([N]-[L]\) merger originates in the element-oriented speech perception programme based in London in early 1990's. The first formal evidence that \([N]\) and \([L]\) are two instantiations of the same object is provided in Nasukawa (1995a, 1997), which present an integrated approach to the paradoxical behaviour of nasal and voice (postnasal voicing assimilation, Lyman's Law and verb-stem-final \(b\sim n\) alternation in Japanese).

Ploch (1999) provides further arguments to support the \([N]-[L]\) merger. First, in languages displaying nasal harmony, nasal and voiced stops exhibit a correlation: they alternate with each other, depending on the nasality/orality of the adjacent vowel. Second, unlike the other elements, both \([N]\) and \([L]\) (interpreted as voicing in non-nuclear positions and low tone in nuclear positions) are incompatible with \([H]\) (interpreted as voiceless aspirated and high tone in non-nuclear and nuclear positions respectively): voiced stops block high tone spreading and voiceless obstruents block nasal spreading. Third, two dissimilation laws, Dahl’s Law and Meinhof’s Law, are captured by a unified account if we assume the merger of the two elements.

Now let us consider how we arrive at the dual manifestation of this object, as nasality on the one hand, and as voicing on the other. The ET literature puts forward two different representational approaches to the issue of a single element having a dual phonetic interpretation: one is the notion of melodic headedness; the other is the notion of complement tier. The former is the more widely accepted means of expressing melodic dependency relations in the literature. This dates back to the earliest models of Dependency Phonology (DP: Anderson & Jones 1974, 1977). In the standard version of the theory (Harris & Lindsey 1995), for example, the contrast between ATR and non-ATR is, as already discussed in §3.3, captured via headship distinctions.\(^2\) It is now widely held that, for example, ATR \(u\) and non-ATR \(u\) are distinguished phonologically by the headship status of the prime \([U]\). If \([U]\) is headed, it is interpreted as tense \(u\); on the other

\(^2\)This structural representation was originally introduced to eliminate the independent prime contributing ATR-ness which belonged to the element inventory in the original version of ET (Kaye, Lowenstamm & Vergnaud 1985). The ATR element was ultimately rejected because of its questionable phonetic interpretability and its less active participation in phonological processes compared with other elements.
hand, if [U] is headless, it is interpreted as its lax counterpart. In this treatment, the headedness of a given element is viewed as an intrinsic property which enhances the acoustic image of the element (Harris 1994, Harris & Lindsey 1995).

(12)

<table>
<thead>
<tr>
<th>Element</th>
<th>Phonetic manifestation</th>
</tr>
</thead>
<tbody>
<tr>
<td>[U] (non-headed [U])</td>
<td>non-ATR ( u )</td>
</tr>
<tr>
<td>[U] (headed [U])</td>
<td>ATR ( u )</td>
</tr>
</tbody>
</table>

On the other hand, the notion of complement tier has been introduced in the geometry-based element theory developed in Backley (1998) and Backley & Takahashi (1998), which has arisen in recourse to problematic aspects of melodic headedness (which will be discussed in the next subsection). Underlying this approach is the assumption that a full set of resonance elements is present within each position, permitting all the melodic contrasts of a language to be expressed using the same structural configuration. According to this view, melodic oppositions are stated not in terms of the presence or absence of particular elements, but via the active or inactive status of elements latently present in the structure. Under this approach, two distinct phonetic instantiations of a single object are expressed, not by the notion of headedness, but by the active or inactive state of a complement tier, which may be licensed by a single element within a given expression and has the effect of enhancing the acoustic image of the overall expression. In the context of vowels, the complement tier contributes ATRness to an expression in which it is active. For example, ATR \( u \) and non-ATR \( u \) are distinguished by the active status of the complement tier licensed by [U]. This is represented in (13), where [comp] denotes the complement tier.
As depicted in (13), if [U] licenses its [comp] to be active, an expression is interpreted as tense $u$; on the other hand, if the [comp] is inactive, it is interpreted as its lax counterpart.

Both representational approaches share some common ground, in that the structural distinctions are in both cases manipulated via parametric setting: the majority of languages show no ATR contrast, and so exclude the structural distinction based on headedness or the complement tier (OFF setting); only languages exhibiting ATR-ness contrasts display the necessary distinctions (ON setting: e.g. English, French, Wolof, Akan).

In this work, I adopt the representation in (13), since the alternative approach utilising melodic headship presents certain problems in relation to phonologically dynamic processes, as I explain below.

### 4.3.2 Potential problems with the notion of melodic headedness

According to Backley & Takahashi (1998), the basic assumption of headedness is undermined, when adopted for the analysis of ATR harmonic agreement. For the purposes of describing ATR harmony, they claim that operations involving the notion of headedness are problematic in two respects: (i) they violate a highly restrictive version of Structure Preservation, and (ii) they cannot account for other types of harmonic agreement without resorting to other devices such as spreading. In order to discuss these potential problems, let us first consider an analysis of ATR harmonic agreement using

<table>
<thead>
<tr>
<th>Element</th>
<th>Phonetic manifestation</th>
</tr>
</thead>
<tbody>
<tr>
<td>[U]</td>
<td>non-ATR $u$</td>
</tr>
<tr>
<td>[Comp] [U]</td>
<td>ATR $u$</td>
</tr>
</tbody>
</table>

(13)
established headedness.

Among the set of languages exhibiting ATR contrasts, some systems involve the lexically specified ATR/non-ATRness of a stem affecting the quality of vowels in affixes. Examples are given from Akan (Clements 1981, cf. Backley & Takahashi 1998: 15).

(14) Akan

(a) tu 'throw' o-be-tu-i 'he came and threw'

(b) tu 'dig' o-be-tu-i 'he came and dug'

The lefthand morphemes in (14a) and (14b) contain a non-ATR vowel ũ and an ATR vowel ü respectively. In terms of ATR/non-ATRness both vowels affect the quality of vowels in the affixes seen in the righthand column.

Adopting the structural distinctions in (13), Harris & Lindsey (1995: 64-5) assume that this type of vocalic harmony\(^3\) is captured by means of headship agreement. Their example case, which is also given in Backley & Takahashi (1998: 15), is shown below:

\(^3\)In standard autosegmental theory, coupled with the ATR prime (e.g. [+ATR]), this type of vocalic harmony has generally been analysed in terms of autosegmental spreading (Goldsmith 1976, Sagey 1986, Rice 1992, Padgett 1994). In autosegmental spreading, a triggering melodic prime becomes associated to positions other than the one to which it is lexically attached. This is illustrated below.

\[
x \times \rightarrow x \times
\]
\[
| \rightarrow | / 
\]
\[
[+ATR] \rightarrow [+ATR]
\]

In recent studies, however, alternatives to the spreading operation have been proposed — notably, by Cole & Kisseberth (1994a), Backley (1998) and Backley & Takahashi (1998).
(15) ATR harmony as a case of head agreement

(a) o-be-tu-i 'he came and threw'  (b) o-be-tu-i 'he came and dug'

In the case of Akan, the [I/U]-tier is sanctioned by head agreement: agreeing with the ATR quality of the second vowel from the right, all vowels within a domain are headless in (15a) and interpreted as non-ATR reflexes; on the other hand, aligning the penultimate vowel means that elements on the [I/U]-tier in (15b) are all headed and manifest themselves as ATR vowels. This type of headship switching operation, however, violates a highly restrictive version of Structure Preservation.

The phonological literature contains many references to the notion of Structure Preservation (SP), although its precise definition and function vary according to theoretical perspective (Selkirk 1982, Kiparsky 1985, Itô 1986 and Harris 1994). Among these different views of SP, the government/licensing-based approach (GLP) notably provides a unified account of phonological and syntactic structures by extending the use of SP established in syntax — that the categorial status of a syntactic unit given in input structure cannot be altered by any syntactic operations — to the phonological domain. According to Harris (1994), the SP in GLP requires that licensing (head-dependent) relations present at derived levels of representation necessarily match those specified in lexical representation. The licensing relations to be preserved throughout derivation are those lexically established between prosodic categories. For example, a lexically specified coda position remains unmodified at all levels of derivation. Here, however, licensing relations between melodic primes can be altered during the course of derivation since the relations are not necessarily subject to SP, as illustrated by the headship switching process in the ATR harmonic operation just described, where the melodic
expression \([I, A]\) can be interpreted as \([L, A]\) under the harmony conditions discussed in (15).

In order to unify the different dimensions of a phonological representation into a single coherent structure, Backley (1998) and Backley & Takahashi (1998) extend the prosodically defined SP to the melodic component. The condition is expressed in a more restrictive guise, as follows:

(16) **INHERENT STRUCTURE PRESERVATION (ISP)**

Lexical head-complement relations must be retained throughout derivation.

ISP prohibits any categorial alteration, whether prosodical or melodic: in other words, any operation involving headship switching must be excluded from the grammar. Under this condition, a melodic expression, say \([I, A]\), cannot be reorganized as \([I, A]\) or \([I, A]\). This is motivated by the same reasons that prevent, for instance, the alternation between a lexically assigned coda position and an onset position in the prosodic component. This type of structure preservation achieves a substantial degree of theoretical restrictiveness. The melodic headship switching operation required for the analysis of ATR harmony in (15) (e.g. \([A, U] \rightarrow [A, U]\)) is to be treated as a violation of ISP.

In addition to this violation, operations involving head switching (such as head alignment) encounter further problems when they are utilised in the analysis of non-ATR-type harmonic agreement. Although ATR harmony is analysed in the standard version of ET using a headship switching operation within a wide-scope domain, another type of operation, spreading, is also required in the analysis of other types of harmony. In autosegmental spreading, unlike any head switching operation, a triggering melodic prime becomes associated to positions other than the one to which it is lexically attached. This is illustrated below.

(17) (a) \[
\begin{array}{c}
\text{X X} \\
| \\
\text{[a]} \\
\end{array}
\quad \rightarrow \quad 
\begin{array}{c}
\text{X X} \\
\text{[a]} \\
\end{array}
\]

(b) \[
\begin{array}{c}
\text{X X} \\
\text{[a]} \\
\end{array}
\]
As Backley & Takahashi (1998) point out, in order to account for, say, palatal harmony observed in languages like Chamorro, it is the spreading instruction in (17), rather than the operation of headship switching, that is typically referred to. In this language, for example, a vowel in the first syllable of a root is interpreted as its fronted reflex when the root is preceded by a front vowel. The following Chamorro data is taken from Kenstowicz & Kisseberth (1979), reproduced in Backley & Takahashi (1998: 25):

(18) **Chamorro** (*i* = the definite article)

(a)  

<table>
<thead>
<tr>
<th>guma</th>
<th>'house'</th>
</tr>
</thead>
<tbody>
<tr>
<td>tomu</td>
<td>'knee'</td>
</tr>
<tr>
<td>lahi</td>
<td>'male'</td>
</tr>
</tbody>
</table>

(b)  

<table>
<thead>
<tr>
<th><em>i</em> gimu</th>
<th>'the house'</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>i</em> temu</td>
<td>'the knee'</td>
</tr>
<tr>
<td><em>i</em> lehi</td>
<td>'the male'</td>
</tr>
</tbody>
</table>

In order to analyse this type of phenomenon, the process is typically accounted for by the spreading of [I] from the definite article *i* to the first vowel in the root, ousting the lexically specified [U]. This is depicted in (19).

(19)  

(a)  

<table>
<thead>
<tr>
<th>i - guma</th>
</tr>
</thead>
</table>

(b)  

<table>
<thead>
<tr>
<th>i - gimu</th>
</tr>
</thead>
</table>

In this type of harmonic agreement, the operation of head alignment is clearly not involved: headship switching is employed only in systems exhibiting tongue root contrasts. Consequently, we are forced to recognize two different approaches to the description of harmonic processes.

However, a uniform description of these two kinds of harmonic agreement is desirable, since the effect of these two mechanisms is identical, to the extent that a property is shared by all the vocalic positions within a given domain.
4.3.3 Element activation and the complement tier

In order to unify harmonic agreement and, additionally, to conform to the strict interpretation of SP, Backley (1998) and Backley & Takahashi (1998) offer an alternative approach, a tier-geometric structure utilising element activation, in which all harmony is uniformly the result of domain-wide activation. As briefly stated in §4.3.1, the basis of this approach is the assumption that a full set of resonance elements is present within each nuclear position, permitting all the melodic contrasts of a language to be expressed using the same structural configuration. For example, the canonical five-vowel system — which displays no ATR contrast — is represented by the following template.

(20) Melodic template

\[
\begin{array}{c}
\times \\
\downarrow \\
[I,U] \\
\downarrow \\
A
\end{array}
\]

The [I/U]-tier in (20) shows a cooccurrence restriction on [I] and [U]. Accordingly, the five expressions [I], [U], [A], [I, A] and [U, A] are possible structures, but [I, U] and [I, U, A] — which contain [I] and [U] in a single expression — are rendered impossible. This template is adopted by languages like Spanish, Japanese, and Chamorro.⁴

In addition, Backley (1998) and Backley & Takahashi (1998) propose the notion of a complement tier, the active/inactive status of which encodes the contrast between ATR and non-ATR in a vocalic expression. A language which incorporates the complement tier ([comp]-tier) in its melodic template is Akan:

⁴For a survey of systems generated by other vocalic templates, see Backley (1998: 81-103).
In Akan, only the [I/U]-tier can license the [comp]-tier, since phonological ATR contrasts are found only in non-low vowels (which are expressed using [I] or [U]). The [comp] is not an element, but its active status must be licensed by an element proper. Therefore, the configuration in (22a) is structurally well-formed, whereas (22b) is ill-formed since it is not licensed by any active element. Here, the inactive status of an element is represented by shading.

The same mechanism is found in the prosodic component: to establish constituent licensing (e.g. a branching onset on nucleus), the licensor (the left branch of a given branching constituent) must be filled by an active element, as illustrated in (23a) and (23b); otherwise, the complement position (the right branch of a given branching constituent) fails to be licensed, as shown in (23c) and (23d).

\[^5\text{For a detailed discussion, see Backley (1998).}\]
In phonetic terms, the active [comp], as briefly stated in §4.3.1, contributes the effect of enhancing the acoustic image of its head element (licensor) — potentially [I] or [U] in the case of Akan.

In the context of the present approach, assimilatory processes such as harmonic agreement are captured by activation operating within a wide span. The operation is formalised as the lexical instruction ‘activate [a]’, which is defined in (24).

(24) **ACTIVATE [a]**

Interpret the melodic element [a].

The melodic element [a] can be interpreted only if this instruction is given. All lexical elements in a segment are activated by a set of these instructions. When **ACTIVATE [a]** is given in a wider domain than a single segment, assimilatory process such as harmony takes place. Under this instruction, the assimilation illustrated in (19) is captured by the following representation.

(25) (a) \( \begin{array}{c}
\alpha \\
\end{array} \)
(b) \( \begin{array}{c}
\alpha \\
\end{array} \)

As seen in (25), element activation results in a different token of the same unit type being interpreted in each position within an assimilatory span. In the case of Chamorro, which
employ the template in (20), palatal harmony is illustrated as follows.

\[(26)\] (26) (a) \(i - \text{gum} \varepsilon\) \(\rightarrow\) (b) \(i - \text{gim} \varepsilon\)

In this language, \textsc{activate} [I] functions on the first vowel of the stem only if its prefix is composed of a lexically activated [I]. To comply with this constraint, as depicted in (26), the lexically active [U] in the leftmost vocalic position of the stem is deactivated, since [I] and [U] cannot be active together in the same position in Chamorro. Other types of harmony such as rounding, height and nasal harmonies are achieved by \textsc{activate} [U], [A] and [N] respectively. These are summarised in Backley (1998: 115), repeated here as (27).

\[(27)\] \textsc{activate ‘a’}

<table>
<thead>
<tr>
<th>Type of harmony</th>
<th>Alignment target</th>
</tr>
</thead>
<tbody>
<tr>
<td>Palatal harmony</td>
<td>[I]</td>
</tr>
<tr>
<td>Rounding harmony</td>
<td>[U]</td>
</tr>
<tr>
<td>Height harmony</td>
<td>[A]</td>
</tr>
<tr>
<td>Nasal harmony</td>
<td>[N]</td>
</tr>
<tr>
<td>Tongue root harmony</td>
<td>[comp]</td>
</tr>
</tbody>
</table>

In addition, as shown in the bottom row of the tableau in (27), it is not only elements, but also [comp], that can be an alignment target. According to Backley (1998) and Backley & Takahashi (1998), ATR harmony is captured by [comp] activation, illustrated by the Akan forms in (28).
In Akan, ACTIVATE I/U-[COMP] functions on all vocalic positions in a harmonic domain. As a result, all vocalic positions containing an active [I/U] are forced to display an active I/U-[comp] wherever a harmonic trigger is present. In the absence of an ATR trigger (i.e. a vocalic expression containing an active I/U-[comp]), however, all vowels within the domain contain an inactive complement tier. This treatment complies with ISP, because headship is not altered between lexically specified elements during the course of derivation. In addition, all types of harmonic agreement (such as ATR and palatal harmony) are uniformly analysed using the same device of activation.

Below, I exploit the notions of activation and the complement tier as the basis for an integrated account of the assimilatory phenomena involving voice and nasality.

4.3.4 The nasal-voice distinction

In the same way that tongue root distinctions may be encoded by referring to a melodic complement tier, I propose that the contrast between nasality and voicing may be expressed using the same idea: if the element [N] licenses its [comp], then it is interpreted as long-lead voicing, while the same element without a licensed [comp] manifests itself as nasality. Some further mechanisms are involved. See Backley (1998).

I have opted for [N] rather than [L] to represent the relation between nasality and long-lead voicing, since the ‘bare’ element without its [comp] contributes nasality.
Chapter 4. An integrated approach to nasality and long-lead voicing

The assignment of [comp]-licensing to long-lead voicing rather than to nasality can be justified as follows. First, the structures in (29) can encode an implicational universal between nasality and voicing. As discussed in §2.2.1, almost all languages exploit contrastive nasality, whereas voicing is parametrically controlled. The optional status of voicing is captured by the employment/deployment of N-[comp]: some systems are not permitted to license N-[comp], while others allow this structural possibility. The tier geometry approach also accounts for cross-linguistic ATR contrasts in a similar way. As argued in §4.3.3, for example, in the majority of languages, which show no ATR contrast, resonance elements do not license a [comp]. In contrast, languages which do display an ATR contrast exploit a complement tier.

Before proceeding, let us briefly consider the alternative of assigning the N-[comp] structure to nasality. Recall Williams (1997)'s headedness-based proposal for unifying nasality and voicing, where headed [N] is interpreted as nasality in all positions, and its headless counterpart manifests itself as voicing in non-nuclear positions and as low tone in nuclear positions. This approach captures neither the implicational universal between nasality and voicing in non-nuclear positions, nor that between nasality and low tone in nuclear sites. Low tone is not necessarily employed in all languages displaying nasal vowels. In Williams' representations, however, the existence of nasality (headed [N]) implies the existence of low tone (non-headed [N]). In addition, such representations contradict recent proposals that question the validity of low tone as an independent melodic unit (Yoshida 1995, Cabrera-Abreu in press).

