Chapter 2
A CROSS-LINGUISTIC TYPOLOGY OF NASAL HARMONY

In this chapter I develop a description and analysis of a cross-linguistic typology of nasal harmony, focusing on variability in the set of segments undergoing nasalization and in those that block or behave transparent to nasal spreading. Across these variables, I propose to unify our understanding of nasal harmony as conforming to one basic type of pattern. As the basis for this study, I have compiled a database of nasal harmony systems, which comprises descriptions from over 75 languages. Each language entry includes information about the inventory of segments, the set of segments undergoing nasalization, and any blocking or transparent segments. The cross-linguistic generalizations established in this research define the facts to be explained by the analysis. These facts are summarized in this chapter and a condensed version of the database itself is appended.

Two central theoretical points illuminate the unified account of nasal harmony. First, building on previous studies of the compatibility of nasalization with different segments, it is argued that cross-linguistic variation in nasal harmony is limited by a phonetically-grounded hierarchy which ranks segments in terms of their harmonicity under nasalization. After nasal stops, vowels are ranked as most compatible with nasalization in this hierarchy. Obstruents, on the other hand, are ranked as least compatible. The nasalization hierarchy is implicational in the sense that if a segment undergoes nasal spreading, all segments more compatible with nasalization will also be targeted. The hierarchy is analyzed in an optimality-theoretic framework as composed of intrinsically-ranked nasal feature cooccurrence constraints. Variation in the set of undergoing segments is then derived by ranking the nasal spreading constraint at different points in the constraint hierarchy, generating just the variability which is attested.

The second point concerns transparent segments in nasal harmony. To begin, there appears to be a gap in the set of variants predicted by the implicational hierarchy: there is no language in which all segments are nasalized in nasal harmony; some obstruents resist nasalization (see second row in (1a)). Also, as diagrammed in (1a), the typology of nasal harmony outlined here finds that while the majority of segments either block spreading or become nasalized, some obstruents (typically voiceless ones) behave differently, either blocking or behaving transparent. When transparent, obstruents remain oral but permit the continuation of nasal spreading. These two observations fit together like pieces of a puzzle: systems with a set of transparent segments form the complement to those with blocking segments. To explain this complementarity, it is proposed that systems with transparent obstruents fill the gap of a system targeting all segments, i.e. transparent obstruents should be understood as belonging to the set of segments undergoing nasal harmony, as outlined in (1b).

(1) a. Observed possible patterning of segments in nasal harmony:

<table>
<thead>
<tr>
<th></th>
<th>Vowoids</th>
<th>Liquids</th>
<th>Obstruents</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blockers (block spreading)</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Targets (become nasalized)</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Transparent segments (remain oral, do not block)</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
</tbody>
</table>

b. Proposed analysis of segmental behavior in nasal harmony:

<table>
<thead>
<tr>
<th></th>
<th>Vowoids</th>
<th>Liquids</th>
<th>Obstruents</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blockers (block spreading)</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Targets (undergo [nasal] spreading)</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
</tbody>
</table>

Factorial ranking in the optimality-theoretic framework (Prince and Smolensky (1993) predicts the possibility of a grammar in which nasal spreading would be ranked high enough to derive even nasalized segments at the extreme of incompatibility. With this move, nasal harmony is unified into a basic pattern in which segments simply either undergo or block, and all possible variations produced by different rankings are attested. In this unified analysis of the typology, transparency arises as a resolution for an incompatible segment that undergoes nasal spreading.

In further support of this claim, it is observed that there is an implication in the occurrence of voiceless transparent obstruents and the behavior of other segments. When voiceless obstruents behave transparent to nasal harmony, all other classes of segments undergo nasalization, that is, they exhibit a nasal alternant in nasal contexts. Voiceless obstruents never behave transparent when segments more compatible with nasalization block nasal spreading. As I will show, this asymmetry suggests that all segments, including obstruents, are targetted by nasalization in these languages. Importantly, the finding that descriptively transparent segments pattern with undergoers
null
Sundanese

a. "i'ann
'to wet"

b. kuma'ah
'how?'

c. bFNhar
'to be rich'

d. mi'si
'to love'

e. Na'ja
'to sift'

f. ma'wur
'to spread'

g. mo'lohok
'to stare'

h. ma'ro
'to halve'

i. Nu'dag
'to pursue'

j. Na'tur
'to arrange'

The Johore dialect of Malay, another Malayo-Polynesian language, illustrates the second variation, in which glides also undergo a rightward spreading of nasality from anasal consonant (Onn 1980). Liquids and obstruents block spreading. The Malay inventory contains the following consonants $\{p, b, t, d, t^s, d^s, k, g, s, m, n, \tilde{n}, N, l, r, j, w, h, /\}$ (glottal stop is again non-phonemic).

(4) Malay (Johore dialect)

a. mi'nom
'to drink'

b. baNon
'to rise'

c. ma'/a)p
'pardon'

d. p'n'nah
'central focus'

e. ma'jaN
'stack (palm)'

f. m'n'na'
'to capture' (active)

g. m'ratapp
'to cause to cry'

h. p'Nah
'supervision'

i. mkan
'to eat'

Ijo, a Kwa language of Nigeria, is an example of the third variation, where liquids are added to the set of undergoing segments (Williamson 1965, 1969b, 1987). In this language, nasality spreads from a vowel to adjacent consonants, 

(5) Ijo (Kolokuma dialect)

a. Umba
'breath'

b. anda
'wrestle'

c. wa)i'
'prepare sugarcane'

d. j'aRI'
'shake'

e. sçRç)
'five'

f. sanlo
'gills'

g. izo'ngo
'jug'

h. abamu
'loft'

i. oto'Ngbolo
'mosquito'

j. tçni'
'light (a lamp)'

The Applecross dialect of Scottish Gaelic, a Celtic language spoken in Scotland, illustrates the fourth variation in which nasalization carries through fricatives (Ternes 1973). Nasality spreads from a nasal vowel to adjacent syllable nuclei throughout the phrase. It also nasalizes the onset of the syllable containing the stressed vowel, provided the onset is not an obstruent stop.

(6) Scottish Gaelic (Applecross dialect)

a. /ma>har/ /ma>h)a)r/ 'mother'

b. /tJi'anu/ /tJi'a)nu/ 'to do, to make'

c. /fri'a>v/ /f'r)i'a)>v/) 'root' (plural)

d. /SEnE>var/ /S)E)nE)v)a)r/ 'grandmother'

1 Ternes notes some complexities in relation to the mid-high vowels. These will be discussed in section 2.4.
The above examples illustrate the general distribution of nasal spreading across Tuyuca.