The structures in (29) straightforwardly capture the other implicational universal discussed in §2.4 and §3.7, in which the existence of long-lead voicing implies the

(29)

<table>
<thead>
<tr>
<th>Element</th>
<th>Phonetic manifestation</th>
</tr>
</thead>
<tbody>
<tr>
<td>N</td>
<td>nasality</td>
</tr>
<tr>
<td>Comp</td>
<td>long-lead voicing</td>
</tr>
</tbody>
</table>

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The structures in (29) straightforwardly capture the other implicational universal discussed in §2.4 and §3.7, in which the existence of long-lead voicing implies the
existence of nasal.

Furthermore, the representations in (29) reflect differences in complexity between nasality and long-lead voicing. As we will see in Chapter 5, nasality must be less complex structurally than long-lead voicing, since the latter property is often suppressed in intervocalic contexts and instead nasality is interpreted (e.g. in some dialects of Japanese, some Western Indonesian languages and several Bantu languages). According to Harris (1994, 1997), segmental structure is less complex in weak positions than in strong positions — a state of affairs predicted by the proposed structures in (29).

4.3.5 N-[comp] Licensing

In order for it to be active, N-[comp] must be licensed by its head element [N]. Additionally, however, complement activation is restricted by another condition. As already discussed in §3.5, those elements that create phonation-type contrasts can only participate in a phonological expression when the noise element [h] is also present in the same sound. This distributional fact about source elements is provisionally expressed using the constraint [L]/[H]→-[h] which demands that the presence of [L]/[H] must be licensed by [h]. Since our present proposals have eliminated [L] from the element inventory in favour of N-[comp] licensing, the constraint [L]→-[h] is redefined as follows.

(30) **N-[COMP] LICENSING**
N-[comp] must be licensed by [h].

As a result, the successful activation of N-[comp] must be licensed along two different paths: melodically endocentric licensing by [N] and exocentric licensing by [h]:
At the prosodic level, the same relations are responsible for establishing the well-formedness of a rhymal complement (coda). In GLP, for example, a rhymal complement position is licensed not only by its preceding nucleus, but also by a following onset. This is formalised by the following principle (Kaye 1990: 311):

(32) **Coda’ Licensing**

A rhymal complement position (coda) must be licensed by an onset position.

The two licensing paths involved in the definition of a ‘coda’ position are illustrated in (33). The similarity between this and the structure in (31) should be immediately apparent.

The fact that the same licensing mechanism is employed at two different representational levels provides us with some degree of theoretical coherence within the present framework.

Using the structure in (31) for long-lead voicing, the following section demonstrates how nasal-voice phenomena in Japanese can be successfully analysed.
4.4 Rendaku with N-[comp]

Under Rendaku, as already mentioned, the initial voiceless consonant of the second member of a compound becomes voiced. Itô & Mester (1986) assume that the source of the voicing is a compounding conjunctive morpheme, which contains no melodic material other than a voice feature. In Rendaku, then, the conjunctive morphological property is realised at the left edge of the second member of a compound.

The conjunctive morpheme derives historically from the genitival particle no via the intermediary stages of moraic N and voiced prenasalisation (Vance 1982). As an example, Vance (1987) gives the Old Japanese word kido ‘wooden gate’ as a derivative of ki ‘wood’ + no + to ‘door’. (In some other formations, the dative/locative particle ni has been involved.) This diachronic change also exhibits an interconnected aspect of nasality and voicing, and increases the evidence to support the proposed view of nasal-voice unification: N-[comp] (voicing) cannot be activated without an active [N] (nasality).

 Adopting the same assumption in the context of the proposed structures in (29) and (31), Rendaku is represented in terms of the following morphological concatenation. In (34) I omit any latently present elements that are irrelevant to the present discussion.

(34) ‘woman’s heart’
onna ‘woman’ + kokoro ‘heart’

\[
\text{ACTIVATE N-[COMP]} \\
\downarrow
\]

\[
\begin{array}{c}
[\text{onna} \ n \ n \ a] \\
[\text{kokoro} \ o \ k \ o \ r \ o]
\end{array}
\]

\[
\begin{array}{ccc}
x & x & x \\
h & h & x
\end{array}
\]

\[
\begin{array}{c}
[\text{onna} \ n \ n \ a] \\
[\text{kokoro} \ o \ k \ o \ r \ o]
\end{array}
\]

\[
\begin{array}{c}
g \ o \ k \ o \ r \ o
\end{array}
\]
By means of the morphologically motivated instruction ACTIVATE N-[COMP], the N-[comp] in (34) — which is interpreted as long-lead voicing — is activated at the left edge of the second member of the compound. Its head [N] is also activated to comply with the instruction.

In contrast, the form in (35) is ill-formed.

* (35) ‘divine wind’

kami ‘divine’ + kaze ‘wind’

\[
\text{ACTIVATE N-[COMP]} \\
\downarrow \\
[k \ a \ m \ i] \quad [k \ a \ z \ e] \\
\begin{array}{c}
\times \\
\text{h} \\
\text{N} \\
\end{array} \quad \begin{array}{c}
\times \\
\text{h} \\
\text{N} \\
\end{array}
\]

Recall that Lyman’s Law prohibits a sequence of two voiced obstruents in a given domain, but allows a sequence consisting of a voiced obstruent and a nasal. In terms of the proposed distinction in (29), it is clear that a sequence of two active N-[comp]s is prohibited in the second member of a compound, while a sequence comprising an active N-[comp] and an inactive N-[comp] is permitted, as in (36).
(36) ‘paper folding’
ori ‘folding’ + kami ‘paper’

**ACTIVATE N-[COMP]**

\[\begin{array}{c}
  \text{[o r i]} \\
  \text{[k a m i]}
\end{array}\]

To capture this distribution pattern in Yamato Japanese, we need to posit the following constraint:

(37) *N-[comp]N-[comp]

Given this constraint, sequences such as an active N-[comp] and an inactive N-[comp], and an inactive N-[comp] and an active N-[comp], are possible. Yet the motivation for the negative constraint in (37) is not immediately obvious. Why should this particular sequence not be permitted?

Itō *et al* (1995) interpret Lyman’s Law as an instance of the **OBLIGATORY CONTOUR PRINCIPLE** (OCP: Leben 1973) — a line of argument which is also pursued in McCarthy (1986). In compounding, when [voice] is interpreted on the second compound member, this voicing process will be blocked by the OCP whenever [voice] is already present: hence, *[voice][voice]. This analysis draws on a very general constraint that is widely accepted in the phonological literature.
Chapter 4. An integrated approach to nasality and long-lead voicing

4.5 [N]-activation in NC-clusters

4.5.1 The extension of [N]-activation

Postnasal voicing assimilation is the second phenomenon to be treated here in terms of the proposed melodic structure in (29).

As far as element activation is concerned, the distinction between nasals and voiced obstruents rests on the status of N-[comp]: [N] in nasals does not license its [comp], whereas N-[comp] is licensed in voiced obstruents.

In cases of both dynamic alternation and static distribution involving postnasal voicing assimilation ((1a) and (1b) respectively), I suggest that the variable [α] in (24) takes the value of the element [N], and that this instruction is extended to the following non-nuclear position and creates the effect of postnasal voicing. Note that, in order to extend the instruction ACTIVATE [N], a trigger must be lexically active. Otherwise, the process fails to be carried out.

To capture this assimilatory pattern, I employ the following constraint (the validity of which will be discussed in more detail in §6.4).

(38) **PRINCIPLE OF EXTENSION (PEx)**

Extend the domain of ACTIVATE [α] to enhance element interpretability.

PEx requires that the activation of a unit [α] in a particular position is extended to other potential targets in a given assimilatory domain. In the case of postnasal voicing, it is considered that the NC sequence is an assimilatory domain where [N]-interpretability in the nasal of an NC cluster is extended onto the right adjacent obstruent C.
4.5.2 Postnasal voicing and proper government

In the GLP literature (Nasukawa 1995a, 1997, 1998b, Kula & Marten 1998), postnasal voicing assimilation takes place between two onset positions only if they are mediated by an empty nucleus\(^*\) which is followed by a filled nucleus at the nuclear level. This is portrayed in (39). (Nas and Obs denote ‘nasal’ and ‘obstruent’ respectively.)

\[
(39) \quad \begin{array}{c}
\begin{array}{c}
\text{C}_{\text{Nar}} \\
\text{[x]}_{\text{Nuc1}} \\
\text{[x]}_{\text{Nuc2}} \\
\text{C}_{\text{Obs}} \\
\text{[x]}_{\text{Ons1}} \\
\text{Ons2} \\
\end{array}
\end{array}
\]

In the above representation, an empty nucleus Nuc\(_1\) is uninterpreted so that the sequence consisting of Ons\(_1\), Nuc\(_1\), and Ons\(_2\) is phonetically manifested as a string of two consonants. In the framework of GLP (Kaye 1990, 1995; Charette 1990, 1991, 1998; Harris 1994), an uninterpreted empty nucleus such as this must be licensed by the following filled nucleus (40a); otherwise, the position is phonetically interpreted (40b).

\[
(40) \quad \begin{array}{c}
\begin{array}{c}
\text{Prosodic licensing} \\
\downarrow \\
\text{[x]}_{\text{Nuc1}} \\
\text{[x]}_{\text{Nuc2}} \\
\text{[x]}_{\text{Ons1}} \\
\text{Ons2} \\
\text{C} \\
\emptyset \\
\text{C} \\
\text{[x]}_{\text{Ons2}} \\
\text{V} \\
\text{C} \\
\text{V} \\
\end{array}
\end{array}
\]

Normally a nuclear position without any melodic material manifests itself phonetically

*The idea of empty positions in phonology traces back to Anderson (1982).
as the language-specific neutral vowel of the system in question (Harris 1994: 109). In Japanese this vowel is a high back unrounded vowel \( w \), in English \( a \), in French \( o \), in Spanish \( e \), in Telugu and Korean \( u \), and in Yoruba \( i \) (Archangeli 1984, Kaye 1990, Charette 1990, Harris 1994).

In languages displaying postnasal voicing assimilation, prosodic licensing is assumed to be fulfilled only if the assimilatory process operates between onsets flanking an empty nucleus, as illustrated in (41).^6

\[(41)\]

\[
\text{Prosodic licensing} \quad \downarrow \\
\text{[x]}_{\text{Nuc}1} \quad \text{[x]}_{\text{Nuc}2} \\
\text{[x]}_{\text{Ons}1} \quad \text{[x]}_{\text{Ons}2} \\
\emptyset \\
\]

This is typically true in Japanese, where the permitted consonant clusters -NC- (word-initial [NC- in some dialects) and -CC- always consist of segments with identical source

^6For prosodic licensing to proceed, the other type need specify no conditions in relation to consonants in a given environment. An example is given in the following representation of the English word *family* ‘family’ (Harris 1994: 191).

\[
\text{Prosodic licensing} \quad \downarrow \\
\text{[x]}_{\text{Nuc}1} \quad \text{[x]}_{\text{Nuc}2} \quad \text{[x]}_{\text{Nuc}3} \\
\text{[x]}_{\text{Ons}1} \quad \text{[x]}_{\text{Ons}2} \quad \text{[x]}_{\text{Ons}3} \\
\emptyset \\
\]

The melodically empty nuclear position Nuc\(_3\) is phonetically uninterpreted by virtue of its being properly governed by the filled nuclear position Nuc\(_2\). In this configuration, no processes are required between Ons\(_3\) and Ons\(_2\) — flanking the empty nucleus — which are licensed by Nuc\(_3\) and Nuc\(_1\), respectively.
and place specifications. The direction of assimilation depends, however, on which element type is involved: the righthand consonant influences the lefthand consonant in place assimilation, while the lefthand consonant affects the righthand consonant in voicing and postnasal voicing assimilation. Examples are given from Japanese verb inflexion.

(42) (a) \textit{kaw} + ta (past indic.) $\rightarrow$ \textit{katta} ‘bought’
(b) \textit{tor} + ta $\rightarrow$ \textit{totta} ‘took’
(c) \textit{kam} + ta $\rightarrow$ \textit{kanda} ‘chewed’
(d) \textit{tob} + ta $\rightarrow$ \textit{tonda} ‘flew’
(e) \textit{tog} + ta $\rightarrow$ \textit{toida} ‘ground’

In terms of element activation, this is captured according to (43).

(43)

Ons$_2$ loses a lexically-active resonance element, and instead, is influenced by a resonance element in Ons$_3$. A detailed discussion of this mechanism lies beyond the scope of the present work. Briefly, however, we may observe that the direction of assimilation in the
case of resonance elements reflects the direction of proper government\(^{10}\), due to the fact that the triggering resonance element is only present when followed by a filled nucleus.

In contrast, I assume that the rightward extension of [N] is reflected in the directionality of inter-nuclear licensing. Languages like Japanese exhibit rightward inter-nuclear licensing; and this directionality is mirrored in [N]-activation between two adjacent onset positions separated by an empty nucleus: inter-nuclear licensing is reflected in inter-onset licensing since onsets are licensed by their head nuclei. Consequently, [N] is interpreted in each onset position in question. Accordingly, the input representation of \(\tilde{\text{sinde}}\) (< \(\tilde{\text{sin}} + -\text{te}\)), which is taken from the examples in (11), is as follows.\(^{11}\)

\[(44) \quad \text{Input} \]

\[
\begin{align*}
\text{Ons}_2 & & \text{Ons}_3 \\
\text{Nuc}_2 & & \text{Nuc}_3 \\
\tilde{s} & i & n \quad t & e
\end{align*}
\]

(44) gives the representations of \(n\) and \(t\). I follow Harris (1994) and Harris & Lindsey (1995) in assuming that \(t\) consists of the edge ('occlusion') element [?], the noise element [h] and the rise ('coronal') element [R]. The structure of \(n\) consists of [?] and [N] with no [comp]. For the convenience of the present discussion, I omit other element material, which is assumed to reside latently in non-nuclear positions.

In the input form in (44), Ons\(_2\) and Ons\(_3\) flank an empty nucleus Nuc\(_2\), forming


\(^{11}\)Unlike the melodic representations encountered in Backley (1998), those above the (skeletal) positions involve no geometrical implication. For the convenience of the present discussion, I portray such a structure.
two adjacent onsets at the level where onset heads are projected; Ons₂ contains a lexically active [N], so it triggers postnasal voicing assimilation — PEx ([N]). Although the expected output is (45b), in fact (45a) is the attested output representation.

(45) (a) *(b)

\[
\begin{array}{c}
\text{PEx}[N] \\
\checkmark \\
\checkmark
\end{array}
\]

4.5.3 *[h, N] and PARSE (strong)

In order to formally eliminate (45b) from the system, I first consider the constraint which refers to the relation between [h] and [N]. As argued in §3.6, we observe some degree of cross-linguistic variation in the way these properties combine. In the majority of languages — where nasals but not prenasalised obstruents appear, the cooccurrence of [h] and [N] in a single position is forbidden. In contrast, languages displaying both nasals and prenasalised obstruents allow the combination of [h] and [N]. This variation in cooccurrence may be captured by the following parametric constraint.

(46) **Parameter *[h, N] [h] and [N] are mutually exclusive in melodic expressions**

<table>
<thead>
<tr>
<th>Setting</th>
<th>Example languages</th>
<th>ON</th>
<th>OFF</th>
<th>The majority of languages</th>
<th>✓</th>
<th>Fijian, Northern Tohoku Japanese, etc.</th>
<th>✓</th>
</tr>
</thead>
</table>

In the case of Yamato Japanese — which disallows prenasalised obstruents — the ON
This kind of cooccurrence restriction is widely adopted in element-based vocalic models. For example, the most widespread vowel system of all exploits the five vowels $a, i, u, e, o$, which are generated by combining the elements $[A], [I]$ and $[U]$ under the condition that $[I]$ and $[U]$ are mutually exclusive in a single segment (normally expressed using a combined $[I]$-[U] tier).

(47)  
*I[I, U]  

\[
\begin{align*}
&\text{(a) } [A] \ a \quad [I] \ i \quad [U] \ u \quad [I, A] \ e \quad [U, A] \ o \\
&\text{(b) } *[I, U] \ \ddot{u} \quad *[I, U, A] \ \emptyset
\end{align*}
\]

The restriction *$[I, U]$ permits the representations in (47a), but excludes the elemental compounds in (47b). In contrast, languages like Swedish, which allow the cooccurrence of $[I]$ and $[U]$ in a single position, utilise all the expressions in (47).

The difference between a vocalic constraint like *$[I, U]$ and one such as *$[h, N]$ arises in its relation with other constraints. On the one hand, *$[I, U]$ is absolute: the combination of $[I]$ and $[U]$ is never allowed in systems where *$[I, U]$ functions. On the other hand, in relation to the principle of N-[comp] LICENSING, $[h]$ and $[N]$ may cooccur in languages selecting the ON mode of *$[h, N]$. In languages exploiting long-lead voicing, as discussed in §3.6, N-[comp] must be licensed along two different paths in accordance with N-[comp] LICENSING: melodically endocentric licensing by $[N]$ and exocentric licensing by $[h]$. This cooccurrence of $[h]$ and $[N]$ is necessary to activate N-[comp]. Conforming with the universal principle of N-[comp] LICENSING, the parametric constraint *$[h, N]$ in (46) is reformulated as follows.

(48)  
*I[h, N]:  

$[h]$ and $[N]$ are mutually exclusive in melodic expressions iff they have no licensee.
Given all the constraints (PEx ([N]), *[h, N] and N-[comp] LICENSING) discussed so far, we identify (45b) as ill-formed since it violates *[h, N] in Ons₃, while (45a) satisfies all the constraints in question. This is illustrated in (49b) and (49a) respectively.