<table>
<thead>
<tr>
<th>Oral</th>
<th>Nasal</th>
</tr>
</thead>
<tbody>
<tr>
<td>wa@a</td>
<td>n.wa@aèa)</td>
</tr>
<tr>
<td>watiê</td>
<td>w)a)ti'è</td>
</tr>
<tr>
<td>hoo@</td>
<td>h)o)ho)o)è</td>
</tr>
<tr>
<td>keero@</td>
<td>ke)e)r)o)è</td>
</tr>
<tr>
<td>oso@</td>
<td>j'o)so)è</td>
</tr>
<tr>
<td>bota@</td>
<td>e)mo)è</td>
</tr>
<tr>
<td>pade@</td>
<td>w)i'no)è</td>
</tr>
<tr>
<td>sˆge@</td>
<td>tˆ'No)èè</td>
</tr>
<tr>
<td>sia@</td>
<td>si'a)è</td>
</tr>
<tr>
<td>pee@</td>
<td>pe)e)è</td>
</tr>
<tr>
<td>bipiê</td>
<td>mi'pi'ê</td>
</tr>
<tr>
<td>ditiê</td>
<td>ni'ti'ê</td>
</tr>
<tr>
<td>aka@</td>
<td>a)ka))è</td>
</tr>
</tbody>
</table>

In attributing a special status to the first syllable, I follow Beckman (1995, 1997, 1998), who finds that the root-initial syllable often has a privileged status in triggering spreading and resisting change to other segments in the word. In Tuyuca, spreading from a nasal vowel or stop in the first syllable to a nasal morpheme (Tuyuca) is an instance of this case. This kind of pattern occurs in Tuyuca.

Kind of pattern occurs in Tuyuca.
continuous sequence of voiced segments; voiceless segments block spreading.

Importantly, nasalization is contrastive for vowels only in the initial syllable. I assume that both voiced oral and nasal stops are 'phonemic' in Tuyuca, i.e. they may both occur underlyingly. This will be motivated as the analysis of Tuyucadevelops: I posit underlying nasalization of the stem to which they are affixed (8) or they are fixed in their nasality (9) (there are no prefixes in Tuyuca).

(8) Nasality alternations with /-ri/ 'imperative of warning'

a. Oral suffix alternant with oral stem

/\tutiê-ri\n\[tutiêri\] 'watch out or you will get scolded!'

b. Nasal suffix alternant with nasal stem

/\h)̃'̃ê-ri\n\[h)̃'̃êri\] 'watch out or you will get burned!'

(9) Suffixes with fixed nasality

a. Fixed oral suffix

/w)a)ka)go/\n\[w)a)ka)go\] 'she awakens'

b. Fixed nasal suffix

/\koa-ma)/\n\[koama)è\] 'allow me to dig'

A list of some Tuyuca suffixes by their nasalization categories is given in (10-11). Interestingly, suffixes that alternate exclude ones with initial stops or fricatives.

5 As Barnes (1996: 34) observes, this indicates that obstruents block nasal spread from stem to suffix, otherwise the gap of obstruent-initial suffixes in the alternating set would be purely accidental.

(10) Alternating suffixes:

- a. animate plural
- b. contrast
- c. imperative
- d. evidential
- e. evidential
- f. imperative of warning
- g. specifier
- h. adverbializer
- i. pl. nominative

(11) Fixed oral suffixes:

- a. recent past
- b. emphatic
- c. classifier
- d. classifier
- e. classifier
- f. classifier
- g. classifier
- h. classifier
- i. classifier
- j. classifier
- k. classifier
- l. classifier
- m. classifier
- n. classifier
- o. classifier
- p. classifier
- q. classifier

Fixed nasal suffixes:

- a. inanimate sg. nominative
- b. inanimate pl. nominative
- c. classifier
- d. classifier
- e. classifier
- f. classifier
- g. classifier
- h. classifier
- i. classifier
- j. classifier
- k. classifier
- l. classifier
- m. classifier
- n. classifier
- o. classifier
- p. classifier
- q. classifier

5 Voiced velar stops behave somewhat differently from the others, because they are no longer stops in

they are affixed (9) or they are fixed in their nasality in

in本质上, voiced velar stops are realized as oral word-initially and nasal medially (McCarthy and Prince 1995; Itô and Mester 1997c).
The fact that voiced stops pattern with the obstruents in blocking nasal spread across morphemes is strong evidence that when oral they are obstruents themselves. This blocking effect would be wholly non-mandatory if nasal spreading were restricted to nasaliser classes, with their behavior in cross-morphemic harmony. The full system of Tuyuca nasal harmony forms a case study in chapter 3.

Nasal harmony within Tuyuca morphemes provides an example in which nasal spreading targets all classes of segments, including obstruents. This completes the exemplification of the hierarchical typology, summarized in (12).

(12) Hierarchical typology of nasal harmony

\[
\begin{array}{|c|c|c|c|c|c|}
\hline
\text{Vowels} & \text{Glides} & \text{Liquids} & \text{Fricatives} & \text{Obstruent stops} \\
\hline
\text{Spanish} & \text{Spanish} & \text{Spanish} & \text{Spanish} & \text{Spanish} \\
\text{Sundanese} & \text{Sundanese} & \text{Sundanese} & \text{Sundanese} & \text{Sundanese} \\
\text{Malay (Johore)} & \text{Malay (Johore)} & \text{Malay (Johore)} & \text{Malay (Johore)} & \text{Malay (Johore)} \\
\text{Ijo (Kolokuma)} & \text{Ijo (Kolokuma)} & \text{Ijo (Kolokuma)} & \text{Ijo (Kolokuma)} & \text{Ijo (Kolokuma)} \\
\text{Gaelic (A.cross)} & \text{Gaelic (A.cross)} & \text{Gaelic (A.cross)} & \text{Gaelic (A.cross)} & \text{Tuyuca} \\
\hline
\end{array}
\]

All of the variation in the set of non-undergoing (blocking) segments, and all of the variation in the set of undergoing (non-blocking) segments, should be understood as realizations of nasal harmony. The proposed hierarchical typology supports the perception of variation in nasal harmony. The cross-linguistic generalizations that support the perception of variation in nasal harmony are listed below:

1. The fact that voiced stops pattern with the obstruents in blocking nasal spread across morphemes is strong evidence that when oral they are obstruents themselves. This blocking effect would be wholly non-mandatory if nasal spreading were restricted to nasaliser classes, with their behavior in cross-morphemic harmony. The full system of Tuyuca nasal harmony forms a case study in chapter 3.

2. Nasal harmony within Tuyuca morphemes provides an example in which nasal spreading targets all classes of segments, including obstruents. This completes the exemplification of the hierarchical typology, summarized in (12).

3. All of the variation in the set of non-undergoing (blocking) segments, and all of the variation in the set of undergoing (non-blocking) segments, should be understood as realizations of nasal harmony. The proposed hierarchical typology supports the perception of variation in nasal harmony.
spreading. In chapter 3 I argue that transparency only occurs as the result of an opaque constraint interaction: one that arises to resolve a conflict between fully satisfying thenasal spreading constraint and... 

2.2 Analysis of the typology

The typology established by the database confirms that cross-linguistic variation in nasal harmony obeys the implicational hierarchy in (2). The notion of a spreading scale is more precise and... 

2.2.1 The constraints

To characterize the basic typology of nasal harmony, two kinds of constraints will be required: spreading constraints and... 

Schourup (1972), I assume that all... 

Drawing on a proposal initially made by Schourup (1972), I assume that all variation in the set of target segments in nasal harmony is based on the phonetically-grounded universal harmony scale of... 

Nasalized segment harmony scale

(13) Nasalized segment harmony scale

The nasalized segment hierarchy reflects the fact that a sonorant stop is most compatible with nasality and is most widely attested across inventories (Ferguson 1965, 1969; Maddieson 1975; Pulleyblank 1994; Comrie 1999). In nasal harmony the nasalized segments are ranked in a hierarchy according to their nasality. 

2.3 The constraints

Develop an optimal ordering and ranking of the constraints...

Table of the typology

The typology established by the database contains the cross-harmony variation in nasal...
The nasalized segment constraints will conflict with the constraint driving the nasality hierarchy. Overall, it is both articulatory/aerodynamic and acoustic/perceptual factors that contribute to the basis for the nasalization hierarchy, as noted by Cohn (1993a). For example, it is difficult to produce nasalized fricatives... Guaraní are produced with clearly perceptible nasalization but they lose audible frication: Gregores and Suárez describe /v/, ʃ), ʃ)W as ‘nasalized frictionless spirants’ (1967: 81-2).

With the harmony scale in (13), we can explain the variation in nasal harmony as variability in where languages make the cut between segments that are sufficiently compatible with [+nasal] to be nasalized. The approach of using feature cooccurrence constraints to achieve segmental blocking is one that builds on previous work by Krämer (1985), Pulleyblank (1988), and McCarthy and Pulleyblank (1994).

Nasalized segment constraint hierarchy:

a. *NASOBSSTOP » *NASFRICATIVE » *NASLIQUID » *NASGLIDE » *NASVOWEL » *NASSONSTOP

b. A possible elaboration in featural terms:

*NASOBSSTOP: *[-nas, -cont, -son]

*NASFRICATIVE: *[-nas, -cont, +son]

*NASLIQUID: *[-nas, +approx, -cons]

*NASGLIDE: *[-nas, +approx, -cons, -syll]

*NASVOWEL: *[-nas, +approx, -cons, +syll]

*NASSONSTOP: *[-nas, +son, -cont]

The feature cooccurrence constraints in this hierarchy may be stated in terms of features:

\[
\begin{align*}
\text{Nasalized segment:} & \quad [\text{nas}\,\text{cont}\,\text{son}] \\
\text{Nasalized fricative:} & \quad [\text{nas}\,\text{cont}\,\text{son}] \\
\text{Nasalized liquid:} & \quad [\text{nas}\,\text{approx}\,\text{cons}] \\
\text{Nasalized glide:} & \quad [\text{nas}\,\text{approx}\,\text{cons}, \text{syll}] \\
\text{Nasalized vowel:} & \quad [\text{nas}\,\text{approx}\,\text{cons}, \text{syll}] \\
\text{Nasalized sonorant stop:} & \quad [\text{nas}\,\text{son}, \text{cont}]
\end{align*}
\]

Overall, it is both articulatory/aerodynamic and acoustic/perceptual factors that contribute to the nasalization hierarchy. The approach of using feature cooccurrence constraints to achieve segmental blocking is one that builds on previous work by Krämer (1985), Pulleyblank (1988), and McCarthy and Pulleyblank (1994).
The multiply-linked outcome of feature spreading:

Input:  
\[ S_1 \mid S_2 \mid S_3 \]

Output:  
\[ S_1 \mid \frac{+F}{\downarrow} \mid S_2 \mid \frac{+F}{\downarrow} \mid S_3 \]

Feature spreading is not satisfied by feature copying:

Input:  
\[ S_1 \mid S_2 \mid S_3 \]

Output:  
\[ S_1 \mid \frac{+F}{\downarrow} \mid S_2 \mid \frac{+F}{\downarrow} \mid S_3 \]

To achieve the multiply-linked outcome of spreading, the spreading constraint needs to make reference not just to feature specifications but to individual occurrences of feature specifications. The output in (15) has one occurrence of the feature specification [+F], while the output in (16) has three occurrences of the feature specification [-nasal]. I propose to formulate the general spreading constraint as in (17).

\[
\text{SPREAD}([\text{F}]) \leftarrow \bigwedge_{i \in \text{domain}} \left( \left( \frac{\text{Assoc}(f, s_i)}{s_i \in D} \right) \wedge \left( \bigwedge_{j \in \text{other segments}} \text{Assoc}(f, s_j) \right) \right) \]

The spreading constraint in (17) expresses the requirement that for any segment linked to an occurrence of a feature specification F in some domain D, a violation is incurred for each feature occurrence f in that domain for which (i) is false.

The spreading constraint in (18) requires that every occurrence of a [+nasal] feature on a segment in a morpheme be linked to all segments in that morpheme. It says nothing about feature occurrences on segments belonging to other morphemes. If the spreading constraint is not satisfied for some feature specification, violations will be incurred for each occurrence of that feature specification.

\[
\text{SPREAD}([\text{+nasal}], M) \leftarrow \bigwedge_{i \in \text{domain}} \left( \left( \frac{\text{Assoc}(n, s_i)}{s_i \in M} \right) \wedge \left( \bigwedge_{j \in \text{other segments}} \text{Assoc}(n, s_j) \right) \right) \]

The spreading constraint in (18) expresses the requirement that for any feature occurrence f and any segment linked to that occurrence, a violation is incurred for each other feature occurrence that is not linked to the same segment.

I am grateful to Geoff Pullum for suggestions concerning the formal statement of this constraint.
The formulation of the spreading constraint so far incorporates nothing explicit about the direction of spreading. For the bidirectional spreading of [+nasal] in Tuyucamorphemes, this is sufficient; for the rightward nasal spreading in languages like Malay and Capanahua, it must be possible to encode directionality in the spreading constraint.