(49)  (a) *(b) *(c)

One may suggest that *[h, N] be satisfied by suppressing the lexically-active [h] to derive the structure of Ons₃ in (49c). This operation is not permitted, however, because Japanese demands that all the lexically-active elements in foot-internal onset positions followed by a filled nuclear position be parsed. In (50a), further examples show that lexically-active melodic units are suppressed only in foot-internal positions which are followed by an empty nucleus. (Empty nuclei are symbolised by □. Sounds in boldface are represented with their internal structure. Suppressed melodic units are bracketed by < >.)
(50)  

(a)  

(i)  \( ka.w \) + \( ta \) (past indic.) \( \rightarrow \)  
\( ka.r\).\( ta \)  
‘bought’  
\( [U] \)  
\( [R, ?, h] \)  
\( [<U>, R, ?, h][R, ?, h] \)  

(ii)  \( ka.m \) + \( ta \) \( \rightarrow \)  
\( ka.n\).\( da \)  
‘chewed’  
\( [U, ?, N] \)  
\( [R, ?, h] \)  
\( [<U>, R, ?, N][R, ?, h, N, N-{comp}] \)  

(iii) \( to.b \) + \( ta \) \( \rightarrow \)  
\( to.n\).\( da \)  
‘flew’  
\( [U, ?, h, N, N-{comp}][R, ?, h] \)  
\( [U, ?, N, <N-{comp}>][R, ?, h, N, N-{comp}] \)  

(iv)  \( ka.k \) + \( ta \) \( \rightarrow \)  
\( ka.i\).\( ta \)  
‘wrote’  
\( [@, ?, h] \)  
\( [R, ?, h] \)  
\( [@, ?, h][R, ?, h] \)  

(v) \( to.g \) + \( ta \) \( \rightarrow \)  
\( to.i\).\( da \)  
‘ground’  
\( [@, ?, h, N, N-{comp}][R, ?, h] \)  
\( <[@, ?, h, N, N-{comp}>][R, ?, h, N, N-{comp}] \)  

(b)  

(i) \( sa.bi \) + \( ta \) \( \rightarrow \)  
\( ka.b\).\( ta \)  
‘rusted’  
\( [U, ?, h] \)  
\( [R, ?, h] \)  
\( [U, ?, h][R, ?, h] \)  

(ii) \( si.mi \) + \( ta \) \( \rightarrow \)  
\( si.m\).\( ta \)  
‘penetrated’  
\( [U, ?, N] \)  
\( [R, ?, h] \)  
\( [U, ?, N][R, ?, h] \)  

(iii) \( ma.ne \) + \( ta \) \( \rightarrow \)  
\( ma.n\).\( ta \)  
‘imitated’  
\( [U, ?, N, N-{comp}][R, ?, h] \)  
\( [U, ?, N, N-{comp}][R, ?, h] \)  

(iv) \( ma.ke \) + \( ta \) \( \rightarrow \)  
\( ma.k\).\( ta \)  
‘be defeated, lost’  
\( [@, ?, h] \)  
\( [R, ?, h] \)  
\( [@, ?, h][R, ?, h] \)  

(v) \( na.ge \) + \( ta \) \( \rightarrow \)  
\( na.g\).\( ta \)  
‘threw, cast’  
\( [@, ?, h, N, N-{comp}][R, ?, h] \)  
\( [@, ?, h, N, N-{comp}][R, ?, N] \)  

Although suffix-initial onsets occur foot-internally in inflected forms and some of them exhibit the addition of lexically-unspecified elements through the influence of neighbouring sites, they do not show any melodic suppression, since they precede a filled nucleus. In contrast, the examples in (50b) show a stem-final nucleus that is melodically filled. In this case, its preceding onset position is never subject to melodic suppression.

In addressing the question of why melodic suppression takes place only in foot-internal onset positions followed by empty nuclear positions, I follow Harris (1994, 1997) and assume that phenomena of this type in Japanese are sensitive to the prosodic hierarchical architecture which is established via phonological licensing. In this
framework, the licensing relations relevant to the example in (50a) are represented as follows.

(51)

As illustrated above, all phonological units except the head of the domain are licensed according to the PHONOLOGICAL LICENSING PRINCIPLE (Kaye 1990). Differences in the structure of prosodic licensing paths are mirrored by differences in the melodic licensing potential of positions. In order to license melodic units, prosodic positions inherit licensing potential from their licensors (LICENSING INHERITANCE: Harris 1992, 1994, 1997). A position located relatively distant from the ultimate source of the potential (Nuc1) may receive less potential to license melodic units (see §5.3 for a more detailed discussion). Accordingly, many languages (e.g. Spanish, Ibibio) suppress units of melodic structure in those positions which receive less licensing potential than Ons1.

In the case of Japanese, I assume that the suppression of elements occurs not only in those positions located relatively low down a licensing path, but also in those licensed by an empty nucleus. The latter possesses less potential than a filled nucleus to pass on to its dependents, itself having received less potential from the domain head because it does not license any melodic units. In contrast, other onset positions do not allow the suppression of melodic units, since the filled nuclei that follow them have/receive more potential to license melodic units. Here, I shall label positions in Japanese like Ons2 in (51) weak positions, and those like Ons1 and Ons3 strong positions in Japanese.

To avoid the suppression of [h] in the Ons3 position in (49c), I assume that Japanese selects the following constraint.
Chapter 4. An integrated approach to nasality and long-lead voicing

(52) **PARSE (strong)**

Do not suppress lexically active properties in prosodically strong sites.

A similar idea is found in Optimality theory (OT)-oriented frameworks (Beckman 1997, Kager 1999), where this type of constraint is known as **positional faithfulness** and employs one of the faithfulness constraints, IDENT-IO \((\alpha, \beta)\), which prescribes that an output segment standing in the \(\beta\) position has the same value for the feature [\(\alpha\)] as its input correspondent. In both IDENT-IO \((\alpha, \beta)\) and the constraint in (52), the arguments vary from system to system. The difference between these constraints relates to violability: IDENT-IO \((\alpha, \beta)\) is violable whereas PARSE (strong) is not. However, both IDENT-IO \((\alpha, \beta)\) (like other faithfulness constraints) and PARSE (strong) are motivated by psycholinguistic evidence which demonstrates the perceptual salience of the relevant contexts (Beckman 1997).

Under the constraint PARSE (strong), suppressing the lexically-active [h] in (49c) is prohibited except in weak positions like Nu_c in (51). Accordingly, in order to fulfil the required activation instruction in accordance with the given structural restrictions, I claim that the activated [N] in Ons\(_1\) must license its [comp] in Japanese, as illustrated in (45a/49a). This is because [N] can occur with the noise element [h] only if it licenses its [comp]. The output sequence nd results.

(53) (a) *(b) *(c)

\[
\begin{array}{c}
\text{PEX}[N] \\
\text{*}[h, N] \\
\text{N-[comp]LaC} \\
\text{PARSE(strong)}
\end{array}
\]

\[
\begin{array}{c|c|c|c}
\text{PEX}[N] & \checkmark & \checkmark & \checkmark \\
\text{*}[h, N] & \checkmark & \times & \checkmark \\
\text{N-[comp]LaC} & \checkmark & \checkmark & \checkmark \\
\text{PARSE(strong)} & \checkmark & \checkmark & \times
\end{array}
\]
Thusfar, with recourse to ET and the proposed N-[comp] distinction, I have offered an analysis of the behaviour of nasals in Yamato Japanese, calling on the lexical instruction ACTIVATE [N], the element cooccurrence restriction *[h, N] and PARSE (strong).

In contrast to the analysis in Itô et al (1995), where two different primes [voice] and [nasal] are utilised, I have offered an account of the paradoxical behaviour of nasals in a framework where both nasality and voicing are expressed using the active/inactive status of the N-[comp]. An additional advantage of my analysis is that it can provide an account of verbal inflexion, which I consider in the following subsection.

4.6 The appearance of [N] in verb-stem-final b

4.6.1 Earlier work within ET

In the verbal inflexion of Yamato Japanese, the stem-final b in a verbal stem such as tob 'to fly' is interpreted as a nasal that is homorganic with the initial obstruent of a suffix such as -te (gerundive).\(^\text{12}\) This phenomenon has been analysed within many different theoretical approaches (McCawley 1968, Ashworth 1976-77, Poser 1986, Davis & Tsujimura 1991, Yoshida 1991). All of these analyses are wholly dependent on stipulative rewrite rules. Below I shall discuss Yoshida's analysis, which is based on a version of ET, and then offer an alternative analysis which has recourse to the proposals presented above.

Regarding the appearance of nasality in verb-stem-final b, Yoshida provides two possible analyses. The first proposes that an ambient nasality element [N] is added to the stem-final b, converting the b into m (which also assimilates to the place specification of the following segment). The second proposal suggests that b in Japanese contains the

\(^{12}\)b~m variation was also common in Old Japanese (Miller 1967). The variants are still observed in a few words (e.g. samišii ~ sabišii 'sad') in modern Japanese.
Chapter 4. An integrated approach to nasality and long-lead voicing

[N] element in its underlying internal structure, which receives interpretation in the process in question. In (54), the first analysis is shown in the concatenation of *tob 'to fly' and -te (gerundive).

\[
\begin{align*}
\text{(54) a.} & \quad \text{O N O N O N} \\
\text{b.} & \quad \text{O N O N O N} \\
\text{c.} & \quad \text{O N O N O N}
\end{align*}
\]

In (54b), an ambient [N] appears in the second onset, which does not contain [N] lexically. In the absence of any obvious lexical source for the [N] in (54a), the process might be viewed as one of [N]-epentheses. However, this treatment is clearly *ad hoc*, and in order to eliminate this arbitrariness, we need to identify the source of [N].

The second analysis suggested by Yoshida provides no theoretical reason why \( b \), as opposed to any other segment, underlyingly possesses [N].

4.6.2 Nasal alternation in \( b \) and \([N]/N-[\text{comp}]-\text{activation}\)

Following the same line of argument employed in the description of postnasal voicing in §4.5, I now provide an alternative analysis of the b-nasal alternation in Japanese. In my analysis, the input structure of *tonde* \((< tob + -te)\) is represented as follows:
The process in question is almost identical to that discussed in the analysis of postnasal voicing assimilation. In accordance with the account in §4.5, Ons₂, which is followed by an empty nucleus and contains a lexically active [N], becomes a trigger for voicing assimilation. Notice that the active status of N-[comp] is irrelevant here; what matters is that this element [N] is lexically active. In the following position Ons₃, as a result, [N] is activated in order to satisfy ACTIVATE [N]. We may, for example, consider the following candidates as output.

All the forms in (56) satisfy the instruction ACTIVATE [N]. However, each violates one of the constraints — either *[h, N], PARSE (strong) or *[N-[comp]N-[comp]]. The representation in (56a), for example, violates the constraint *[h, N] which establishes the
mutual exclusion of [h] and [N] when no [comp] is licensed within a position. This constraint is satisfied in (56b), but this form violates the obligatory parsing of lexically active elements in prosodically strong positions — Parse (strong). The candidate in (56c) is well-formed with respect to these two constraints, but creates a sequence which is ruled out by the constraint *N-[comp]N-[comp] discussed in (37).

In order to conform to all the given constraints and arrive at the structure of Onsj in (56c), Japanese alters some parts of Onsj in the stem — to which the constraint Parse (strong) is blind. In this case, note that [N] in Onsj in the stem cannot be deactivated since it is a trigger for [N]-activation. Focusing on the melodic representation below the positions, we identify [h] and N-[comp] as the targets subject to alteration. In this context, three kinds of alteration are logically possible in the Onsj position: (i) only [h] is deactivated; (ii) only N-[comp] is deactivated; (iii) both [h] and N-[comp] are deactivated. The first alteration is shown in (57a), which is ill-formed since the principle of N-[comp] Licensing (which requires that N-[comp] — the complement of its head [N] — must be licensed by an active [h]) is violated. (The mark ♦ below Onsj indicates that the melody unit is not interpreted.)

\[
(57) \quad \text{*(a)} \quad \quad \text{*(b)} \quad \quad \text{(c)}
\]

The second alteration, illustrated in (57b), is also ill-formed this time, because it violates *[h, N]. In the remaining structure given in (57c), the N-[comp] and [h] in Onsj lose their
active status together. We conclude that this is the only means of complying with all the
given conditions and of generating a well-formed output.

Thus, in contrast to Yoshida's proposal, the analyses of the \(b\)-nasal alternation
and postnasal voicing assimilation are integrated under a single explanatory mechanism
which directly links voicing and nasality.

4.7 Summary

In this chapter, I have discussed the apparently paradoxical behaviour of voicing in nasals
in Yamato Japanese: voice is apparently specified for a nasal in voicing assimilation; on
the other hand, it is apparently unspecified for a nasal which is transparent to Lyman's
Law, the latter prohibiting two voicing specifications in a word domain. I also raised the
question of a related problematic phenomenon: the nasal alternant of the stem-final \(b\) in
verbal suffixation.

In order to explain this paradox, I introduced the notion of complement tier
applied to \([N]\). This was developed within the context of the tier geometry model: if \([N]\)
licenses its [comp], the whole is interpreted as voicing; otherwise it manifests itself as
nasality. This approach permits the elimination of the element [L] (voicing) from the
inventory of elements. With this structural operation I have adopted the principle of N-
[COMP] LICENSING, the parametric constraint PEx [N], \(*[h, N]\), PARSE (strong) and \(*N-
[cmp]N-[comp]\), and analysed all three phenomena under these conditions.

One advantage of my analysis over earlier works discussed in this paper is that
postnasal voicing assimilation and the \(b\) -nasal alternation are given a unitary analysis.
In addition, the analysis does not make use of any redundancy implications, cooccurrence
rules/constraints or the major-class feature [sonorant].

In order to validate the proposed structures contributing nasality and voicing, the
next chapter will consider spontaneous nasalisation and prenasalisation.
5 Prenasalisation and nasalisation of voiced obstruents

5.1 Introduction

This chapter presents additional evidence for the proposed structures of nasality and voicing by analysing spontaneous prenasalisation (henceforth SPN) and spontaneous velar nasalisation (henceforth SVN) found in several dialects of Japanese. SPN is an alternation between voiced plosives and prenasalised voiced plosives. SVN is an alternation between voiced velar plosives and nasalised voiced velar plosives. Both take place in the absence of any obvious lexical source for nasality and occur in the same intervocalic context which typically displays consonantal lenition. The former process is observed in the northern Tohoku dialect of Japanese (henceforth NTJ), while the latter is often found in conservative Tokyo Japanese (henceforth CTJ).

Unlike previous analyses, the proposed structures offer the benefit of identifying nasality in the source of the processes: a nasal element is lexically present in the targets of the processes — voiced obstruents — in which voicing is interpreted in a complex expression containing a nasal prime and its complement tier. Coupled with the principle of Licensing Inheritance (Harris 1994, 1997), both processes involving nasality are regarded as lenition of the complement tier in intervocalic sites. There is thus no need to introduce arbitrary notions such as lexically floating nasality or rules like nasal insertion (Kanai 1982).

The chapter is structured as follows. In §5.2 I focus on SPN in NTJ (§5.2.1) and outline an orthodox account of the processes (§5.2.2). §5.3 explores the mechanism of intervocalic lenition in the light of Licensing Inheritance. In §5.4 I propose an

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1Some Shikoku dialects of Japanese display a similar phenomenon.

2The same phenomenon is also found in some northern Kanto dialects of Japanese.
5.2 Spontaneous prenasalisation in Northern Tohoku Japanese

5.2.1 The distribution of prenasalised segments

The NTJ dialect is spoken in the northern part of the Tohoku area of Mainland Japan, and is distinguished by the prenasalisation process shown below.

(1) NTJ

\[
\begin{array}{ccc}
\text{çi} & + & \text{daruma} & \rightarrow & \text{çi}^*\text{daruma} \\
\text{‘fire’} & & \text{‘Dharma’} & & \text{‘be covered with flames’} \\
\text{tsuu} & + & \text{gakko} & \rightarrow & \text{tsu}^*\text{gakko} \\
\text{‘middle’} & & \text{‘school’} & & \text{‘junior high school’} \\
o & + & \text{baasan} & \rightarrow & \text{o}^*\text{basan} \\
\text{‘grandmother’} & & \text{‘grandmother (polite form)’} \\
niyu & + & \text{fä}^*\text{ga} & \rightarrow & \text{niyu}^*\text{fä}^*\text{ga} \\
\text{‘meat’} & & \text{‘potato’} & & \text{(name of a dish)}
\end{array}
\]

The NTJ examples given in (1) illustrate the process of compounding in this dialect: if the first segment of the second member of a compound is a voiced obstruent, then this segment is interpreted as its prenasalised reflex. This occurs only in an intervocalic

\[\text{Some exceptions exist. See Inoue (1967) and Iitoyo (1998) for discussion.}\]
environment, and targets only voiced oral plosives. The characteristics of this dynamic process are also reflected in the lexical distribution of prenasalised plosives.  

(2) Tokyo Japanese  NTJ

(a) kagi  ‘key’  ka"gi
saga  ‘destiny’  sa"ga
igaiga  ‘thorny’  i"gai"ga

(b) hada  ‘skin’  ha"da
kuda  ‘pipe, tube’  ku"da
ido  ‘well’  i"do

(c) kabu  ‘turnip’  ka"bu
kiba  ‘tusks’  ki"ba
sabi  ‘rust’  sa"bi

Comparing the Tokyo dialect forms in (2) with the corresponding NTJ forms, it can be seen that all intervocalic plosives may exhibit prenasalisation.  

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4 It has been argued from both diachronic and synchronic perspectives that prenasalised plosives in NTJ are derived from the prenasalisation of voiced oral plosives (Inoue 1967, Ashworth 1976-77, Kanai 1982).

5 This dialect exhibits other alternations involving alveolar: voiced alveolar obstruents are prenasalised and interpreted as prenasalised affricates before high vowels:

midzu  ‘water’  →  m"dzu
kuji  ‘lottery’  →  ku"ji (regional)

Not only in cases involving prenasalisation but also in all other cases, alveolar obstruents become affricates when they are followed by high vowels:

tsumiki  ‘bricks’  →  tsumiki
katsuo  ‘bonito’  →  kadzuo

This kind of alternation can be analysed as local place assimilation, but it is beyond the scope of the present discussion to pursue its mechanism here.
In comparison, neither voiced oral plosives in either word-initial or foot-initial position (see Vance 1987), nor the voiceless cognates of plosives in intervocalic position, undergo the process. This is illustrated below.

(3) Tokyo Japanese   NTJ

(a)  
 gakkoo  ‘school’  gakkoo   *gakko  
daruma  ‘Dharma’  daruma  *daruma  
baku  ‘tapir’  bayu  *baku

(b)  
kaki  ‘persimmon’  kayi  *ka*gi  *ka*ki  
saka  ‘slope’  saya  *sa*ga  *sa*ka  
hata  ‘flag’  hata  *ha*da  *ha*ta  
kata  ‘shoulder’  kata  *ka*da  *ka*ta

As shown in (3a), word-initial position fails to support the prenasalisation of voiced oral plosives. Furthermore, the process may only target voiced plosives; the alternation in (3b) shows that intervocalic voiceless plosives never become prenasalised. Instead, the voiceless stops are potential targets for vocalisation.

Interestingly, the neighbouring dialect of Southern Tohoku Japanese (henceforth STJ) also exhibits voiceless plosive vocalisation in the (3b) environment. In the Southern system, however, it is voiced cognates, as well as voiceless plosives, that undergo the

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4 In the consonantal inventory of modern Japanese (including the dialect in question), the distribution of the voiceless bilabial plosive is lexically restricted: it can appear only as a full geminate (e.g. kappa ‘water imp’) or as the second part of a NC sequence (sampo ‘stroll’). Therefore, it is never found in the intervocalic environment in (3b).

5 The intervocalic reflexes of voiceless plosives in the Tohoku dialect in general have been regarded as voiced counterparts — *g and *d (Inoue 1967, Kanai 1982). However, my own research shows that the reflexes are not *g and *d, but the voiced approximant y and voiced alveolar tap r respectively.
Chapter 5. Prenasalisation and nasalisation of voiced obstruents

process. The examples in (4) show the neutralisation of voiced and voiceless plosives in the Southern dialect.

(4) Tokyo Japanese STJ

(a) kaki 'persimmon' kagi 'key'

(b) hata 'flag' hada 'skin'

5.2.2 Nasal insertion

The literature provides several accounts of the voiced plosive prenasalisation effect illustrated above (Inoue 1967, Muraki 1970, Itoyo 1998). The approach adopted by Kanai (1982) uses the following rewrite-rule in his analysis:

(5) **Nasal Insertion**

\[ \emptyset \rightarrow [n/\eta] / V \_ [d/g]V \]

The structural change in (5) takes place exclusively before intervocalic voiced plosives, where the resulting sequence — an inserted nasal and a lexically given voiced oral plosive — is analysed as a prenasalised plosive. This treatment may be viewed as 'voiced plosive fortition'.

However, Kanai's analysis ignores the case of prenasalisation on a voiced bilabial plosive b, which is targeted in the same way as d and g. Moreover, the rule in (5) does not overtly address the two fundamental issues of (i) why the process occurs only in an
intervocalic environment, and (ii) why the process affects only voiced oral plosives. The NASAL INSERTION rule in (5), as with other types of rewrite rules, provides no formal link between a process (nasal insertion) and the context in which it occurs (the position immediately preceding an intervocalic voiced plosive). The arbitrariness of this analysis stems from the very nature of a rule-oriented approach, where the output of the rule and its environment stand as independent entities. In what follows I shall develop a non-arbitrary account of why prenasalisation affects only intervocalic b, d and g.

5.3 Intervocalic sites as contexts favouring lenition

In developing an alternative analysis of prenasalisation in NTJ, I begin by examining the context where the phenomenon takes place.

As already noted in §5.2.1, the process is observed only in intervocalic position — a site well-known to favour lenition (Lass 1984; Harris 1994, 1997; Harris & Lindsey 1995): Spanish, Ibibio, English, Korean and many other languages exhibit this kind of phonological process. The following examples are taken from Harris (1997).

(6) (a) Ibibio spirantisation  
\( \text{dip} \) ‘hide’  \( \text{di} \text{be} \) ‘hide oneself’  
\( \text{fAk} \) ‘cover’  \( \text{fAy} \text{g} \) ‘cover oneself’

(b) English t-tapping  
\( \text{pi}[/\text{ly}  

In Ibibio, \( p \) and \( k \) weaken intervocically to \( \beta \) and \( y \) respectively; and in the same context a number of English systems show t-tapping.

In addressing the question of why phenomena of this type are particularly prevalent in intervocalic position, Harris (1994, 1997) draws on the notion of licensing — a head-dependent relation that controls all aspects of phonological architecture in accordance with the following principle (Kaye 1990):
Chapter 5. Prenasalisation and nasalisation of voiced obstruents

(7) **PHONOLOGICAL LICENSING PRINCIPLE**

Within a domain, all phonological units must be licensed save one, the head of that domain.

Phonological licensing manifests itself in one of two guises: p[rosodic]-licensing defines a licensing relation established between two positions in prosodic structure, while a[utosegmental]-licensing describes the licensing relation between a melodic unit and a prosodic position. The following structure illustrates these two kinds of licensing relation:

![Diagram](image)

In (8), Nuc₁ is the ultimate head of the p-licensors in the domain. Ons₁ (its preceding onset) and Nuc₂ (another nucleus in the domain) are directly p-licensed by Nuc₁ at the inter-constituent and the foot level respectively, whereas the onset Ons₂ is indirectly p-licensed by Nuc₁ through Nuc₂ at an inter-constituent level.* Differences in the architecture of the p-licensing paths shown in (8) are mirrored by differences in a-licensing potential. A position located relatively low down a licensing path will enjoy less distributional freedom than one located higher up. A direct implication for consonant distribution is that a greater number of contrasts may be supported by Ons₁ than by Ons₂, owing to differing amounts of a-licensing potential inherited by a p-licensee from its p-licensor. The following formulation (Harris 1992, 1994, 1997) defines this asymmetric relation:

*Thus an onset is universally licensed by its following nucleus. For details, see the definition of Onset Licensing in Harris (1994: 160).
(9) **Licensing Inheritance**

A licensed position inherits its a-licensing potential from its licensor.

The a-licensing potential of a position may be equated with the capacity of that position to support melodic oppositions. (9) requires that, whenever two positions enter into a p-licensing relation, the p-licensed position must gain a-licensing potential (directly or indirectly) from its p-licensor. The a-licensing potential inherited from the p-licensed position is, however, less than that possessed by its p-licensor, since, each time a position is p-licensed, the stock of a-licensing potential is depleted. As a result, this difference in the amount of a-licensing potential possessed by a p-licensor and its p-licensee is reflected in the unequal capacity of each position to support units of melodic structure. Specifically, the melodic structure of a p-licensee can be no more complex than that of its p-licensor.

This means that lenited consonants such as those in (6) may be identified as segments occupying the lowest positions on the licensing path in a given domain. An example from (6a) demonstrates this:

(10)

Following the principles of Prosodic Licensing and Licensing Inheritance, the representation in (10) shows why lenition is favoured in a foot-internal environment. A prosodically weak position is able to support a relatively small set of lexical contrasts — hence, we find a tendency for neutralisation to occur in this context.
Evidence for the existence of foot structure is also available in Japanese, where lenition fails in coordinate compound nouns derived from Yamato-Japanese morphemes. For example, k in *širokuro* ‘white and black’ (< *širo* ‘white’ + *kuro* ‘black’) is not subject to lenition since it is intervocalic but not foot-internal. Each of the two members of the compound has its own foot domains: i.e. *[širo][kuro]* but not *[širokuro]* (feet indicated by double-brackets).

Independent evidence to support Japanese foot structure comes from several phenomena. Some of these are listed below (Poser 1990, Itô 1990).

(11) (a) In loanwords, truncation leaves behind only the first bi-nuclear (bimoraic) foot (e.g. *rokešon* ‘location’ → *roke*).

(b) In compounds, truncation leaves behind only the first bi-nuclear (bimoraic) foot of each member of the compound (e.g. *samušingu erusu* ‘name of a pop band’ → *samueru*).

(c) In hypocoristic name shortenings, the melodic content of the original name is often mapped onto a bi-nuclear (bimoraic) foot template, with an invariant suffix -čaN (e.g. *midori-čaN* → *mido-čaN*, *dori-čaN*).

(d) In reciting telephone numbers, every digit is realised as a bi-nuclear (bimoraic) unit (e.g. the number 256-1483 — which sounds like *ni-go-roku*, *ichi-yon-hachi-saN* in a neutral context — is realised as *niì-goo-roku*, *ichi-yon-hachi-saN*).

---

*Coordinate compounds derived from Yamato-Japanese morphemes are not subject to Rendaku. Unlike other types of compound, the first voiceless obstruent of a compound’s second member does not become voiced (*kusa* ‘grass’ + *ki* ‘tree’ → *kusaki* ‘grass and trees’, *kusagi*) since each compound member has its own foot domain.*
(e) In mimetics, all stems obey a bi-nuclear (bimoraic) foot constraint (e.g. 
_pika_ in _pikapika_ 'shining', _niko_ in _nikoniko_ 'smiling').

As the examples in (3b) have shown, the process of voiceless plosive vocalisation 
in NTJ operates in a similar environment — a foot-internal non-nuclear position.

(12) Lenition of voiceless plosives in Northern Tohoku Japanese

![Diagram for lenition of voiceless plosives in Northern Tohoku Japanese]

The southern Tohoku (STJ) dialect also exhibits lenition in this environment. In 
this system, however, it is voiced plosives, as well as their voiced cognates, that are 
subject to the process:

(13) Neutralisation of voiceless and voiced plosives in Southern Tohoku Japanese

_kayi_ (cf. Tokyo Japanese: _kaki_)

![Diagram for neutralisation of voiceless and voiced plosives in Southern Tohoku Japanese]

To account for lenition of this type we can adopt an approach similar to that taken in the 
case of (10), the one difference being that lexically voiced and voiceless plosives lose 
their voicing contrast in this particular context.

These facts indicate that the prenasalisation observed in NTJ is similarly a 
consequence of lenition in foot-internal weak positions.
In accordance with Licensing Inheritance, we can expect the melodic structure of Ons₂ in (14) to be less complex than that of Ons₁, because a position relatively low down the licensing path inherits a reduced amount of α-licensing potential. This result is inconsistent with Kanai’s analysis, in which prenasalised plosives are treated as being more complex than voiced plosives.

If we accept the analysis in (14), then two questions must be addressed. First, what is the source of nasality in prenasalisation? Second, is it possible to analyse prenasalised plosives as being less complex than voiced plosives? To answer these questions, we must identify the melodic organisation of the relevant segments.

5.4 Prenasalisation as lenition

5.4.1 Element suppression

Employing the elements discussed in §3.3, we may follow Harris (1997) by treating foot-internal lenition as follows (where < > indicates underparsing/suppression):
(15) (a) Labial plosive vocalisation  
\[ P \rightarrow \beta \]
\[ [U, ?, h] \rightarrow [U, <\gamma>, <h>] \]

(b) Velar plosive vocalisation  
\[ k \rightarrow \gamma \]
\[ [@, ?, h] \rightarrow [@, <\gamma>, <h>] \]

(c) \(-t\)-tapping (alveolar plosive vocalisation)  
\[ t \rightarrow \gamma \]
\[ [R, ?, h] \rightarrow [R, <\gamma>, <h>] \]

The vocalisation process is represented in (15) as the suppression of [?] and [h]; the remaining elements [U], [@] and [R] then define a labial approximant, a velar approximant and a tap respectively. Each instance of element suppression reflects the reduced a-licensing potential available in the prosodically weak foot-internal position.

As (16) shows, vocalisation in both NTJ and STJ receives a parallel analysis. Note that the remaining [R] element in (16b) is interpreted in isolation as an alveolar tap.

(16) (a) Velar plosive vocalisation  
\[ ka k i \rightarrow ka \gamma i \]
\[ [@, ?, h] \rightarrow [@] \]

(b) \(-t\)-tapping  
\[ ha t a \rightarrow ha \gamma a \]
\[ [R, ?, h] \rightarrow [R] \]

5.4.2 The melodic representation of prenasalised plosives

Before proceeding to a discussion of voiced plosive prenasalisation as lenition, let us first consider the intrasegmental structure of prenasalised plosives.

Recall the standard element account in §3.6 where it is assumed that the voiced alveolar plosive in (17a) comprises the components of a plain alveolar plosive ([R, ?, h]) together with a voicing element ([L]) (Brockhaus 1992, 1995). The internal structure of
an alveolar nasal (17b), on the other hand, is expressed by the set [R], [?] and [N] (the nasal element) (Harris 1990, 1994). As for the prenasalised stop "d in (17c), this is assumed to consist of all the elements found in (17a) and (17b), on the basis of the fact that "d is the derived reflex of d in voiced plosive prenasalisation in NTJ. The structures given in (23) of Chapter 3 are repeated here as (17).

(17) Provisional representations of d, n and "d

(a) d (b) n (c) "d

[R, ?, h, L] [R, ?, N] [R, ?, h, L, N]

The representations in (17) successfully establish the necessary phonological contrasts: the distinction between d and "d refers to [N]; and "d is distinguished from n by the presence of [h] and [L].

However, these melodic structures do not square with the analysis given in §5.4.1. Recall that lexically given voiced plosives are neutralised in foot-internal position, this environment receiving only a reduced amount of licensing potential that is insufficient to a-license all the lexically specified elements. As discussed in §5.3, this leads us to propose that the melodic structure of "d must be less complex than that of d. This is inconsistent with the representation in (17c).

As already mentioned in §5.3, another problem is the appearance of [N] during the course of the process. If "d has the representation in (17c), then the appearance of [N] during the derivation from d remains unexplained. The arbitrariness of this account sheds little light on the question of why the prenasalisation process only targets voiced plosives.

In order to establish an alternative representation for prenasalised plosives, let us focus on the fact that the prenasalisation process never affects voiceless plosives, but only voiced plosives in intervocalic position. What this indicates is again that the correlation between voicing and nasality — [L] and [N], in elemental terms — must be a key factor in identifying the representation of prenasalised plosives.
Chapter 5. Prenasalisation and nasalisation of voiced obstruents

In order to capture the relation between \([L]\) and \([N]\), I again call upon the proposal that the two primes are in fact the same object, with the difference between voicing and nasality being captured by recourse to the notion of complement tier: if element \([N]\) licenses its \([\text{comp}]\), then it is interpreted as voicing; and the same element, licensing no \([\text{comp}]\), manifests itself as nasality.

(18)

<table>
<thead>
<tr>
<th>Element</th>
<th>Phonetic manifestation</th>
</tr>
</thead>
<tbody>
<tr>
<td>(\text{N})</td>
<td>nasality</td>
</tr>
<tr>
<td>(\text{Comp})</td>
<td>voicing</td>
</tr>
</tbody>
</table>

Following (18), I propose the melodic representations in (19):

(19) (a) \(d\) (b) \(n\) (c) \(\cdot d\)

\([R, ?, h, N, N-[\text{comp}]]\) \([R, ?, N]\) \([R, ?, h, N]\)

In these representations, \(\cdot d\) is distinguished from \(d\) by the absence of \(N-[\text{comp}]\), which behaves as an independent unit. The same sound \(\cdot d\) is differentiated from \(n\) by the presence of \([h]\) (noise).

5.4.3 Complement tier and melodic complexity

Given the representations in (19), voiceless plosive vocalisation in NTJ consists in the suppression of \([?]\) and \([h]\) — see §5.4.1 above. Position \(\text{Ons}_2\) in (20) is prosodically weak and does not receive enough a-licensing potential to sustain \([?]\) and \([h]\).
(20) (a) Voiceless velar plosive vocalisation

(b) Voiceless alveolar plosive vocalisation (t-tapping)

Voiced plosive prenasalisation is also triggered by insufficient a-licensing potential in the same prosodically weak position; in this instance, [N] of the voiced plosive d loses its complement tier:
In the case of NTJ — in contrast to the southern dialect discussed in §5.3 — I propose that the complement tier of [N], in addition to the melodic primes [?] and [h], are sensitive to the degree of a-licensing potential available: N-[comp] becomes a target for suppression in prosodically weak positions. In this approach, tier complements are treated as melodic units on a par with elements — that is, equally susceptible to effects such as melodic suppression.

This account of voiced plosive prenasalisation and voiceless plosive vocalisation allows us to establish a unified analysis — in stark contrast to the orthodox analyses discussed in §5.2 and §5.3, where these phenomena are treated as two unconnected processes, lenition and fortition. Another advantage of the representation in (21) is that it captures the fact that voiceless segments, since they lack [N], are not subject to prenasalisation in a weak context. Voiceless plosive prenasalisation can be observed only if an adjacent morpheme or position possesses [N] in its melodic structure and triggers a fortition process (see §2.5.2). This contrasts with Kanai's rule-based analysis, which predicts not only voiceless plosive prenasalisation but also other kinds of prenasalisation, even if no nasal category is lexically specified. As already mentioned in §5.2.2, this kind of rule-oriented analysis can never establish any formal link between a process and the context where it occurs.
5.5 Spontaneous velar nasalisation

5.5.1 The distribution of the voiced velar nasal

In a context identical to that required for the SPN process, CTJ exhibits SVN (spontaneous velar nasalisation), in which a voiced velar obstruent is fully nasalised. This is exemplified in §1.2.2.2 and repeated below.

\[
\begin{align*}
\text{tsuu} & + \text{gakko} \rightarrow \text{tsuyakko} \\
\text{‘middle’} & \quad \text{‘school’} & \quad \text{‘junior high school’} \\
\text{tei} & + \text{gi} \rightarrow \text{teigi} \\
\text{‘to fix’} & \quad \text{‘faithfulness’} & \quad \text{‘definition’} \\
\text{kai} & + \text{gun} \rightarrow \text{kaigun} \\
\text{‘sea’} & \quad \text{‘army’} & \quad \text{‘navy’} \\
\text{su} & + \text{gei} \rightarrow \text{suigei} \\
\text{‘hand’} & \quad \text{‘art’} & \quad \text{‘handicraft’} \\
\text{kai} & + \text{goo} \rightarrow \text{kaigoo} \\
\text{‘to meet’} & \quad \text{‘to assemble’} & \quad \text{‘meeting’}
\end{align*}
\]

The morpho-syntactic concatenation in (22) requires the first segment of the second member of a compound to be interpreted as its nasalised reflex if that segment is a voiced velar obstruent. This phenomenon does not require any lexical nasality in the given environment; the only condition necessary for the process to apply successfully is that the target must be in an intervocalic context.\(^{10}\)

\(^{10}\)Other examples below show that the process is triggered if a voiced velar plosive is sandwiched between a placeless nasal \(n\) and a vowel.

\[
\begin{align*}
\text{man} & \quad \text{‘full’} \quad + \quad \text{getsu ‘moon’} \rightarrow \text{magetsu ‘full moon’} \\
\text{ken} & \quad \text{‘prefecture’} \quad + \quad \text{gai ‘outside’} \rightarrow \text{kegai ‘outside of prefecture’}
\end{align*}
\]

In this case, spontaneous velar nasalisation is considered to be triggered by the intervocalic context, since \(n\) is syllabic/moraic and behaves like a vowel (Nasukawa 1998a).
In CTJ, the lexical distribution of velar nasals is also subject to this phenomenon, as seen in (23):

<table>
<thead>
<tr>
<th>Non-conservative Tokyo Japanese</th>
<th>CTJ</th>
</tr>
</thead>
<tbody>
<tr>
<td>saga 'destiny'</td>
<td>sa(\eta)a</td>
</tr>
<tr>
<td>kagi 'key'</td>
<td>kagi</td>
</tr>
<tr>
<td>igai ga 'thorny'</td>
<td>i(\eta)ai ga</td>
</tr>
<tr>
<td>kigu 'tool'</td>
<td>kigu</td>
</tr>
<tr>
<td>kage 'shadow'</td>
<td>kage</td>
</tr>
<tr>
<td>kago 'basket'</td>
<td>kago</td>
</tr>
</tbody>
</table>

Compared with the non-conservative Tokyo-Japanese forms in the left column, the CTJ forms to the right never display a voiced velar plosive intervocally. Rather, the corresponding segments are all nasal in this context.

In contrast, a voiced velar obstruent can appear only in word-initial position or the C position of NC clusters. Recall that a similar distributional restriction was noted in the case of SPN earlier in this chapter.