To obtain the different direction of spreading in Malay and Capanahua, it must be possible to encode directionality in the spreading constraint. I propose to formulate directional spreading as in (20).

\[ \text{SPREAD-R}([F], D) \]

Let \( f \) be a variable ranging over occurrences of a feature specification \([F]\), and \( S \) the ordered set of segments \( s_1 \ldots s_k \) in a domain \( D \). Let \( \text{Assoc}(f, s_i) \) mean that \( f \) is associated to \( s_i \), where \( s_i \in S \).

\[ \text{SPREAD-R}([F], D) \text{ holds iff} \]

1. \( ([s_i \in S] \land \text{Assoc}(f, s_i)) \rightarrow \forall j > i \text{ Assoc}(f, s_j) \)

2. For each feature occurrence \( f \) associated to some segment in \( D \), a violation is incurred for every \( s_j \in S \) for which (i) is false.

\[ \text{SPREAD-L}([F], D) \]

Let \( n \) be a variable ranging over occurrences of the feature specification \([+\text{nasal}]\), and \( S \) consist of the sequence of segments \( s_1 \ldots s_k \) in the prosodic word \( P \). Let \( \text{Assoc}(n, s_i) \) mean that \( n \) is associated to \( s_i \), where \( s_i \in S \).

\[ \text{SPREAD-L}([+\text{nasal}], P) \text{ holds iff} \]

1. \( ([s_i \in S] \land \text{Assoc}(n, s_i)) \rightarrow \forall j < i \text{ Assoc}(n, s_j) \)

2. For each feature occurrence \( n \) associated to some segment in \( D \), a violation is incurred for every \( s_j \in S \) for which (iii) is false.

The formulation of spreading in (20) adds directionality by making reference to the place of a segment within the sequence of segments in the domain. For any occurrence of a feature specification \( f \) linked to a segment \( s_i \), SPREAD-R requires that the feature specification occurrence be linked to any segment \( s_j \) which comes after \( s_i \) in the sequence of segments in the domain. For any occurrence of a feature specification \( n \) linked to a segment \( s_i \), SPREAD-L expresses a similar demand but requires that a feature specification occurrence on \( s_i \) be linked to any segment \( s_j \) coming before \( s_i \) in the sequence.

(21) gives the formulation of the rightward nasal spreading constraint that will be required for Malay.

\[ \text{SPREAD-R}([+\text{nasal}], P) \text{ holds iff} \]

1. \( ([s_i \in S] \land \text{Assoc}(n, s_i)) \rightarrow \forall j > i \text{ Assoc}(n, s_j) \)

2. For each feature occurrence \( n \) associated to some segment in \( D \), a violation is incurred for every \( s_j \in S \) for which (i) is false.
Then \( \text{SPREAD-R}([+\text{nasal}], \text{Pwd}) \) holds iff

(i) \( \text{si} \in S \)[\(\text{[\[n (\text{Assoc}(n, \text{si}))\]]}\) fi\(\text{[\(\text{sj} \in S \text{[\(\text{[j}>i \text{fi} (\text{Assoc}(n, \text{sj}))\]]}\)]}\)

where \(1 \leq i, j, k \).

(ii) For each feature occurrence \(n\) associated to some segment in \(P\), a violation is incurred for every \(\text{sj} \in S\) for which (i) is false.

Let us consider the evaluation of the representations in (22) in relation to this constraint. The structures in (a) and (b) each perfectly satisfy SPREAD-R, because for any segment linked to \([+\text{nasal}]\), all segments to the right of it are also linked to that same occurrence of the \([+\text{nasal}]\) feature specification. On the other hand, (c) incurs one violation with respect to \(S\text{PREAD-R}\), because one segment to the right of \(S_2\) is not linked to \([+\text{nasal}]\).

\(\text{(22)a. S}_1 \text{ S}_2 \text{ S}_3\)
\(\text{(b. S}_1 \text{ S}_2 \text{ S}_3\)
\(\text{(c. S}_1 \text{ S}_2 \text{ S}_3\)

In cases of spreading where directionality need not be stated in the constraint, I will continue to use a simpler formulation like that in (17). Alternatively, this kind of spreading could be captured with two constraints, one spreading to the left and the other to the right.

Interaction of nasal spreading constraints and the nasalized segment constraint will derive the hierarchical variation in the typology of nasal harmony. The spreading constraint and nasalized segment constraint will interact to derive the hierarchical variation in the typology of nasal harmony. The interaction of nasal spreading constraints and the nasalized segment constraint is highly suggestive of the segmentally strict view of locality.

Interaction of nasal spreading constraints and the nasalized segment constraint is highly suggestive of the segmentally strict view of locality. It has shown us that nasality spreads from segment to segment. Importantly, apparent skipping of segments in nasal spreading does not occur as an alternative to blocking for non-undergoers, rather systems with descriptively transparent segments fill the slot where we expect to find all segments undergoing nasalization.

The motivation for a segmentally strict view of locality is reviewed and argued for in a paper by Ní Chiosáin and Padgett (1997). Their work seeks to understand asymmetries in long-distance feature spreading, namely that while features (or gestures) like vowel-place, \([+\text{nasal}]\), and place of major consonants are nasalized across vowels and consonants, the spreading of vowel major place features through consonants is possible, since superimposing a vocalic degree of stricture on a consonant will not produce a consonant with a similar vocalic realization.

8 Following Gafos (1996) and Flemming (1995b), Ní Chiosáin and Padgett point out that coronal consonant harmonies do not involve spreading of a major consonantal place, but rather features involving tongue shape or place of articulation (characterized by some analysts as \([\text{anterior}]\) or \([\text{distributed}]\)), which do not entail spreading of stricture as well.
The implicational nasalization hierarchy are attested. It also explains why voiced stops always undergo nasalization rather than block when voiceless stops behave transparent.

The requirement of segmentally strict locality follows more generally from the claim that a 'gapped configuration' like that in (23) is universally ill-formed.

(23) The gapped configuration: universally ill-formed

a  b   g

where a, b, and g are any segment.

In prohibiting a configuration like that in (23), which violates segmental adjacency in feature linking, I follow Ní Chiosáin and Padgett (1993, 1997), Padgett (1995a), and Walker (1996) (McCarthy 1994; ... (1994), and Pulleyblank (1993, 1996), among others. It should be noted that some previous conceptions of locality permit a, b, and g to be defined as projected targets, allowing skipping of non-target segments (see, for example, Archangeli and Pulleyblank on 'prosodic transparency' 1994: 358-9, also feature-geometric approaches make use of elaborated structure below the segment; Piggott 1992); however, under segmentally strict locality, a, b, and g are interpreted as any segment, so spreading and linking must be between adjacent segments. Building on the insights of Articulatory 'Local Adjacency', the requirement of segmentally strict locality is that featural gestures must carry on uninterrupted between each of those segments to which it is linked. In describing the gapped configuration as universally ill-formed, I mean that it represents a structural configuration that may never be violated in the candidate set: it is not a structure that Gen is free to attach to a word.

9  An alternative approach adopting a violable notion of gapping is considered and rejected in chapter 5.

As Ní Chiosáin and Padgett suggest, it is reasonable to assume that convexity holds of phonological representations without exception.10  The ill-formedness of the gapped configuration in (23) may thus be understood in these terms: the gapped configuration is not a possible phonological representation because it is not a convex featural event.

(24) A featural event F is convex iff it satisfies the following condition:

For all segments, a, b, g, if a precedes b, b precedes g, a overlaps F and g overlaps F, then b overlaps F.

The consequence of segmentally strict locality for the analysis of nasal harmony is this: spreading of [+nasal] may never skip a segment by linking across it. If nasalization of a particular segment is blocked by spreading, then the only outcome that may occur is that the segment blocks spreading. As Ní Chiosáin and Padgett characterize the ill-formedness of gapping in terms of convexity, if spreading were to target moras (as they suggest for vowel harmony), non-moraic segments may be skipped.

10  Archangeli and Pulleyblank (1994: 38) also argue that the gapped configuration can be ruled out on a formal basis in terms of precedence; however, they relativize this to skipping of anchors. Thus if spreading were to target moras (as they suggest for vowel harmony), non-moraic segments may be skipped.
which dominate spreading will produce blocking effects, as it would be worse to form these nasalized segments than violate spreading. In contrast, nasalized segment constraints outranked by spreading will ... as it is better to violate these constraints by forming the nasalized segments, than it is to violate spreading instead.

(25) Hierarchical variation through constraint ranking:

Spanish:

*NASOBSSTOP » *NASFRIC » *NASLIQUID » *NASGLIDE » *NASVOWEL » SPREAD [+nas]

Sundanese:

*NASOBSSTOP » *NASFRIC » *NASLIQUID » *NASGLIDE » *NASVOWEL fi

Malay (Johore):

*NASOBSSTOP » *NASFRIC » *NASLIQUID » *NASGLIDE » *NASVOWEL fl

Ijo (Kolokuma):

*NASOBSSTOP » *NASFRIC » *NASLIQUID » *NASGLIDE » *NASVOWEL °

Scottish Gaelic (Applecross):

*NASOBSSTOP » *NASFRIC » *NASLIQUID » *NASGLIDE » *NASVOWEL –

Tuyuca:

*NASOBSSTOP » *NASFRIC » *NASLIQUID » *NASGLIDE » *NASVOWEL

For case ‹ (Spanish), which exhibits no nasal harmony, SPREAD [+nas] is ranked below all nasalization constraints, as it fails to force violations of any of these constraints. For ‹ (Sundanese), where only vowels undergo nasal harmony, SPREAD [+nas] dominates just the constraint against nasalized vowels; other nasalization constraints are ranked above SPREAD [+nas], since they remain unviolated. (Malay) maintains the same ranking of the nasalization constraints with respect to each other but moves SPREAD [+nas] over the nasalized glide constraint as well. (Ijo) moves SPREAD [+nas] up one more to dominate the constraint against nasalized liquids, and for ° (Scottish Gaelic) SPREAD [+nas] moves one more again so that fricatives also undergo. Finally for – (Tuyuca), SPREAD [+nas] dominates all nasalization constraints, giving a pattern in which all segments undergo harmony. The *NASSONSTOP constraint is not shown here, because all of the underlying sonorant stops are already nasal, so this constraint never conflicts with satisfaction of SPREAD [+nas].

The overall ranking that has been established for the typology of nasal harmony is given in (26). A crucial feature of this pattern is that the ranking of nasalization constraints with respect to each other remains constant according to the intrinsically-ranked hierarchy in (14).

(26) Summary of constraint ranking:

<table>
<thead>
<tr>
<th>Nasalized segment constraints</th>
<th>SPREAD [+nas]</th>
<th>(blocking segments)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nasalized segment constraints</td>
<td>SPREAD [+nas]</td>
<td>(target segments)</td>
</tr>
</tbody>
</table>

The ranking pattern is exemplified in (27-29). The tableau in (27) illustrates the pattern for Sundanese, with rightward spreading.

11 In this variation, only vowels undergo harmony, so the spreading constraint dominates the nasalized segment constraints only up to the constraint against nasalized vowels. The other nasalization constraints are unviolated, since they remain unviolated. (Malay) maintains the same ranking of the nasalization constraints with respect to each other but moves SPREAD [+nas] over the nasalized glide constraint as well. (Ijo) moves SPREAD [+nas] up one more to dominate the constraint against nasalized liquids, and for ° (Scottish Gaelic) SPREAD [+nas] moves one more again so that fricatives also undergo. Finally for – (Tuyuca), SPREAD [+nas] dominates all nasalization constraints, giving a pattern in which all segments undergo harmony. The *NASSONSTOP constraint is not shown here, because all of the underlying sonorant stops are already nasal, so this constraint never conflicts with satisfaction of SPREAD [+nas].

The overall ranking that has been established for the typology of nasal harmony is given in (26). A crucial feature of this pattern is that the ranking of nasalization constraints with respect to each other remains constant according to the intrinsically-ranked hierarchy in (14).
The optimal output selected on the basis of this ranking is the one in (a), in which all segments are nasalized, including the voiceless obstruent stop. This segment is devoiced and unassimilated.

We have now seen how the constraint hierarchy ranking of the spreading constraint in relation to the hierarchy of nasalized segment constraints derives precisely the hierarchical variation observed across languages. A common understanding is required of how the optimal candidate in (a) is mapped to the outcome in (d) in an opaque constraint interaction between the constraint against nasalization of the voiceless obstruent stop and the constraint against nasalization of the spreading constraint. This understanding is provided by the recognition that the spreading constraint spans nasalized voicing and nasalized voicing and nasalized voicing, and that the spreading constraint is ranked above nasalization and nasalization of nasalization of voicing.

When the spreading constraint dominates all of the nasalized segment constraints, all segments will participate in nasal harmony. This is how I propose to treat Tuyuca:

(29) Tuyuca

The optimal output selected on the basis of this ranking is the one in (a), in which all segments are nasalized, including the voiceless obstruent stop. This segment is devoiced and unassimilated.

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We have now seen how the constraint hierarchy ranking of the spreading constraint in relation to the hierarchy of nasalized segment constraints derives precisely the hierarchical variation observed across languages. A common understanding is required of how the optimal candidate in (a) is mapped to the outcome in (d) in an opaque constraint interaction between the constraint against nasalization of the voiceless obstruent stop and the constraint against nasalization of the spreading constraint. This understanding is provided by the recognition that the spreading constraint spans nasalized voicing and nasalized voicing and nasalized voicing, and that the spreading constraint is ranked above nasalization and nasalization of nasalization of voicing.

When the spreading constraint dominates all of the nasalized segment constraints, all segments will participate in nasal harmony. This is how I propose to treat Tuyuca:

(29) Tuyuca

The optimal output selected on the basis of this ranking is the one in (a), in which all segments are nasalized, including the voiceless obstruent stop. This segment is devoiced and unassimilated.
different kinds of nasalization will be discussed further in chapter 3.