<table>
<thead>
<tr>
<th>CTJ</th>
</tr>
</thead>
<tbody>
<tr>
<td>gaki 'urchin, bully'</td>
</tr>
<tr>
<td>gi(\eta) 'silver'</td>
</tr>
<tr>
<td>gu(\eta) 'army'</td>
</tr>
<tr>
<td>geri 'diarrhoea'</td>
</tr>
<tr>
<td>gomi 'dust, trash'</td>
</tr>
<tr>
<td>k(\eta)geki 'impression'</td>
</tr>
<tr>
<td>k(\eta)gae 'thought'</td>
</tr>
</tbody>
</table>
5.5.2 Licensing and the voiced velar nasal

The complementary status of \( p \) and \( g \) in CTJ can be explained using an analysis identical to that adopted for SPN in §5.3. Under the principles of PROSODIC LICENSING and LICENSING INHERITENCE, \( p \) can occur only in a prosodically weak position which is able to support a relatively small set of lexical contrasts, while \( g \) occupies all other positions. Again, this distribution indicates that SVN observed in CTJ is a manifestation of lenition in foot-internally weak positions.

(25) SVN in CTJ

By showing the element structure of the weakened consonant, we may capture foot-internal lenition as follows.

(26) Voiced velar plosive nasalisation
Unlike SPN in NTJ, SVN is represented in (26) as the suppression of not only N-[comp], but also [h], which is an exocentric licensor of N-[comp]. Since CTJ — which, unlike NTJ, exploits the cooccurrence restriction *[h, N] — prevents prenasalised segments from occurring, the cooccurrence of [h] and [N] without N-[comp] must be excluded. To achieve this, and at the same time suppressing N-[comp], CTJ selects to deactivate [h]. As a result, the remaining elements — [@], [?] and [N] — are interpreted as a voiced velar nasal.

5.6 Summary

In this chapter I have discussed the mechanism of voiced plosive prenasalisation in NTJ and voiced velar plosive nasalisation in CTJ, developing an analysis which treats the process as an instance of lenition.

In accordance with Licensing Inheritance (Harris 1994, 1997), lenition is viewed as a reduction in melodic complexity occurring in prosodically weak sites. In my analysis, this reduction takes place via two mechanisms: the suppression of elements and the suppression of the melodic complement tier. In NTJ, element suppression is found in voiceless plosive vocalisation, while the suppression of the complement tier accounts for voiced plosive prenasalisation. In CTJ, both types of suppression are involved in voiced velar plosive nasalisation. These accounts are made possible by recognizing the proposed structures of nasality and voicing.
6 Assimilatory processes involving nasality and voicing

6.1 Introduction

In this chapter, I shall explore how the proposed representations accommodate the dynamic phenomena of nasal harmony and voicing assimilation, and I also consider why assimilation caused by prenasality is never attested.


Here I attempt to unify these two approaches to the analysis of assimilation by bringing both nasal harmony and voicing assimilation into line with vowel harmony. Ultimately, I conclude that all assimilatory processes are controlled by prosodic hierarchical structure, rather than by any segment-to-segment operation. Underlying this proposal is the assumption that assimilatory processes may be captured within the scope of the generalised constraint PEx ([a]) (Backley 1998), which transmits the lexical instruction ACTIVATE [a] (which is lexically a functional property of the ultimate head of a word-level domain) between prosodic categories in a given span via a licensing path defined by prosodic dependency relations (Harris 1994, 1997). In addition, for the analysis of nasal harmony, I shall discuss the phonetic interpolation of nasality, since this issue will prove to be crucial in presenting a convincing argument for prosody-driven
nasalisation. Furthermore, the approach developed here will reveal why, unlike nasal harmony, long-distance voicing assimilation (i.e. voicing harmony) is unattested cross-linguistically. In addition, I consider why no short or long-distance prenasal assimilation is attested in natural languages.

This chapter is structured as follows. §6.2 discusses distinct aspects of nasal harmony and voicing assimilation. Then in §6.3, I discuss some previous analyses of nasal harmony. In §6.4, in conjunction with the predictions of phonological licensing (Kaye 1990; Harris 1994, 1997), I present a re-analysis of nasal harmony within ET and tier geometry (Backley 1998, Backley & Takahashi 1998). Using an approach similar to that adopted for nasal harmony, §6.5 investigates voicing assimilation and explains why the phenomenon never manifests itself as long-distance harmony. Finally, §6.6 reveals why assimilation caused by prenasality is never attested.

6.2 Classes of target, scope and directionality

To describe the general mechanism of assimilation, the autosegmental literature (Goldsmith 1976, et passim) typically adopts the operation of spreading. Under this notion, the basic mechanism of assimilation is captured by the following scheme:

(1) (a) Input (b) Output

\[
\begin{align*}
\text{Input:} & \quad x_1 \quad x_2 \\
\text{Output:} & \quad \overline{x}_1 \quad \overline{x}_2 \\
\text{[\(\alpha\): unspecified]} & \quad \text{[\(\alpha\): specified]}
\end{align*}
\]

A segment which is unspecified for [\(\alpha\)] acquires the missing prime [\(\alpha\)] from its neighbouring position. As a result, not only the position which is lexically associated to [\(\alpha\)] but also the target position of [\(\alpha\)]-spreading interprets \(\alpha\)-ness phonetically. In the analyses of nasal harmony and voicing assimilation, [\(\alpha\)] is identified as nasality and voice, respectively. Assuming the formulation in (1), we may note three ways in which nasal harmony and voicing assimilation are distinct from one another.
Chapter 6. Assimilatory processes involving nasality and voicing

The first difference refers to the kind of segmental target involved. As for nasal harmony, as already discussed in §2.2.2, the process is cross-linguistically classified into two types: Type I (= Type IV in §2.2.2) shows opacity effects while Type II (= Type III in §2.2.2) exhibits transparency effects. Although both types can affect vowels, we do observe certain classes of consonant which are not subject to the process. These vary from language to language, as shown in (2) for Type I languages (= (9) in Chapter 2).

(2) Opaque segments in Type I nasal harmony

<table>
<thead>
<tr>
<th>Type</th>
<th>Opaque Seg.</th>
</tr>
</thead>
<tbody>
<tr>
<td>IA</td>
<td>Sundanese</td>
</tr>
<tr>
<td>IB</td>
<td>Malay</td>
</tr>
<tr>
<td>IC</td>
<td>Urhobo</td>
</tr>
<tr>
<td>ID</td>
<td>Applecross Gaelic</td>
</tr>
</tbody>
</table>

According to Walker (1998), the majority of languages exhibiting opacity effects belong to either Type IB or Type IC. From these findings, we may thus identify fricatives and plosives as the consonant classes which most typically block nasalisation.

In contrast to Type I, languages belonging to Type II exhibit only a single pattern of transparency: fricatives and plosives are transparent to nasal harmony, and all other segment types always undergo nasalisation.

(3) Transparent segments in Type II nasal harmony

<table>
<thead>
<tr>
<th>Type</th>
<th>Transparent Seg.</th>
</tr>
</thead>
<tbody>
<tr>
<td>II</td>
<td>Guarani</td>
</tr>
</tbody>
</table>

From these transparency (2) and opacity (3) cases, we arrive at the observation that obstruents typically resist nasalisation.
Chapter 6. Assimilatory processes involving nasality and voicing

On the other hand, obstruents are always targets in both types of voicing assimilation: one is triggered by voiced obstruents in languages like Dutch and Polish (voiced-obstruent voicing assimilation) and the other by nasals (postnasal voicing assimilation, as discussed in Chapter 4) in languages like Yamato Japanese. Rarely does the process target sonorants.

(4) Target segments in voicing assimilation

<table>
<thead>
<tr>
<th>Trigger Seg.</th>
<th>Glides</th>
<th>Liquids</th>
<th>Fricatives</th>
<th>Plosives</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vcd obstruents Dutch, Polish</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td></td>
</tr>
<tr>
<td>Nasals       Yamato Japanese</td>
<td>✔</td>
<td></td>
<td>✔</td>
<td>✔</td>
</tr>
</tbody>
</table>

The second difference in behaviour between nasal harmony and voicing assimilation refers to the scope of the assimilatory process. As the term implies, nasal harmony occurs not only between two adjacent positions like (1), but also across a wide-scope domain. This type of [α]-spreading is shown in (5).

(5) (a) Input (b) Output

\[
\begin{align*}
\text{Input:} & \quad x_1 \quad [\alpha] \quad x_2 \quad x_3 \\
\text{Output:} & \quad x_1 \quad x_2 \quad x_3 \quad [\alpha]
\end{align*}
\]

In contrast to (5b), however, autosegmental theory generally considers the spreading device shown in (6b) — where [α] in X₁ skips X₂ and associates to X₃ — to be ill-formed, since it violates the condition of string-adjacency/locality (van der Hulst & Smith 1986; Archangeli & Pulleyblank 1994; cf. Kaye, Lowenstamm & Vergnaud 1990, Harris 1994).
The notion of string-adjacency requires that a given spreading process be local.

On the other hand, voicing assimilation takes place only between two adjacent consonant positions: the trigger may be a voiced obstruent or nasal, whereas the target must be an obstruent. Vowels are never involved in the process.

The third difference in behaviour between nasal harmony and voicing assimilation is concerned with directionality. Within conventional derivational approaches, the direction in which feature spreading operates is determined on a system-specific basis.

(7) Nasal harmony

In the case of nasal harmony, the three possibilities illustrated in (7) present themselves: rightward, leftward and bi-directional spreading.

On the other hand, in the case of voicing assimilation which takes place between two consonant positions, only two patterns of [voice]-spreading are attested: rightward and leftward. These are shown in (8).
(8) Voicing assimilation

(a) \( X_1 \ X_2 \)

(b) \( X_1 \ X_2 \)

\[ \text{[voi]} \qquad \text{[voi]} \]

As discussed in §2.3.4 and §2.3.5, in most languages displaying voiced-obstruent voicing assimilation, the process takes place leftwards as in (8b). Rightward spreading (8a) is found in postnasal voicing assimilation in languages like Yamato Japanese. Both kinds of spreading are attested word-internally and across word boundaries.

In the rest of this chapter I develop a mechanism which accounts for these differences between nasal harmony and voicing assimilation. In the next section I discuss nasal harmony in more detail, then develop an analysis of voicing assimilation.

6.3 Nasal harmony

6.3.1 Opacity and transparency in autosegmental spreading

To account for the behaviour of neutral segments in harmony domains, Piggott (1992) introduces a degree of parametric variation into the structure of nasal consonants. He proposes the following dependency relations (1992: 49):
Chapter 6. Assimilatory processes involving nasality and voicing

(9) The variable dependency of nasality

(a) 
\[
\begin{array}{c}
R = \text{Root node} \\
\quad | \\
SP = \text{Soft Palate node} \\
\quad | \\
[nas]
\end{array}
\]

(b) 
\[
\begin{array}{c}
R = \text{Root node} \\
\quad | \\
SV = \text{Spontaneous Voicing node} \\
\quad | \\
[nas]
\end{array}
\]

In Type I nasal harmony, the feature \([\text{nasal}]\) is a dependent of the Soft Palate node, as in (9a), while in Type II, it is dominated by the Spontaneous Voicing (SV) node. The structure in (9a) is motivated by the strong articulatory correlation between nasality production and the soft palate node articulator, while support for (9b) comes from Avery & Rice (1989), who distinguish non-contrastive voicing in sonorants from contrastive voicing in obstruents.

Piggott proposes that, in the case of Type I, the Soft Palate node is specified in the triggering nasal and opaque segments but generally unspecified in all other segments. In addition, opaque segments employ an SP node but no dependent feature. With this melodic configuration, complete nasalisation is depicted as in (10a), which is taken from Piggott (1992, 1996):

(10) Malay nasal harmony

(a) \textit{māyān} ‘stalk (palm)’ 
\[
\begin{array}{ccccccc}
m & ā & ſ & ā & n \\
\chi_1 & \chi_2 & \chi_3 & \chi_4 & \chi_5 \\
R & R & R & R & R \\
SP & & & [nas]
\end{array}
\]

(b) \textit{mākan} ‘to eat’
\[
\begin{array}{ccccccc}
m & ā & k & a & n \\
\chi_1 & \chi_2 & \chi_3 & \chi_4 & \chi_5 \\
R & R & R & R & R \\
SP & SP & SP & [nas]
\end{array}
\]
In (10a), only the leftmost nasal is specified for the SP node, and it is this SP node itself, rather than the nasal feature, which spreads to the other segments in the domain: as a result, all the segments in the word are nasalised. Spreading is blocked only by opaque segments which employ the SP node but no dependent feature. With the rightward spreading of the SP node, only the leftmost nasal — which contains the SP node with dependent [nasal] — can trigger the process; the opaque segment containing an SP node without [nasal] can never initiate harmony in this way; although the rightmost nasal employs the feature [nasal], it cannot initiate rightward spreading. In short, the trigger must be specified as SP with dependent [nasal], rather than as SP alone.

In contrast, Piggott (1992: 53) regards Type II nasal harmony as the spreading of the feature [nasal] itself. In this case, languages employ the SV node instead of the SP node, which is specified in all sonorants and dominates [nasal]. From this configuration, the following transparency effects achieved:

(11) Southern Barasano nasal harmony

(a) māsā ‘people’

\[
\begin{array}{c}
m \; ā \; s \; ā \\ x_1 \; x_2 \; x_3 \; x_4 \\ R \; R \; R \; R \\ \text{SV} \; \text{SV} \; \text{SV} \\
\end{array}
\]

[b]

(b) wālī ‘demon’

\[
\begin{array}{c}
\tilde{w} \; ā \; t \; ĭ \\ x_1 \; x_2 \; x_3 \; x_4 \\ R \; R \; R \; R \\ \text{SV} \; \text{SV} \; \text{SV} \\
\end{array}
\]

In Type II languages like Southern Barasano in (11), [nasal] — a dependent of the SV node — cannot spread to obstruents which are not specified for the SV node. Without a landing site for [nasal], these segments fail to prevent the spread of nasality to the following segment because the process operates at the level of the SV node. The notion of strict locality is not violated on this tier.

However, the representations in (11) cannot account for another harmonic event — tautosyllabic agreement for nasality — found in Southern Barasano (Piggott & van
der Hulst 1997: 99) and all other Type II languages. This phenomenon is exemplified as follows:

(12) Southern Barasano

(a) rimā  ‘poison’  (b) *wāfī
romīō  ‘woman’  *yurā
yi-mā  ‘they say’  *dirō
hati-amī  ‘he sneezes’  *hikorī

In the example language of Southern Barasano, nasal agreement is a rightward process, resulting in a distributional restriction where nasalised liquids and semivowels must be followed by nasal vowels and their oral counterparts can appear only before oral vowels. We never find strings such as those given in (12b), where oral liquids and semivowels are followed by nasal vowels. This distribution pattern indicates that the nasalisation of sonorants in Southern Barasano is independent of the rightward harmonic agreement of nasality, since sonorants to the left of a nasal vowel must be nasal, never oral. This obligatory rightward sonorant nasalisation can be identified as tautosyllabic sonorant-vowel agreement for nasality, and cannot be explained merely by the rightward spreading operation in (11). Instead, we need an additional device to account for this event.

6.3.2 Nasality as a property of prosodic categories

To provide an account of the obligatory agreement for nasality within syllables according to the Type II harmony pattern, Piggott & van der Hulst (1997) retain the geometric structure in (9a) and propose that nasality may exist not only as a property of the melodic part of a segment, but also as that of a prosodic category (i.e. syllable, foot). In this way, the harmonic agreement of nasality (= [nas] in feature terms) is expressed as follows.
Chapter 6. Assimilatory processes involving nasality and voicing

(13) (a) \( \text{[nas]} \) (b) \( \text{[nas]} \) (c) \( \text{[nas]} \)

\[ x_1 x_2 x_3 x_4 \]

\[ \sigma_1 \sigma_2 \sigma_3 \sigma_4 \]

\[ Ft_1 Ft_2 Ft_3 Ft_4 \]

The representation in (13a) shows that the lexically given [nasal] in the leftmost position is specified in the other positions at a string-adjacent level in the output form. On the other hand, the representations in (13b) and (13c) exhibit a prosodically-oriented [nasal]-agreement: [nasal] is a lexical property of the leftmost syllable in (13b) and of the leftmost foot in (13c), and is then specified in the remaining syllables/feet in the output following harmonic agreement.

Harmony of this sort, between prosodic categories, is found elsewhere in the literature. Several analyses of vowel harmony are based on this type of model (Anderson & Ewen 1987, Lowenstamm & Prunet 1988, Archangeli & Pulleyblank 1994, Harris & Moto 1994, Harris & Lindsey 1995, van der Hulst & van de Weijer 1995, Humbert 1995, Cobb 1997, Backley 1998, Backley & Takahashi 1998, Charette & Göksel 1998). For example, within the framework of Dependency Phonology (DP), Anderson & Ewen (1987:278) allow the melodic prime to be a lexical property of a prosodic node in their analysis of Khalkha Mongolian palatal harmony. An example word is given in (14), in which the palatal prime \{i\} is lexically specified in the foot/word-head node. \( \{i\} \), \{u\} and \{a\} indicate ‘frontness’, ‘roundedness’ and ‘lowness’. In their analysis, palatality is characterised by \{i\}. For the conventions surrounding the use of braces and verticals, see Anderson & Ewen 1987: 28-9.)

---

1Also, the analysis of nasal harmony in Nasukawa (1995b) employs this line of argument. This will be discussed in §6.4.2.
Chapter 6. Assimilatory processes involving nasality and voicing

(14) nüüyee 'let me love'

\[
\begin{array}{c}
{\text{(i)}} \\
{\text{(C)}} & {\text{([V])}} & {\text{([V])}} & {\text{(C)}} & {\text{([V])}} & {\text{([V])}} \\
{\text{(u)}} & {\text{(a)}} \\
\end{array}
\]

The structure in (14) is built around binary asymmetric (head-dependent) relations holding between categorial units. As \{u\} and \{a\} are depicted in (14), melodic units are generally considered as dependents of prosodic categories. But in addition, primes can also be specified in nodes within prosodic structure. In Anderson & Ewen's analysis of Khalkha Mongolian, for example, the prime \{i\} is specified lexically as a property of the foot/word-head node. All languages that exhibit harmonic agreement are assumed to follow this basic construction, where a property of a prosodic node percolates downwards and is realised in each relevant position in the melodic string. So in (14), \{i\} is realised with \{u\} and with \{a\} in the long vowel positions to the left and right respectively; then, the combination of \{i\} and \{u\} yields ū and \{i\} and \{a\} together generate e. (In terms of the combination of primes, the basic vowel architecture used in DP is identical to that of ET. However, we do find some disagreement as to the precise definition of each prime in the two systems. For a detailed discussion, refer to Backley 1998: Ch3.) As just described, the literature analyses vowel harmony as a process which takes place only between nuclear positions, neglecting consonantal (non-nuclear) positions altogether.

In order to explain both rightward agreement for nasality and tautosyllabic agreement for nasality in Type II harmony systems, Piggott and van der Hulst abandon the formation in (13a) used for Piggott's analysis of Type I harmony systems. Instead, they adopt the core mechanism of vowel harmony in (14) and claim that the structure in
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(13b) — where [nasal] agreement takes place at the level of the syllable — can be better represented in this way. The facts of nasal harmony in Southern Barasano are then described as follows (see Piggott & van der Hulst 1997: 102-3):

(15) A revised analysis of Barasano nasal harmony

\[
\begin{align*}
\text{(a)} & \quad [\text{nas}] \\
& \quad \sigma_1 \quad \sigma_2 \\
& \quad C_1 \quad V_1 \quad C_2 \quad V_2 \\
& \quad m \quad \ddot{a} \quad s \quad \ddot{a} \\
& \quad \text{SV} \quad \text{SV} \quad \text{SV} \\
& \quad [\text{nas}] \quad [\text{nas}] \\
\text{(b)} & \quad [\text{nas}] \\
& \quad \sigma_1 \quad \sigma_2 \\
& \quad C_1 \quad V_1 \quad C_2 \quad V_2 \\
& \quad \ddot{w} \quad \ddot{a} \quad t \quad \ddot{i} \\
& \quad \text{SV} \quad \text{SV} \quad \text{SV} \\
& \quad [\text{nas}] \quad [\text{nas}] \quad [\text{nas}] \\
\end{align*}
\]

The representations in (15) show that, by allowing the feature [nasal] to be specified in the syllable head/nucleus, the two events in question can be accounted for simultaneously. On the one hand, in Southern Barasano, as well as all other languages of Type n, nasality must be expressed in each unit within the syllable when the feature is associated with the syllable head, since the properties of the head of a constituent are simultaneously the properties of the entire structure. Therefore, the [nasal] lexically specified in \( \sigma_1 \) is inherited by each constituent within the syllable. In this treatment, no direct relation between individual tokens of [nasal] need be specified at the segment-internal level.

On the other hand, the lexical property [nasal] in \( \sigma_1 \) is regarded as a trigger of harmonic agreement. As a result of the rightward agreement of [nasal], the [nasal] in \( \sigma_1 \) is specified in the adjacent syllable head \( \sigma_2 \). Then, the acquired nasal property in \( \sigma_2 \) must also be transmitted down to all the segments in that syllable. In the examples in (15),
however, obstruents in $C_2$ are not nasalised because those segments lack an SV node — a prerequisite for the specification of [nasal], as (9) shows.

Piggott (1996: 161) also adopts this mechanism to explain other languages like Kikongo which employ [nasal] at the foot level.

(16) Kikongo nasal harmony

In the above structure, [nasal] is a lexical property of $Ft_1$ and is a trigger of rightward nasal agreement.\(^2\)

In contrast to the prosodically-oriented analysis of the Type II harmony pattern in (15) and (16), Piggott & van der Hulst maintain the analysis in (10) for Type I harmony patterns: harmonic agreement of nasality takes place at the segmental level. In this way, the possibility of obligatory tautosyllabic sonorant-vowel agreement for nasality is predicted never to occur in Type I systems where those sonorants which are followed by nasal vowels are not necessarily nasal. In this way, their analysis successfully excludes unattested phenomena.

\(^2\)In this case, unlike the widespread Type II patterns, vowels (including other types of sonorant) are transparent to nasalisation (Piggott 1996: 147). However, at least in phonetic terms, it seems that those segments are subject to the process.
6.3.3 Problems

I have illustrated Piggott & van der Hulst’s analysis of opacity and transparency in nasal harmony, in which the two effects are accounted for by recognizing a direct connection between segments and prosodic categories: the opacity effect results from a segment-to-segment nasal assimilatory process, while the transparency effect is derived from the nasal assimilation that operates between prosodic categories.

There are, however, some questions concerning Piggott & van der Hulst’s analysis that ought to be addressed. First, they treat nasal harmony differently from other types of harmony, such as height (Bantu), rounding (Yawalmani), fronting (Turkish) and ATR harmony (Akan). In their proposed analysis of nasal harmony, two different mechanisms are called for — a segment-to-segment agreement for the Type I pattern and an agreement between nuclei or between syllable heads for the Type II pattern. In contrast, for most other types of harmony it is only nuclei/syllable heads which are involved in harmonic agreement. They fail to explain why nasal harmony must be treated as a unique case — exploiting both inter-prosodic-categorial agreement and inter-segment assimilation.

Second, Piggott & van der Hulst treat transparency as an unmarked effect in nasal harmony, while opacity is seen as the marked case: the former is analysed using a mechanism (inter-nuclear agreement) similar to the most prevalent/unmarked wide-scope agreement process — vowel harmony; the latter is analysed by a segment-to-segment agreement process which is never found in vowel harmony. However, this treatment of the two different effects of nasal harmony fails to square with cross-linguistic facts, since the majority of languages displaying nasal harmony exhibit opacity rather than transparency, indicating the former as the unmarked state in nasal harmony systems.

Third, in Piggott & van der Hulst’s analysis of Type II nasal harmony, [nasal] is treated as a property of the syllable head, which forces all segments (both nuclear and

---

3Systems such as Chumash and Basque provide examples where onsets seem to play an important role in the assimilatory process of palatality, but these cases are beyond the scope of this dissertation.
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non-nuclear) to be specified for the feature. However, this kind of specification across an entire constituent domain never occurs in other types of harmony; instead, non-nuclear positions typically inherit no harmonic features from their heads (nuclear positions). Piggott & van der Hulst provide no formal explanation for this peculiarity.

Fourth, Piggott & van der Hulst offer no account of the relation between the SV node and the use of [nasal] in prosody. In their analysis, only harmony systems employing the SV node, rather than the SP node are allowed to exploit nasality as a property of prosodic categories. However, no clear explanation for this restriction is offered. Unlike the SV node, the SP can spread to the other segmental positions in a given domain in Type I harmony systems. The SV node itself does not participate in any dynamic alternation involving nasality, but the SP node itself contributes to the harmonic agreement of nasality. Again, the difference in behaviour between the SV node and the SP node is left unexplained.

Fifth, we have reason to question the status of the feature-geometric SV node, which was originally introduced in Piggott (1992) and Rice (1993) as a means of capturing phenomena involving obstruent-sonorant alternations and the postnasal voicing of obstruents. In this function it takes the place of the traditional feature [sonorant]. Yet according to Harris (in prep.: 24), it is possible to analyse these phenomena without introducing the SV node as an additional categorial entity. The analysis of obstruent-sonorant alternations can be expressed in terms of manner features such as [lateral] or [nasal], and postnasal obstruent voicing can be straightforwardly captured by referring to the affinity of nasality and voicing. This is then consistent with the assumption that the SV node is phonologically active in nasals belonging to a language exhibiting postnasal voicing assimilation, while other sonorants (i.e. liquids, glides and vowels) do not display the same ability to bring about a similar effect on a neighbouring obstruent.

Next, I shall offer an alternative analysis of nasal harmony which avoids the problems outlined above. Following the discussion provided in §4.3.2 and also the relevant literature (Backley & Takahashi 1998; Backley 1998; Nasukawa 1997, 1998b), the model I develop rejects the notion of spreading in favour of activation as a harmonic mechanism for nasal harmony.
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6.4 A unified analysis of opacity and transparency effects in nasal harmony

6.4.1 Harmonic agreement

According to Piggott & van der Hulst's analysis, nasal harmony differs from most other types of harmony, such as vowel harmony, in two respects: (i) while most kinds of harmony involve only nuclei as targets, they suggest that nasal harmony may also target other prosodic categories; (ii) while most kinds of harmony use higher prosodic levels as the driving force of the process, they assume that nasal harmony relies on both suprasegmental levels (for transparency effects) and also segmental and sub-segmental structures (for opacity effects).

Besides these differences, however, both types of harmony are similar to the extent that nuclei are central to the mechanisms concerned. This fact must be the key to an analysis of different harmonic patterns. In the interests of a coherent and restrictive theoretical position, which is, in many ways, at odds with Piggott & van der Hulst and many others (van der Hulst & Smith 1982; Kiparsky 1985; Cohn 1989; Piggott 1988, 1992, 1996, 1997; Noske 1993; Trigo 1993; Cole & Kisseberth 1994ab; Walker 1995, 1998; Ploch 1999), I propose that nasal harmony functions principally between nuclear positions in the same way that other types of harmony do. In the licensing-driven framework which is pursued here, we can characterise this mechanism of harmonic agreement as in (17).\(^4\)

\(^4\)Following the metatheoretical assumption of minimal componentiality, Takahashi (1993a) eliminates constituent nodes from phonological representation and proposes the minimal prosodic domain which is the model I adopt here.
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With the notion of element activation (Backley 1998 and see also §4.3.3), the above structure illustrates that the lexical instruction **activate [a]** — which is lexically a functional property of the ultimate head of a given domain at the word level — is transmitted to the other nuclei in a given span via a licensing path (indicated by dotted lines) defined by dependency relations.

This type of wide-scope agreement is expressed by Backley (1998: 174) as follows (repeated from Chapter 4).

(18) **PRINCIPLE OF EXTENSION (PEx)**

Extend the domain of **activate [a]** to enhance element interpretability.

A version of this principle is given in Cole & Kisseberth (1994a) as **WIDE SCOPE ALIGNMENT (WSA)** — a member of the family of **ALIGN** constraints within their Optimal Domain Theory (ODT). WSA functions to match the domain of interpretation of a melodic prime with a morphologically or prosodically determined span. Interacting with an independent constraint termed **Expression**, which ensures that the concordant feature is associated with every potential target within the domain, WSA is responsible for harmonic agreement. In contrast, PEx requires only a single specification of the relevant prosodic category (e.g. foot, word) which suffices to isolate the target sequence. This exhibits the unified nature of the melodic and prosodic hierarchy: the prosodically-specified active unit (e.g. at the level of the foot or word) is interpreted in every potential
target further down the same licensing path. Via this mechanism, languages display vocalic agreement processes by means of the dominant influence of PEx.

To illustrate, Backley (1998: 116-7) cites the case of frontness harmony in native Finnish words (in which the front vowels æ, ø and ü and the back vowels a, o, and u cannot co-occur, while i and e behave transparently). Here the value of a is [I] in the generalised instruction ACTIVATE [a], which is specified as a word-level property. So the structure of *poütæ + stæ* ‘table (elative)’ is as follows.\(^5\)

\[(19)\]

```
Activate [I]
```

The representation in (19) shows [I]-activation extending throughout the prosodic word domain, highlighting the palatal alternations o~ø, u~ü and a~æ observed in nuclear positions.

As (19) shows, the mechanism of vowel harmony involves only nuclear positions, which agree with their head position for a particular melodic quality. The relative importance of vowels within an account based on licensing paths seems empirically plausible, since nuclei provide the basic units of prosodic structure while non-nuclear categories are, whether p-licensees or not, irrelevant at this level of structure.

\(^5\)In a context of element activation, Backley (1998: 117) assumes that Finnish allows [I] to license a [comp].
6.4.2 Nasal harmony as inter-nuclear agreement

In the interests of a coherent and restrictive theoretical position, I assume that cases of nasal harmony receive a similar treatment along the lines of (19), the only difference being that the value of 

\[\text{ACTIVATE} \left[ \alpha \right] \text{ is } [N] \text{, rather than } [I].\]

\[\text{(20)}\]

\[
\begin{array}{c}
\text{Activate } [N] \\
\Downarrow \\
\bigdownarrow \\
\bigdownarrow \\
\bigdownarrow \\
\end{array}
\]

In order to capture the basic mechanism of nasal harmony using the structure in (20), I refer to the analysis of nasal harmony in Gokana\(^6\) given in Nasukawa (1995b). The following data show the environment conditions which allow/disallow wide-scope nasalisation to take place in the morphemes of this language.

\[\text{(21) (a) } \begin{array}{c}
\text{C} \tilde{V} \tilde{C} \text{ C } \tilde{C} \tilde{V} \\
\text{C} \tilde{V} \tilde{V} \tilde{C} \text{ C } \\
\text{C} \tilde{V} \tilde{V} \text{ C} \tilde{V} \\
\end{array} \begin{array}{c}
\text{‘tongue’} \\
\text{‘monkey’} \\
\text{‘cooking stove’} \\
\end{array} \begin{array}{c}
\cdot d \tilde{m} \quad \cdot d \tilde{b} \\
\cdot f i \tilde{n} \quad \cdot f i \tilde{n} \\
\cdot k\tilde{\text{u}}\tilde{n}\tilde{i} \quad \cdot k\tilde{\text{u}}\tilde{\text{u}}\tilde{i} \\
\end{array}\]

\(^6\)Spoken in eastern Nigeria, this Ogoni language belongs to the Benue-Congo branch of the Niger-Kordofanian family. According to Hyman (1982), lexical morphemes in Gokana conform to the template \(C_1V_1(V)(C_2(V))\) (the symbols \(C\) and \(V\) stand here for any consonant and vowel, respectively).
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(b) \( \tilde{C} \tilde{V} \) : \( n\tilde{u} \) ‘thing’ \( \ast nu \)
\( \tilde{C} \tilde{V} \tilde{C} \) : \( n\tilde{om} \) ‘animal’ \( \ast n\tilde{om} \ast n\tilde{ob} \ast n\tilde{ob} \)
\( \tilde{C} \tilde{V} \tilde{C} \tilde{V} \) : \( m\tilde{an} \tilde{e} \) ‘chief’ \( \ast m\tilde{an} \ast m\tilde{an} \ast m\tilde{a} \tilde{e} \ast m\tilde{a} \tilde{e} \)

(c) \( C \tilde{V} \) : \( l\tilde{i} \) ‘root’ \( \ast l\tilde{i} \)
\( C \tilde{V} \tilde{C} \) : \( zib \) ‘thief’ \( \ast z\tilde{i} \ast zim \)
\( C \tilde{V} \tilde{C} \tilde{V} \) : \( z\tilde{ari} \) ‘buy’ \( \ast z\tilde{ani} \ast z\tilde{ani} \)

One fact concerning distribution emerges from the above data: if \( C_1 \) or \( V_1 \) is nasal, then all successive segments must also be nasal. In contrast, all successive segments must be oral if both \( C_1 \) and \( V_1 \) are non-nasal. In order to create these contrasts in a word-initial CV cluster (which is often considered to be phonologically the most contrastive), we must consider the effects of categorial distinction on nasal participation. The distinction operates in the following contexts.

(22) (a) (b) (c)
\( C_1 V_1 C_2 V_2 \) \( C_1 V_1 C_2 V_2 \) \( C_1 V_1 C_2 V_2 \)
\( [N] \) \( [N] \)

Let us first analyse Gokana nasal harmony using the word type given in (22b), e.g. \( f\tilde{i}n\tilde{t} \) ‘monkey’. Following the same line of argument given by Backley for vowel harmony, the lexical instruction \texttt{Activate} \([N]\) is specified at the highest prosodic level. Then, \( [N]- \) activation extends throughout the prosodic word domain, targeting nuclear sites. This is represented as follows.
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(23)

This procedure allows only nuclei to interpret nasality, as already discussed in the case of vowel harmony in (19). Accordingly, Ons₂ is thus represented as having no active [N]; yet, on the face of it, this position appears to receive nasality. Based on the assumption made in Nasukawa (1995b) — that a position such as Ons₂ may contain a nasal only when it lies within a nasal span — I shall claim that the nasality observed in Ons₂ in (23) does not result from the existence of [N] in that position but rather, that it is derived via phonetic interpolation through the entire \( \tilde{\nu}C\tilde{\nu} \) (cf. Cohn 1993a). So if Ons₂ is not an inter-nasal position, e.g. \( b \) in \( zib \) `thief`, it never shows any phonetic interpolation of nasality.

(24)
(24) represents the phonological structure of (22a), where no [N]-activation is involved. Therefore, Ons$_2$ finds no phonetic source for nasality.

The word type represented in (22b) includes not only strings such as $f\tilde{\iota}n\tilde{\iota}$ in (23), but also lexical morphemes ending in a consonant, e.g. $\tilde{d}m$ ‘tongue’. In the latter case, the nasal interpretation of Ons$_2$ achieved through interpolation does not seem to stem from the neighbouring [N]s, since, on the face of it, the position in question is not flanked by nuclei bearing nasality. However, I shall claim that, in phonological terms, this is indeed the configuration.

(25)

As illustrated in (25) above, one side of the position containing the nasal segment $m$ is Nuc$_1$, which a-licenses [N] and the resonance elements [I] and [A], together interpreted as $\tilde{\varepsilon}$. On the other side is Nuc$_2$ (which is required to conform to the ONSET LICENSING PRINCIPLE (Harris 1994: 160)), which also a-licenses [N] in order to comply with PEx, but incorporates no other elements. Under this configuration, the lone [N] in Nuc$_2$ is interpreted as nasality, although this property is not phonetically discernible in the absence of other elements in the position. However, Nuc$_2$ is one of the two nuclei that flank Ons$_2$ and, following the example in (23), phonetic interpolation of the nasal property is observed.
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A similar analysis is found in Nasukawa (1998a), where the moraic/syllabic placeless nasal ₄ in Japanese is treated as the phonetic manifestation of an onset, which a-licenses [N] and [?] (but no resonance element) followed by an empty nucleus. In this case, the empty nucleus contributes to the moraicity/syllabicity in the segment in question.

A further similarity is observed in the case of pitch-accent contours in Japanese. Consider, for example, a tri-moraic word in which the second mora bears pitch accent (H tone) and forms the first part of a voiceless geminate obstruent, as depicted in (26).

(26) kokki 'national flag'

In this case, the pitch of the high tone cannot be physically realised during the silent interval of the voiceless obstruent (Ons₂) of the null-vowelled syllable (Nuc₂), but its presence is betrayed by the pitch contour realised on the flanking nuclei Nuc₁ and Nuc₃.

Next, I turn to the remaining word types in (22), and analyse (22c) under the inter-nuclear agreement approach to nasal harmony. An example word of the structure given in (22c) is mënē ‘chief’, which employs a lexical instruction ACTIVATE [N] at Ons₁, which lies outside the expected harmony domain. However, in order to conform to PEx, Ons must extend the lexical instruction. For the position in question, the only structurally-defined path is the licensing relation between its immediate head Nuc₁ and itself. Then, inheriting ACTIVATE [N] from its dependent position Ons₁, Nuc₁ becomes the source from which [N]-activation is extended throughout the domain. This mechanism is illustrated in the following configuration.
In addition, Ons₂ phonetically acquires nasality from its neighbouring nuclei although in phonological terms it receives no active [N].

6.4.3 Opacity in inter-nuclear nasal agreement

On the basis of the above analysis of nasal harmony in Gokana, I now turn to the question of harmonic opacity in the Type I system of nasal harmony. I assume that languages with segments that are opaque to wide-scope nasalisation exploit the same mechanism of harmony that is assumed to operate in Gokana, but with the additional characteristic of allowing ‘blocking’ segments to interrupt the harmonic span. As most researchers have claimed (Piggott 1992, 1996; Walker 1998), the internal organisation of segments must play a central role in defining these opaque properties.