2.2 Interaction of the hierarchy with multiple constraints

Walker and Pullum (1997) argue for a different view in which glottal segments can be nasalized in phonological representations. Walker and Pullum note that strong evidence for the possibility of phonologically nasalized glottals is provided by instances of languages with a phonemic nasal glottal continuant ([h] in Kwangali, Arabela). Further support comes from the finding that nasal spreading is strictly local, as noted by Walker (1996) and argued for in this chapter. The skipping approach suggested by Walker (1996) and repeated for this chapter. The skipping approach is necessary for the phonological nasalization of glottals to be modeled in a way that respects the fixed ranking of the constraints in the nasalization hierarchy. This makes the prediction that different languages will exhibit different behaviors in nasal harmony. Walker and Pullum observe that there is no reason to posit glottals as skipped. The existence of phonemic nasal glottals shows that nasal spreading can target glottals, even though there is no perceptual cue to nasalization. This kind of false transparency can be distinguished from cases of true transparency, where a segment that is highly compatible with a spreading feature is nasalized, whereas a segment that is weakly compatible with a spreading feature is not. In the case of glottals, the spreading feature [nasal] is highly compatible with a spreading feature, whereas the spreading feature [fricative] is weakly compatible. This model of segmental structure, spreading of [+nasal] will target only supralaryngeal segments (i.e. those with a supralaryngeal node), and glottal segments will be skipped. This approach is also supported by the observation that glottals are typically blocked in nasal harmony, whereas obstruents are not. The role of perceptibility of nasalization in some instances of glottal blocking is also discussed.
The constraints may be ranked at separate points in the hierarchy in the same language. I will now briefly examine two such cases.

The first example is found in Epena Pedee, a Choco language spoken in Colombia described by Harms (1985, 1994). Epena Pedee has two separate nasal harmony phenomena. It exhibits a rightward spreading nasalization that spreads from nasal to adjacent sonorants but is blocked by obstruents, while the (leftward) nasalization within the syllable nasalizes sonorants and obstruents. Interestingly, the two nasal harmony phenomena of Epena Pedee differ in their degree of strength. The rightward nasal spreading nasalizes sonorants but is blocked by

<table>
<thead>
<tr>
<th>Constraints</th>
<th>Rightward Spreading</th>
<th>Leftward Spreading</th>
</tr>
</thead>
<tbody>
<tr>
<td>*NASFRICATIVE</td>
<td></td>
<td></td>
</tr>
<tr>
<td>*NASLIQUID</td>
<td></td>
<td></td>
</tr>
<tr>
<td>*NASGLIDE</td>
<td></td>
<td></td>
</tr>
<tr>
<td>*NASVOWEL</td>
<td></td>
<td></td>
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<tr>
<td>*NASVOWEL</td>
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<tr>
<td>*NASVOWEL</td>
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<td>*NASVOWEL</td>
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<tr>
<td>*NASVOWEL</td>
<td></td>
<td></td>
</tr>
<tr>
<td>*NASVOWEL</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

This indicates that two nasal spreading constraints are active in Epena Pedee. The constraint that dominates nasal spreading within the syllable and the other constraint that dominates nasal spreading within the word is ranked at different points in the hierarchy. The rightward spreading is dominated by a constraint that is ranked more deeply in the hierarchy than the leftward spreading.

The second example of constraints ranked at separate points in relation to the nasalization hierarchy comes from Ijo (Williamson 1965, 1969b, 1987). The nasal harmony pattern of Ijo was discussed in section 1.2. The nasal nasalization hierarchy comes from Ijo (Williamson 1995:1996, 1998). The nasal nasalization is established by ranking a leftward nasal spreading constraint between *NASFRICATIVE and *NASLIQUID in the nasalization hierarchy. Another break in the hierarchy is needed to obtain nasality as a phonemic property of nasal stops and vowels. This is achieved by ranking I_{DENT-IO[+nasal]} over *NASVOWEL and *NASSONSTOP (see section 1.3.3).

The constraint that dominates nasal spreading within the syllable and the other constraint that dominates nasal spreading within the word is ranked at different points in the hierarchy. The rightward spreading is dominated by a constraint that is ranked more deeply in the hierarchy than the leftward spreading.
After McCarthy and Prince (1995: 280), I use \( F'[^{\text{nas}}] \) to indicate the class of constraints that dispose of other possible ways of satisfying nasal spreading, for example through deletion or denasalization of the nasal trigger segment.

14

(34) Nasal vowel triggers in Ijo

\[
\begin{array}{c}
\text{Nasal vowel triggers in Ijo} \\
\text{\varepsilon_R^c_R^c} \hspace{1cm} \text{*NAS} \\
\text{OBSST} \hspace{1cm} \text{*NAS} \\
\text{FRIC} \hspace{1cm} \text{F'}[^{\text{nas}}] \\
\text{SPREAD-L} \hspace{1cm} \text{([+n], Pwd)} \\
\text{*NAS} \hspace{1cm} \text{LIQUID} \\
\text{*NAS} \hspace{1cm} \text{GLIDE} \\
\text{IDENT-IO}[^{\text{+nasal}}] \\
\text{*NAS} \hspace{1cm} \text{VOWEL} \\
\text{*NAS} \hspace{1cm} \text{SONST}
\end{array}
\]

(35) No 'phonemic' nasal liquids in Ijo

\[
\begin{array}{c}
\text{No 'phonemic' nasal liquids in Ijo} \\
\text{\varepsilon_R^c_R^c} \hspace{1cm} \text{*NAS} \\
\text{OBSST} \hspace{1cm} \text{*NAS} \\
\text{FRIC} \hspace{1cm} \text{F'}[^{\text{nas}}] \\
\text{SPREAD-L} \hspace{1cm} \text{([+n], Pwd)} \\
\text{*NAS} \hspace{1cm} \text{LIQUID} \\
\text{*NAS} \hspace{1cm} \text{GLIDE} \\
\text{IDENT-IO[^{\text{+nasal}}]} \\
\text{*NAS} \hspace{1cm} \text{VOWEL} \\
\text{*NAS} \hspace{1cm} \text{SONST}
\end{array}
\]

More generally on the subject of inventories, the nasalization hierarchy predicts that inventories will exhibit the same kinds of implications as spreading, that is, if an nasalized segment occurs in the ... that follows.  Almost every language of the world has nasal stops as part of its inventory (97%; UPSID; Maddieson 1984). 15 Distinctively nasal vowels occur considerably less frequently (in less than 25% of the languages in UPSID). Nasalized continuant consonants are also frequent (Thomason and Thompson 1991). This is evidenced by the fact that the languages which have nasal stops also tend to have nasalized continuant consonants (Ferguson 1963, 1975). 16 UMbundu, a Benue-Congo language of Angola, is a more extreme case.  UMbundu is noted by Schadeberg (1982) to have a contrastively nasalized voiced fricative /v/. In addition to this, the inventory of this language has nasal stops, nasal vowels, a nasal glottal, nasal glide, and nasal liquid.