As discussed in §2.2.2 and §6.2, languages of Type I (which further divides into four sub-types) typically utilise fricatives and plosives as opaque segments in nasal harmony. Marked sub-types employ not only obstruents but also sonorants (Type IA) or only plosives (Type ID) as opaque segments. Here, I concentrate not on the parametric difference but on the most typical blocking process in nasal harmony — viz. nasalisation is interrupted by obstruents — since the primary focus of this chapter is to reveal the potential differences between dynamic processes triggered by nasality and voicing within the scope of the proposed nasal-voice representations. For a detailed discussion of minor
blocking processes and a parametric analysis of Type I nasal harmony, see Walker (1998). Now, we consider why obstruents are typical blockers in Type I nasal harmony. What prevents the progress of nasalisation can only be explained by reference to the structural component common to all obstruents. As discussed in §4.5.3, obstruents require the presence of an active [h], which is absent from nasals/nasalised segments. This distributional restriction on [h] in relation to [N] is captured by the condition *[h, N], referred to in Chapter 4 as (46) and repeated here as (28).

(28) Parameter *[h, N]

[h] and [N] are mutually exclusive in melodic expressions?

<table>
<thead>
<tr>
<th>Example languages</th>
<th>ON</th>
<th>OFF</th>
</tr>
</thead>
<tbody>
<tr>
<td>The majority of languages</td>
<td>✔️</td>
<td></td>
</tr>
<tr>
<td>Fijian, Northern Tohoku Japanese, etc.</td>
<td></td>
<td>✔️</td>
</tr>
</tbody>
</table>

I claim that the ON mode of this constraint applies in all languages exhibiting nasal harmony (as well as most other languages): as a result of the constraint in (28), nasalisation is blocked if the target position lexically a-licenses [h]. Incorporating this view into an inter-nuclear analysis of nasal harmony allows the following possibility for investigating the overall agreement pattern in Type I systems.
Targeting only nuclei, the configuration in (29) illustrates that the lexical instruction ACTIVATE [N] specified as a property of the ultimate head (prosodic word level) extends its influence across the word domain. Unlike the case of Gokana, however, [N]-activation fails to affect the entire harmonic span: in (29), Nuc$_1$ p-licenses Ons$_3$, where the latter a-licenses [h] and therefore prevents nasalisation from being sanctioned. Specifically, the constraint *[h, N] identifies a nucleus as a blocker if it p-licenses an onset position which a-licenses [h]. In other words, all elements contained within the domain of the target nucleus are subject to the element cooccurrence constraint: the existence of an active [h] below the nuclear level prevents the nucleus from becoming nasalised. In this case, even if another nucleus follows Nuc$_1$ in the same word, the extension of [N]-activation is halted since Nuc$_1$ cannot exist as an island/medium for transmitting the instruction ACTIVATE [N]. The following examples are taken from Malay.
In (30a), PEx requires the lexical instruction **ACTIVATE [N]** to be extended throughout the given domain. However, the extension of [N]-activation is halted by the second minimal prosodic domain containing the noise element [h], which is incompatible with [N] owing to the requirement *[h, N]*. As a result, only the first onset-nucleus sequence interprets nasality. In the case of (30b), on the other hand, [N]-extension is not interrupted. As a result, both positions in the first Ons-Nuc pair and also Nuc₂ and Nuc₃ receive active [N]. In this environment, Ons₂ and Ons₃ — which are flanked by positions carrying active [N] — acquire phonetic nasality via interpolation.

On the basis of these examples, it appears that the Type I pattern of nasal harmony differs from the generalised mechanism of vowel harmony only with respect to the domain where cooccurrence constraints operate. In the case of vowel harmony, its constraints (such as *[I, U]*: see §4.5.3) affect only nuclear sites. On the other hand, *[h, N]* for nasal harmony functions only in non-nuclear sites (i.e. in onsets). This difference is reflected in the characteristics of the individual elements involved. In vowel harmony, we expect a cooccurrence restriction to refer only to resonance elements, which can be a-licensed in nuclear positions. These constraints do not therefore have any bearing on prosodic structure other than at the nuclear level. Similarly, [h] in *[h, N]* for nasal harmony is a non-resonance element and is, as a result of the universal characteristics of this unit (which can be a-licensed only in non-nuclear positions), systematically absent.
from nuclear positions. Accordingly, *[h, N] affects only subordinate domains of nuclear positions where [h] can be realised. Elsewhere, the constraint is phonologically redundant, since the cooccurrence restriction involving [h] and [N] derives naturally from the absence of [h] in nuclei: because [h] never appears in nuclei, [N] is never active alongside [h] in these positions.

6.4.4 Transparency in inter-nuclear nasal agreement

We expect the Type II pattern of nasal harmony to be analysable using a mechanism similar to that suitable for vowel harmony and the Type I pattern, on the basis that the harmonic process is derived from inter-nuclear element agreement. However, vowel harmony and Type I are somewhat more prevalent in languages displaying harmonic agreement, leaving Type II under-represented cross-linguistically. In order to account for this markedness difference, linguists often utilise the notion of structural/functional complexity: the more complex a mechanism is, the more marked that mechanism is deemed to be. Following this line of argument, I assume that those rare languages exhibiting the Type II pattern exploit a more complex mechanism than is required for the other harmonic patterns. Specifically, two characteristics are worthy of closer scrutiny — the target of PEx and the role of *[h, N].

First, I assume that the target of PEx must be determined parametrically. As argued in §6.4.2, harmonic systems all employ PEx where the extending targets are nuclei. However, following Piggott & van der Hulst (1997), I assume that in the less common cases of nasal harmony — those that follow the Type II pattern — PEx targets non-nuclear positions, and in particular, onsets. This derives from the fact that in Type II languages, both positions in a CV-sequence are uniformly oral or nasal, and never contain a sequence such as CṼ or ÇṼ (see also the examples from Southern Barasano in §2.2.2). That is, both positions in a minimal prosodic domain must agree for nasalisation/oralisation.
As illustrated in (31), if PEx targets onset positions, then the p-licensing nuclei of those onsets are also sanctioned to have an active [N]. This illustrates how nuclei are present as the driving force behind [N]-activation, serving the function of passing the instruction to their dependent onset positions.

In this case, unlike the Type I system, non-nuclear positions display prosodically-specified [N]-activation in order to conform to PEx which has [N] as its variable. This parametric choice in PEx may be captured by the following formalism.

(32)

\[ \text{PEx ([a], \{Nuc\}/Non-nuc)} \]

The formula in (32) contains two functional arguments: [a] and \{Nuc\}/Non-nuc. The first stands for any element which is extended to form wide-scope agreement. In the case of nasal harmony, as we have already seen in this chapter, this variable is [N]. The other argument is a parametric choice to determine the element-extending target. In most cases, nuclei are regarded as the terminal positions to be specified for an active [N]. (The unmarked status of nuclei as a target is denoted by curly brackets in (32).) However, in rare cases, non-nuclear positions can be selected as a harmonic target instead. Type II languages, for example, are relatively marked because their second argument is Non-nuc. Accordingly, the constraint in (32) is described for nasal harmony as follows.
The function in (33a) describes Type I nasal harmony. If the first argument contains any resonance element, it causes vocalic harmony. On the other hand, in the marked case (33b) selects non-nuclear positions as the second argument to create the Type II system.

The way in which the constraint *[h, N] operates is similar in Types I and II, to the extent that it applies within the domain of a given harmonic target. However, in the case of Type II systems, unlike those of Type I, it is only onsets with an active [h] which are prevented from interpreting [N]. In contrast, their nuclei may interpret [N], since the domain affected by *[h, N] corresponds to a non-nuclear position which is targeted by the constraint in (33b).

The following examples from Southern Barasano illustrate this point.
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(35) Southern Barasano nasal harmony

(a) Activate [N]

\[
\begin{align*}
\downarrow \quad [x]_{\text{Nac1}} & \quad \downarrow \quad [x]_{\text{Nac2}} \\
\downarrow \quad [x]_{\text{Ons1}} & \quad \downarrow \quad [x]_{\text{Ons2}} \\
\ \ N & \quad \ \ N & \quad \ \ h \\
\ \ N & \quad \ \ N & \quad \ \ h
\end{align*}
\]

\[m \quad \tilde{a} \quad s \quad \tilde{a}\]

(b) Activate [N]

\[
\begin{align*}
\downarrow \quad [x]_{\text{Nac1}} & \quad \downarrow \quad [x]_{\text{Nac2}} \\
\downarrow \quad [x]_{\text{Ons1}} & \quad \downarrow \quad [x]_{\text{Ons2}} \\
\ \ N & \quad \ \ N & \quad \ \ h \\
\ \ N & \quad \ \ N & \quad \ \ h
\end{align*}
\]

\[\tilde{w} \quad \tilde{a} \quad t \quad \tilde{i}\]

Both structures in (35) show the same mechanism as (34): [N] is interpreted in all positions except Ons₂, since the latter complies with *[h, N] — if an active [h] is present then Ons₂ cannot interpret [N].

6.4.5 Prenasalisation in nasal harmony

As discussed in §2.2.2, another phenomenon relevant to nasal harmony is observed in some Type I languages like Terena and Guaraní, in which those obstruents blocking wide-scope nasalisation themselves appear as prenasalised. Some examples are given from Terena⁷ (Bendor-Samuel 1960: 350-1, Cole & Kisseberth 1994b: 6) below.

⁷Bendor-Samuel (1960) gives the phonemic inventory of Terena as follows.

Vowels:

\[i \quad e \quad a \quad u \quad o\]

Consonants:

\[p \quad t \quad k \quad ?\]
\[s \quad \tilde{s} \quad hy \quad h\]
\[m \quad n \quad l \quad r\]
\[w \quad \quad y\]
(36) Terena

<table>
<thead>
<tr>
<th>First person forms</th>
<th>Third person forms</th>
</tr>
</thead>
<tbody>
<tr>
<td>dũdũ</td>
<td>‘my brother’</td>
</tr>
<tr>
<td>õwãgu</td>
<td>‘my house’</td>
</tr>
<tr>
<td>*biho</td>
<td>‘I went’</td>
</tr>
<tr>
<td>õžaʔašo</td>
<td>‘I desire’</td>
</tr>
<tr>
<td>õdopiko</td>
<td>‘I chopped’</td>
</tr>
</tbody>
</table>

(36) shows that nasals appear throughout first person forms in Terena, but not in third person forms. However, if the first person form contains an obstruent, then no nasal sound can appear to its right. So, Terena’s nasal harmony begins at the left edge and extends up to the first obstruent. Then, the obstruent itself is interpreted as prenasalised.

In order to account for this phenomenon, Piggott (1997) claims that the first person affix is a placeless nasal consonant \( N \), which is attached to the left edge of a given stem. However, in the model of nasal harmony proposed here, the affix triggering nasalisation must be a nucleus which is specified for nasality but no other melodic units, since the instruction \textsc{activate} \[ N \] — which is specified at the nuclear level — extends throughout the domain to fulfil the requirements of PEx. In a Type I harmony system, \[ N \]-activation targets all nuclei specified in the domain, but not non-nuclear positions. Departing from Piggott (1997), I assume that the phonological identity of the first person marker is not in non-nuclear position, since it must be specified for the instruction that initiates the nasal agreement process. Therefore, the first person affix must be a nucleus which is specified for \textsc{activate} \[ N \] but no other elements (and which also \( p \)-licenses an empty onset). This is illustrated in (37).
The first person affix in Terena

\[
\begin{align*}
&\text{Activate } [N] \\
&\downarrow \\
&[x]_{\text{Nuc}1} \\
&[x]_{\text{On}1} \\
&+ \\
&N
\end{align*}
\]

When this affix attaches to the left edge of a stem, in the manner of other Type I languages, \([N]\)-activation extends across all nuclei in that stem in order to satisfy PEx ([N], Nuc). I assume that in this case, a form containing an affix and a stem is morphologically synthetic, since, in Terena, morphologically complex forms are phonologically indistinguishable from simplex forms. This mechanism is illustrated below.

\[
\begin{align*}
&\text{Activate } [N] \\
&\downarrow \\
&[x]_{\text{Nuc}1} \\
&[x]_{\text{Nuc}2} \\
&[x]_{\text{Nuc}3} \\
&[x]_{\text{Nuc}4} \\
&\downarrow \\
&N \\
&N \\
&N \\
&N \\
&h
\end{align*}
\]

As (38) shows, the extension of \([N]\)-activation proceeds up to Nuc_3, while in Ons_3 — which is flanked by two nuclei interpreting \([N]\)_s — nasality is interpolated through its adjacent positions. However, \([N]\)-activation is blocked by Nuc_4, since the rightmost nucleus contains \([h]\) in its own domain. This nucleus is prevented from becoming
nasalised by virtue of *[h, N]. This blocking configuration is identical to that seen in the case of other Type I languages like Malay in (30).

However, the phonetic realisation of opaque segments (obstruents) in (38) is different from that in (30). In the Malay example, the blocker receives no nasality from the preceding nucleus. In contrast, the blocking obstruent in Terena itself appears as prenasalised. How can this latter phenomenon be accommodated by the model being developed here?

The relevant literature often considers this type of prenasalisation as a phonologically motivated phenomenon. Within ODT, for example, Cole & Kisseberth (1994b) treat this outcome as a violation of the cooccurrence restriction *[N, Obstr], which prescribes that the features [nasal] and [obstruent] are mutually exclusive. In Piggott (1997) the first person affix — which is lexically a placeless nasal consonant — must be parsed in the opaque segment as the initial phase of a contour expression in order to fulfil the requirements of PARSESEGMENT and various intrasegmental geometrical conditions.

In contrast, the approach which I am pursuing here posits that this prenasalisation does not result from the constraint requirements, but instead is a matter of phonetic interpretation. In the position which blocks the process, nasality is interpolated through the preceding position and the position itself is realised as a prenasalised voiced plosive. This view is supported by the following facts relating to the static distribution of prenasalised segments.

In Terena, obstruents and their prenasalised counterparts are not contrastive: the latter have been analysed as contextual variants of the former. In fact, the distribution of prenasalised segments is restricted to the position which blocks the harmonic agreement process.

Furthermore, prenasalised segments always appear to the right of a successive harmonic span. The blocker never appears in any other form (such as a postnasalised or fully nasalised segment). This indicates that the nasal phase of a prenasalised opaque segment originates from the preceding nucleus in a nasal harmonic span. The second phase retains its oral properties because the segments that follow are oral.
This argument is developed within the context of the proposed mechanism of nasal harmony. To repeat, if the onset position (if not an obstruent) is flanked by two positions interpreting [N], then nasality is interpolated through the three positions. By the same token, if the onset position is only preceded by a nucleus interpreting [N], then the onset receives nasality only from the left side, and consequently [N] appears as the nasal phase of a prenasalised segment. As discussed in §3.6, obstruent voicing is an expected by-product in this case. This kind of phonetic side effect is observed not only in the middle of a lexical item, as shown in (36), but also in the initial position, as illustrated below.

(39)

In order to create the first person form of *piho*, the relevant affix specified for Activate [N] attaches to the left side of the stem. Due to *[h, N]*, however, [N]-activation does not extend to any part of the stem since the initial minimal prosodic domain includes [h] in its onset position. As a result, the harmony blocker Ons₂ does not receive [N] as a phonological property. Yet the nasality — which is interpreted in the affix — is interpolated on the blocking position. So Ons₂ is phonetically realised as a prenasalised voiced plosive "b.

Let me summarise the discussion so far. Nasal harmony is a dynamic alternation involving the element [N] without a licensed N-[comp]. In order to develop a treatment which mirrors that of vowel harmony, nasal harmony is regarded as an element
Chapter 6. Assimilatory processes involving nasality and voicing

agreement process which operates between nuclei and is driven by p-licensing paths. Both types of nasal harmony — Type I and Type II — come about when the two constraints *[h, N] and PE (N, Nuc/Non-nuc) are sanctioned. The difference between Type I and Type II lies in the parametric setting of the second argument of PE: the former takes the default setting Nuc, whereas the latter takes the marked setting Non-nuc. One outcome of this approach is that non-nuclear positions — typically onsets — never receive the element [N] as a phonological property in the Type I pattern. However, we do nevertheless observe nasality being phonetically manifested in non-nuclear positions. In order to explain this using the distributional facts of nasality, I assume that it results from the phonetic interpolation from neighbouring nuclei interpreting [N]. In languages like Terena, the harmony blocker is also subject to this phonetic side-effect: nasality is interpolated from the left adjacent position interpreting [N] and appears itself as a prenasalised variant.

I assume that the same kind of phonological mechanism (that is, one dependent on p-licensing paths) is also responsible for voiced-obstruent voicing assimilation. In the next section I shall investigate (i) why only obstruents undergo voicing assimilation, (ii) why wide-scope voicing agreement is not attested and (iii) why only rightward agreement is attested in voiced-obstruent voicing assimilation.

6.5 Voicing assimilation as N-[comp] agreement

The same constraint PE ([a], {Nuc}/Non-nuc) that is essential to a description of nasal harmony is also active in the case of voiced-obstruent voicing assimilation. The first argument of PE is N-[comp], which derives voicing assimilation itself. In this case, non-nuclear positions are automatically selected as its second argument. This choice is the result of N-[COMP] LICENSING (§4.3.5) and the static distributional constraints on the noise element [h].

N-[COMP] LICENSING requires that N-[comp] must be excentrically licensed by the noise element [h] in a given position. This is, however, never achieved in nuclear
positions, since the appearance of the noise element is restricted to non-nuclear positions. (Within the ET literature [h] never appears in nuclear positions.) Compare the categorial distributions of [N] and N-[comp]:

\[(40)\]

<table>
<thead>
<tr>
<th>Element structure</th>
<th>The type of position to be potentially activated</th>
</tr>
</thead>
<tbody>
<tr>
<td>(a) N</td>
<td>☑ Non-Nuc ☑ Nuc</td>
</tr>
<tr>
<td>(b) N h</td>
<td>☑ Non-Nuc</td>
</tr>
</tbody>
</table>

Following (40b), the PEx for voiced-obstruent voicing assimilation can be formalised as follows.

\[(41)\]

\[
\text{PEx (N-[comp], Non-nuc)}
\]

Before analysing voiced-obstruent voicing assimilation using the constraint in (41), let us reconsider some data that illustrate the process in question. The following are taken from §2.3.4.

\[(42)\]

(a) **Dutch**

<table>
<thead>
<tr>
<th>Dutch</th>
<th>‘landlord’</th>
<th>‘house’</th>
</tr>
</thead>
<tbody>
<tr>
<td>hui[zb]aas</td>
<td>hui[s]</td>
<td></td>
</tr>
<tr>
<td>a[zb]ak</td>
<td>a[s]</td>
<td>‘ash’</td>
</tr>
</tbody>
</table>
The above examples all display the process of leftward voicing assimilation between two onsets in sequence (Gussmann & Cyran 1998, Harris & Gussmann 1998). In melodic terms, the low source expression N-[comp] specified in the onset on the right causes the onset to its left to activate N-[comp] too. The context for this process seems to be identical to that for postnasal voicing assimilation in Yamato Japanese, which has been discussed in §4.5.2. The differences are (i) the kind of melodic unit which triggers the process, and (ii) the direction of the agreement. As for (i), in postnasal voicing assimilation, the unit which causes the process is [N]; on the other hand, in voiced-obstruent voicing assimilation, it is N-[comp]. In the case of (ii), assimilatory agreement extends rightwards in postnasal voicing assimilation, while it extends leftwards in voiced-obstruent voicing assimilation. These mechanisms are depicted as follows:
As already discussed in §4.5.2, in the postnasal voicing assimilation of Yamato Japanese (43a), the rightward extension of [N] between two adjacent onset positions reflects the directionality of inter-nuclear licensing. In contrast to Japanese, languages exhibiting voiced-obstruent voicing assimilation are typically controlled by leftward inter-nuclear licensing (Gussmann & Cyran 1998). In the case of voiced-obstruent voicing assimilation (43b), therefore, it seems that the leftward extension of N-[comp] between two adjacent onset positions also reflects the directionality of inter-nuclear licensing.

One thing which we need to explain is why languages like Japanese — which display rightward inter-nuclear licensing — do not exhibit rightward voicing assimilation triggered by N-[comp]. An answer to this question is found in the relation between prosodic structure and melodic complexity. Comparing two adjacent positions Onsn2 and Onsn1, as in (43), we may note that the former (which typically occupies a weak morpheme-final syllable) is followed by a properly-governed empty nucleus while the

---

4The process also holds across word boundaries. In this case, NuC2 is not properly-governed by NuC1. NuC2, which occupies the domain-final position is properly-licensed by itself (DOMAIN-FINAL PARAMETER: Kaye 1990, Harris 1994, 1997).
Chapter 6. Assimilatory processes involving nasality and voicing

latter (which typically occupies a strong morpheme-initial syllable) precedes a filled nucleus. According to LICENSING INHERITANCE (Harris 1992, 1994, 1997, also see §5.3), Ons₂ is a weak position which is susceptible to lenition/neutralisation, while Ons₃ is a strong position which typically retains its lexical specifications and resists lenition/neutralisation.

As far as N-[comp] is concerned, this unit — which is licensed by [N] and [h] and viewed as more complex than a lone [N] — cannot be a trigger of the assimilatory process in a weak position. I assume this is because a weak position receives insufficient potential to license such a complex expression. In fact, as the data in §2.3.4 has shown, a weak position (Ons₂) in languages of the (43b) type is sensitive to the active/inactive status of N-[comp] in a stronger position (Ons₃) within the same domain. For example, weak positions like Ons₂ lose their laryngeal properties (N-[comp] and [N]) when they precede a strong position (Ons₃) without any active N-[comp] or [N]. On the other hand, as just shown in (42) and (43b), N-[comp] and [N] are interpreted in Ons₂ when the position is followed by Ons₃ which is lexically specified for these melodic properties.

Another question is why prenasal voicing assimilation is not attested cross-linguistically. This is also explained by observing the relation between prosodic strength and melodic complexity. As discussed in §4.5.2, postnasal voicing assimilation results from the interaction of the four constraints PEx ([N]), *[h, N], N-[comp]Lic and PARSE (strong). As a result, N-[comp] is activated together with [N] in the strong position Ons₃, while only [N] but not N-[comp] is active in the weak position Ons₂. Accordingly, it is feasible to assume that N-[comp] is active in Ons₃ but not in Ons₂ since the complex expression (N-[comp]) cannot be licensed by a weak position, which has insufficient potential to sustain it. However, in the case of prenasal voicing assimilation, the reverse process may take place: using the same four constraints, [N] in Ons₂ triggers assimilation, and [N] and N-[comp] are activated in Ons₂. This is undesirable in two respects: first, Ons₂ cannot sustain N-[comp]; second, the complexity of the weak Ons₂ (which contains both [N] and its [comp]) is greater than that of the strong Ons₃.

In addition, extending Activate N-[comp] from non-nuclear sites to nuclei is impossible, since nuclear positions can never contain [h] and consequently do not exploit
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N-[comp]; this follows from the condition of N-[COMP] LICENSING discussed in §4.3.5. In other words, voicing assimilation is restricted to non-nuclear sequences where a licensing relation is established.

A clear benefit of this analysis is the explanation it offers for why voicing never displays long-distance assimilation. To achieve harmonic agreement, the harmonic element must be specified at a higher prosodic level and nuclear positions play a central role in its extension throughout a given domain.

6.6 Why no short and long-distance prenasal assimilation?

Finally I briefly consider why no short or long-distance prenasal assimilation is attested in natural languages. Here, prenasal assimilation is treated as agreement of both [h] and [N] — of which cooccurrence is, as proposed in §5.4.2, represented as a prenasalised segment.

We may identify a two-fold argument which explains the non-occurrence of prenasal assimilation. First, the combination of [h] and [N] is only contrastive in non-nuclear positions. The harmonic agreement process — which is derived by inter-nuclear transmission — therefore never works for an [h, N] pair. Second, languages with agreement processes involving [N] always employ the cooccurrence restriction *[h, N], which creates opacity/transparency effects in particular types of assimilation. If a system were to display prenasal harmony, it would also be considered to exploit *[h, N], since [N] is involved in the [h, N]-agreement process. In this case, however, *[h, N] conflicts with prenasality — the cooccurrence of [h] and [N]. Even in a local assimilation, harmonic agreement of a pair of [h] and [N] fails for similar reasons.
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6.7 Summary

In this chapter, I have focussed on how the unified nasal-voice representation proposed in this work encodes the distinct properties of nasal, voicing assimilation and unattested prenasal assimilation.

In previous analyses of nasal harmony (van der Hulst & Smith 1982; Cohn 1989; Piggott 1988, 1992, 1996, 1997; Noske 1993; Trigo 1993; Ploch 1999), the phenomenon is fully or partly treated as an effect which is different from other types of harmonic agreement such as vowel harmony.

Nasal harmony shows two different patterns: Type I (opacity effects) and Type II (transparency effects), and in the literature, each is considered to be described using two independent structural mechanisms. In the interests of a coherent and restrictive theoretical position, I have offered a proposal in which all instances of nasal harmony function principally on nuclear positions in the same way as other types of harmony operate (e.g. height, palatal, and rounding harmony). Following Backley (1998), I have utilised the constraint PEx ([N], Nuc/Non-nuc) and suggested that the lexical instruction ACTIVATE [N] — which is lexically a functional property of the ultimate head of a given domain at the word level — is transmitted to the other nuclei in the span via a licensing path defined by prosodic dependency relations (Harris 1994, 1997).

In languages displaying harmonically opaque segments, non-nuclear positions support no [N]-activation since the second argument of PEx refers to nuclei. This analysis assumes that the nasal impression in non-nuclear positions is derived via the phonetic interpolation of nasality originating in the [N]s in the neighbouring nuclei. Opacity in nasalisation is accounted for by [N]-activation blocking by the minimal prosodic domain (an onset-nucleus sequence) containing the noise element [h], which is incompatible with [N] according to the requirement *[h, N]. Furthermore, I have claimed that the prenasalisation found in opaque segments in Type I languages like Terena is also a result of the phonetic interpolation of nasality from a preceding nuclear position, since opaque segments are phonologically non-contrastive and determined by their static distribution.
In the case of languages exhibiting the transparency pattern, the second argument of PEx refers to non-nuclear positions. This means, however, that [N] must also be activated in nuclear positions, since the latter prosodically license their non-nuclear dependents (unless those positions themselves already contain active [h]). If a position does contain [h], then the extending process of [N]-activation ignores that position and all subsequent positions are subject to the process; so a non-nuclear position with active [h] never obstructs the nuclear-oriented expansion of [N]-activation.

Voicing assimilation is described in the same terms as nasal harmony: by satisfying PEx, the prosodically-motivated extension of voicing-activation is achieved. What distinguishes the two phenomena are, firstly, the choice of harmonic property in the first argument, and secondly, the choice of the second argument for PEx ([a], Nuc/Non-nuc). Since the first argument is N-[comp], agreement processes are observed only between non-nuclear positions. In the case of postnasal voicing assimilation in Yamato Japanese, the process results from the interaction of the four constraints PEx ([N]), *[h, N], N-[comp]LIC and PARSE (strong). As a result, N-[comp] is activated together with [N] in the prosodically strong righthand onset: being reflected in the directionality of inter-nuclear licensing, rightward agreement holds between two onsets in sequence. On the other hand, in languages exhibiting voiced-obstruent voicing assimilation, the leftward direction of their inter-nuclear licensing controls the extension of N-[comp] from the prosodically strong righthand onset position to its lefthand weak onset position.

Observing the relation between prosodic strength and melodic complexity explains why (leftward) prenasal voicing assimilation and rightward voiced-obstruent voicing assimilation are not attested cross-linguistically. In prenasal voicing assimilation, we expect [N] in the righthand onset to extend to its lefthand onset, thereby activating not only [N] but also N-[comp]. In this case, the lefthand position is more complex than the righthand position which triggers the process. However, this representation is ill-formed, since LICENSING INHERITANCE requires that the righthand strong onset position be no less complex than its lefthand weak onset position.
Chapter 6. Assimilatory processes involving nasality and voicing

Rightward voiced-obstruent voicing assimilation is also undesirable in terms of the relation between prosodic strength and melodic complexity. If N-[comp] — which is licensed by [N] and [h] and which is more complex than a lone [N] — is in the lefthand weak onset position, then the unit cannot be a trigger of the assimilatory process. A weak position such as this is sensitive to the active/inactive status of N-[comp] in its righthand stronger position within the same domain: the lefthand weak position loses its laryngeal properties (N-[comp] and [N]) when they precede a strong position without any active N-[comp] or [N]. On the other hand, N-[comp] and [N] are interpreted in the lefthand weak onset when the position is followed by a stronger onset which is lexically specified for these melodic properties.

I also attempted to account for why prenasal assimilation is unattested. Two kinds of reasoning are involved. First, the harmonic agreement — which is derived by inter-nuclear transmission — never works for an [h, N] pair since the combination of [h] and [N] is only contrastive in non-nuclear sites. Second, systems with agreement processes involving [N] are required to employ the cooccurrence restriction *[h, N], which conflicts with prenasality — the cooccurrence of [h] and [N].
7 Conclusion

7.1 Summary

This thesis has developed a model of melodic representation which directly encodes two interconnected aspects of nasality and voicing — the relational typology of the two properties and their universal and language-specific patterns of alternation.

In order to incorporate both of these aspects into melodic representation, I have proposed that nasal and voice are phonetic manifestations of the same phonological category. The different phonetic interpretations are controlled by the notion of complement tier (Backley 1998, Backley & Takahashi 1998). When the complement (N-[comp]) of the nasal-voice unit ([N]) is licensed, the realisation of the entire expression is voicing. An unlicensed complement tier results in nasality. Under this approach, the complement tier is treated as a unit on a par with elements, so that it directly contributes to melodic complexity. As a result, a voiced expression is more complex than nasal one, since, the former contains an additional unit N-[comp] which is licensed by [N].

The dependency and complexity relations of [N] and N-[comp] can straightforwardly encode two types of typological relation between nasal and voice — languages typically exploit contrastive nasality, whereas voicing is parametrically controlled and the existence of voicing implies the existence of nasal. In the first case, the optional status of voicing is captured by using N-[comp]: some systems are not permitted to license N-[comp], while others do allow this structural possibility. In the second, a prerequisite for N-[comp] activation is the presence of active [N], which echoes the obligatory role of nasality in systems which exploit contrastive voicing.

The proposed representations have also successfully incorporated both universal and language-specific alternation patterns of nasality and voicing. In order to support the integrated representations of the two properties, I focussed primarily on the paradoxical behaviour of nasals in Yamato Japanese, where nasals appear to be specified for voice
in postnasal voicing assimilation, while in Lyman's Law they behave as if they have no voice unit. By adopting the proposed analysis, postnasal voicing assimilation can be treated as an extension of the element \([N]\) across both positions of an NC cluster, where only the unit in the second position licenses its \(N\)-[comp]. This requirement is controlled by a set of constraints consisting \(N\)-[COMP] LICENSING, PEx [N], *[h, N], and PARSE (strong). The other phenomenon — the transparency of nasal obstruents to Lyman's Law — is due to the effect of the constraint *[N]-[comp]N-[comp], which bans [N] from licensing its \(N\)-[comp] if any other position contains an active \(N\)-[comp] in a given domain.

I also provided additional evidence for the proposed representations of nasality and voicing by analysing spontaneous voiced-obstruent prenasalisation and spontaneous voiced-velar nasalisation which are observed in Northern Tohoku Japanese and conservative Tokyo Japanese respectively. Both phenomena take place in the absence of any obvious lexical source for nasality, and occur in the same intervocalic context that typically supports consonant lenition.

Unlike previous analyses, the proposed representations offer the benefit of identifying the nasal unit which is the source of the processes: a nasal element is lexically present in the targets of the processes — voiced obstruents — in which voicing is interpreted in a complex expression containing [N] and its \(N\)-[comp]. Coupled with the principle of Licensing Inheritance (Harris 1994, 1997), both processes involving nasality are regarded as lenition/suppression of \(N\)-[comp] in foot-internal intervocalic sites — which are considered prosodically weak positions. This avoids the need to rely on arbitrary notions such as lexically floating nasality or nasal insertion rules, which have been proposed elsewhere in the literature.

Furthermore, I considered how the unified nasal-voice representation accommodates the dynamic phenomena of nasal harmony and voicing assimilation. Unlike previous analyses, I proposed that both processes are controlled by prosodic hierarchical structure, rather than by any segment-to-segment operation. Underlying this proposal is the assumption that assimilatory processes are captured within the scope of the generalised constraint PEx ([\(\alpha\]), Nuc/Non-nuc) (Backley 1998), which transmits the
lexical instruction ACTIVATE [α] (which is lexically a functional property of the ultimate head of a word-level domain) between prosodic categories in a given span via a licensing path defined by prosodic dependency relations (Harris 1994, 1997).

In the case of nasal harmony, the process displays two different patterns: Type I (opacity effects) and Type II (transparency effects). I have assumed that both instances of nasal harmony function principally on nuclear positions in the same way as other types of harmony (e.g. height, palatal, and rounding harmony). In both cases, the choice of harmonic property is [N]. However, what distinguishes these two different patterns is the choice of argument for PEx.

In systems exhibiting the opacity pattern, non-nuclear positions support no [N]-activation since the second argument of PEx refers to nuclei. This analysis assumes that the nasal impression in non-nuclear positions is derived via the phonetic interpretation of nasality originating in the [Ns] in the neighbouring nuclei. With respect to opacity in nasalisation, this is accounted for by [N]-activation being blocked by the minimal prosodic domain (an onset-nucleus sequence) containing the noise element [h], which is incompatible with [N] according to the requirement *[h, N].

In systems displaying the transparency pattern, on the other hand, the second argument of PEx refers to non-nuclear positions. This means, however, that [N] must also be activated in nuclear positions, since the latter prosodically license their non-nuclear dependents (unless those positions themselves already contain active [h]). If a position does contain [h], then the extending process of [N]-activation ignores that position and all subsequent positions are subject to the process; so a non-nuclear position with active [h] never obstructs the nuclear-centred expansion of [N]-activation.

Voicing assimilation is also described in the same manner as nasal harmony: by satisfying PEx, the prosodically-motivated extension of voicing-activation is achieved. What distinguishes voicing assimilation and nasal harmony is, firstly, the choice of harmonic property in the first argument, and secondly, the choice of the second argument for PEx ([α], Nuc/Non-nuc). The first argument is N-[comp], which brings about voicing assimilation itself. In this case, non-nuclear positions are automatically selected as the second argument. This choice is the result of N-[comp] Licensing, which prescribes that
N-[comp] be licensed not only by its head [N] but also by [h]. This is, however, never achieved in nuclear positions, since the appearance of the noise element is restricted to non-nuclear positions. Agreement processes are observed between non-nuclear positions (i.e. in an onset-onset sequence).

In systems displaying voiced-obstruent voicing assimilation, the leftward direction of their inter-nuclear licensing controls the extension of N-[comp] from the prosodically strong righthand onset position to its lefthand weak onset position. In addition to the direction of inter-nuclear licensing, the asymmetry in prosodic strength between the onsets explains why rightward voiced-obstruent voicing assimilation is not attested cross-linguistically: a prosodically strong position (which has sufficient potential to sustain a complex expression N-[comp]) can trigger the extension of N-[comp], whereas a weak position is unable to sustain the complex expression, and furthermore, is unable to act as a trigger for the process.

The relation between prosodic strength and melodic complexity also underlies the observation that nasal-triggering voicing assimilation operates rightwards (postnasal voicing assimilation) but never leftwards. In postnasal voicing assimilation, a simplex expression [N] in the lefthand weak onset position triggers the process and then its righthand strong onset position receives a complex N-[comp]. This conforms to Licensing Inheritance, which prescribes that the righthand strong onset position be no less complex than its lefthand weak position. In hypothetical prenasal voicing assimilation, however, a complex N-[comp] would appear in the lefthand weak onset and the triggering simplex [N] would stay in the righthand strong onset. This violates the terms of Licensing Inheritance.

Finally, I have provided two reasons why prenasal assimilation (agreement of both [h] and [N]) is not attested across languages. First, the inter-nuclear harmonic process does not function in the case of an [h, N] pair since the combination of [h] and [N] is excluded from nuclear positions. Second, the constraint *[h, N] is always relevant to languages that display agreement processes, and is incompatible with the [h]-[N] combination.
Chapter 7. Conclusion

7.2 Future research

Replacing the former [L] element with a merged nasal-voice element raises a number of general issues that merit further research.

First, how is low tone to be represented in this model? In fact the overall approach of this thesis dovetails with a recent analysis of tone and intonation, in which low pitch is the phonetic manifestation not of an independent melodic category but of a prosodic boundary unassociated to high tone (Cabrera-Abreu in press).

Second, if we are justified in merging nasal and voice, we are naturally led to consider whether other traditionally recognised melodic distinctions can be eliminated. There have been several recent proposals to extend the element-reducing programme in various ways, for example by merging aspiration with noise and coronality with openness (van der Hulst 1995, Marten 1996, Charette & Göksel 1998, Kula & Marten 1998, Rennison 1999). The conceptual advantages of this approach are clear. However, the empirical consequences have yet to be fully worked out.

Third, on the basis of the clear phonological affinity between voice and nasality, we are prompted to reconsider whether the two properties are really as phonetically disparate as traditionally supposed. This is just the sort of reassessment that was explicitly encouraged in Jakobson, Fant & Halle (1952) (where lip rounding and pharyngealisation, for example, are partially subsumed under the feature [flat]). It is for future research to determine whether there exists some invariant acoustic signature that is common to nasality and voicing.
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