2.4 Appendix: The nasal harmony database

2.4.1 Summary and discussion

In this section I present a condensed version of the database of nasal harmony patterns. This database contains entries that provide an overview of the patterns of nasal harmony in various languages. The database is designed to help researchers understand the relationships between different patterns of nasal harmony and to identify potential areas for further research.
The database assembles substantial information about each language, including the language name, family, and location, the inventory of segments, the segments triggering nasal spread, blocking nasalization, all segments more compatible with nasalization, the direction of nasal spreading, and whether nasal spreading is in a class block nasal spreading, or a segment block nasalization. It also includes blocks nasalization, all segments less compatible with the nasalization, the end of this section. Information included in these entries is as follows (organized by columns in data presentation):

<table>
<thead>
<tr>
<th>Language</th>
<th>Triggers</th>
<th>Through</th>
<th>Direction</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Barasano Northern Tucanoan</td>
<td>Glottals, Glides, Nasals</td>
<td>Obstructions, Obstruents</td>
<td>Retroflex, Retrals, Postalveolars</td>
<td>Nasal spreading patterns included here are those in which nasality spreads across syllables or nasalization targets nonvocalic segments in the syllable.</td>
</tr>
</tbody>
</table>

The central finding of the survey is that variation in nasal harmony across languages verifies the implicational hierarchy outlined in section 2.1. The study finds that if a segment blocks nasalization, then all segments undergo nasalization. We thereby derive a complete typology in which all variants are attested.

The implicational hierarchy defined five basic patterns of nasalization, corresponding to each step in the hierarchy of segmental classes (excluding patterns in which no segments undergo nasalization or when glides undergo nasalization). This signals some variability in the cross-linguistic compatibility of glides with nasal harmony.

<table>
<thead>
<tr>
<th>Summary of languages in the five main patterns of nasal harmony</th>
</tr>
</thead>
<tbody>
<tr>
<td>i. Vowels (Glottals)</td>
</tr>
<tr>
<td>ii. Liquids</td>
</tr>
<tr>
<td>iii. Fricatives</td>
</tr>
<tr>
<td>iv. Obstruent stops</td>
</tr>
<tr>
<td>v. Nasalization patterns included here are those in which nasality spreads across syllables.</td>
</tr>
</tbody>
</table>

6. Selected references

5. Cross-linguistic nasal harmony in the language.


3. Through: Through spreading nasalization. If the glides and nasals are nasalized, these are over-extended.

2. Location: Location of nasal spreading.

1. Language: Language name, language family, and location.

The database assembles substantial information about each language inclusion. The cross-linguistic nasal harmony patterns are included in these patterns.

- Nasal spreading patterns included here are those in which nasality spreads across syllables or nasalization targets nonvocalic segments in the syllable. This signals some variability in the cross-linguistic compatibility of glides with nasal harmony.
### ii. Vowels (Glottals) Glides Liquids Fricatives Obstruent stops

<table>
<thead>
<tr>
<th>Language Dialect Family Location</th>
<th>Language Dialect Family Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acehnese Hesperonesian Indonesia</td>
<td>Aguaruna Jivaroan Peru</td>
</tr>
<tr>
<td>Arabela Zaparoan Peru</td>
<td>Bariba Voltaic Nigeria</td>
</tr>
<tr>
<td>Breton Celtic France</td>
<td>Capanahua Panoan Peru</td>
</tr>
<tr>
<td>Chinantec Tepetotula Chinantecan Mexico</td>
<td>Dayak Kendayan Indonesian Borneo</td>
</tr>
<tr>
<td>Dayak Land, Me &amp; Entu Indonesian Sarawak</td>
<td>Dayak Sea Indonesian Sarawak</td>
</tr>
<tr>
<td>Dayak Land, Me &amp; Entu Indonesian Sarawak</td>
<td>Dayak Land, Me &amp; Entu Indonesian Sarawak</td>
</tr>
<tr>
<td>Dayak Land, Me &amp; Entu Indonesian Sarawak</td>
<td>Dayak Land, Me &amp; Entu Indonesian Sarawak</td>
</tr>
<tr>
<td>Konkani Indo-Iranian India</td>
<td>Lamani Indo-Aryan India</td>
</tr>
<tr>
<td>Madurese Malayo-Polynesian Indonesia</td>
<td>Malay Johore Indonesian Malaysia</td>
</tr>
<tr>
<td>Malay Johore Indonesian Malaysia</td>
<td>Marathi Indo-Aryan India</td>
</tr>
<tr>
<td>Maxakali (isolate) Brazil</td>
<td>Melanau Mukah Austronesian Sarawak</td>
</tr>
<tr>
<td>Orejon (after Velie &amp; Velie) Tucanoan Peru</td>
<td>Oriya Colloquial variety Indo-Aryan India</td>
</tr>
<tr>
<td>Rejang Austronesian South Sumatra</td>
<td>Saramaccan (creole) Surinam</td>
</tr>
<tr>
<td>Seneca Iroquoian Canada, USA</td>
<td>Terena/o Arawakan Brazil</td>
</tr>
<tr>
<td>Warao (isolate) Brazil</td>
<td>Wayandapan Tucanoan Colombia</td>
</tr>
<tr>
<td>Wayandapan Tucanoan Colombia</td>
<td>Wayandapan Tucanoan Colombia</td>
</tr>
<tr>
<td>Wayandapan Tucanoan Colombia</td>
<td>Wayandapan Tucanoan Colombia</td>
</tr>
</tbody>
</table>

### iii. Vowels (Glottals) Glides Liquids Fricatives Obstruent stops

<table>
<thead>
<tr>
<th>Language Dialect Family Location</th>
<th>Language Dialect Family Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>Edo Kwa Nigeria English Midwestern Germanic USA</td>
<td>Epena Pedee Choco Colombia</td>
</tr>
<tr>
<td>Ewe/Gbe Kwa Ghana, Togo, Bénin, Nigeria</td>
<td>Hindi Indo-Iranian India</td>
</tr>
<tr>
<td>Isoko Ozoro Nigeria</td>
<td>Ijo Kolokuma Kwa Nigeria</td>
</tr>
<tr>
<td>Kpelle Mande Liberia, Guinea</td>
<td>Isoko Ozoro Nigeria</td>
</tr>
<tr>
<td>Mandan Siouan USA</td>
<td>Kpelle Mande Liberia, Guinea</td>
</tr>
<tr>
<td>Spanish South Castilian Romance Tucanoan Colombia</td>
<td>Tuyuca Tucanoan Colombia, Brazil</td>
</tr>
<tr>
<td>Uraba Kwa Colombia</td>
<td>Uraba Kwa Colombia</td>
</tr>
<tr>
<td>Venda Zulu South Africa</td>
<td>Venda Zulu South Africa</td>
</tr>
<tr>
<td>Zulu South Africa</td>
<td>Zulu South Africa</td>
</tr>
</tbody>
</table>

### iv. Vowels (Glottals) Glides Liquids Fricatives Obstruent stops

<table>
<thead>
<tr>
<th>Language Dialect Family Location</th>
<th>Language Dialect Family Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ennemor Semitic Ethiopia</td>
<td>Itsekeri Kwa Nigeria</td>
</tr>
<tr>
<td>Scottish Gaelic Applecross Celtic Scotland</td>
<td>Umbundu Benue-Congo Angola</td>
</tr>
<tr>
<td>Umbundu Benue-Congo Angola</td>
<td>Umbundu Benue-Congo Angola</td>
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<td>Umbundu Benue-Congo Angola</td>
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<tr>
<td>Umbundu Benue-Congo Angola</td>
<td>Umbundu Benue-Congo Angola</td>
</tr>
</tbody>
</table>

28 examples in database.
<table>
<thead>
<tr>
<th>Language Family</th>
<th>Location</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>Apinayé</td>
<td>Colombia</td>
<td>Ge</td>
</tr>
<tr>
<td>Barasano</td>
<td>Colombia</td>
<td>Northern Tucanoan</td>
</tr>
<tr>
<td>Bribri</td>
<td>Costa Rica</td>
<td></td>
</tr>
<tr>
<td>Cabécar</td>
<td>Cabécar Northern</td>
<td>Chibchan</td>
</tr>
<tr>
<td>Cayuvava</td>
<td>Bolivia</td>
<td></td>
</tr>
<tr>
<td>Cubeo</td>
<td>Colombia</td>
<td>Tucanoan</td>
</tr>
<tr>
<td>Desano Tucanoan</td>
<td>Colombia, Brazil</td>
<td></td>
</tr>
<tr>
<td>Epena Pedee</td>
<td>Colombia</td>
<td>Choco</td>
</tr>
<tr>
<td>Epera</td>
<td>Panama</td>
<td></td>
</tr>
<tr>
<td>Gbeya</td>
<td>Central African Republic</td>
<td></td>
</tr>
<tr>
<td>Gokana</td>
<td>Nigeria</td>
<td>Benue-Congo</td>
</tr>
<tr>
<td>Guaraní</td>
<td>Paraguay, Brazil, Colombia</td>
<td></td>
</tr>
<tr>
<td>Guaymi</td>
<td>Panama</td>
<td></td>
</tr>
<tr>
<td>Igbo Ohuhu</td>
<td>Nigeria</td>
<td></td>
</tr>
<tr>
<td>Icua Tupí</td>
<td>Brazil, Peru</td>
<td></td>
</tr>
<tr>
<td>Mixtec Atatlahuca</td>
<td>Mexico</td>
<td>Mixtecan</td>
</tr>
<tr>
<td>Mixtec Ocotepec</td>
<td>Mexico</td>
<td></td>
</tr>
<tr>
<td>Orejon</td>
<td>Peru</td>
<td></td>
</tr>
<tr>
<td>Parintintin</td>
<td>Brazil, Tucanoan</td>
<td></td>
</tr>
<tr>
<td>Shiriana</td>
<td>Venezuela, Brazil</td>
<td></td>
</tr>
<tr>
<td>Tatuco</td>
<td>Brazil</td>
<td></td>
</tr>
<tr>
<td>Tucano</td>
<td>Colombia</td>
<td></td>
</tr>
<tr>
<td>Tuyuca</td>
<td>Colombia, Brazil</td>
<td></td>
</tr>
</tbody>
</table>

The above summary shows that all of the cases of nasal harmony examined in the table indicate that nasal harmony can be classified according to the hierarchical typology. However, there is support for the occurrence of nasalized fricatives, and fricatives are not nasalized. This suggests that nasalized fricatives may not be as common as other nasalized segments. The report of nasalized fricatives deserves some comment. The results of nasalization spread through fricatives, and nasalized fricatives have been reported in some languages. The spread of nasalization through fricatives is an interesting phenomenon in the study of nasal harmony. The spread of nasalization through fricatives is due to the nasal harmony effect, which occurs when a nasal consonant is followed by a fricative. The nasal harmony effect is a well-known phenomenon in the study of nasal harmony, and it has been observed in many languages. The spread of nasalization through fricatives is an interesting phenomenon in the study of nasal harmony, and it has been observed in many languages. The spread of nasalization through fricatives is an interesting phenomenon in the study of nasal harmony, and it has been observed in many languages.
nasalized labial continuant, transcribed as \( v \), and after explicitly remarking on Ohala's claim that such segments are impossible, Schadeberg notes that this segment contrasts with a nasalized labial approximant \( w \). Evidence for a voiceless nasalized fricative comes from Gerfen's instrumental investigation of Coatzospan Mixtec (Mixtecan, Mexico), where he finds that nasal airflow persists through a so-called 'transparent' voiceless coronal fricative \( S \). It should be noted that while Gerfen's results are strongly suggestive that it is possible to produce a voiceless fricative with a lowered velum, his technique ... through airflow measurements. For absolute certainty on this issue, a direct measurement of velum position is needed.

Recent work by Ohala, Solé, and Ying (1998) investigated the matter of nasalized fricatives by creating a pseudo-velopharyngeal valve. They created the valve by inserting catheters of various sizes into the nose, where the length of the catheter was greater than the length of the nasal passage. They discovered that for the smallest catheter, 7.9 mm, there was no significant effect on the level of pharyngeal pressure (i.e. pressure behind the constriction for the buccal fricative) and no detectable effect on the quality of the fricative. For catheters with areas of 17.9 mm\(^2\) and above they found that pharyngeal pressure dropped considerably, especially for voiced fricatives. The pressure drop was weaker ... typically either degree of frication or perceptibility of nasalization will suffer in the production of these segments.

Examination of the languages in which nasalization spreads through obstruents will further the production of these segments.

<table>
<thead>
<tr>
<th>blocking</th>
<th>voles. fricatives</th>
<th>voles. stops</th>
<th>voes. fricatives</th>
<th>voes. stops</th>
</tr>
</thead>
<tbody>
<tr>
<td>e.g. Itsekeri, Ennemor</td>
<td>V cd. fricatives</td>
<td>V cd. stops</td>
<td>V cd. fricatives</td>
<td>V cd. stops</td>
</tr>
<tr>
<td>e.g. Scottish Gaelic (Applecross)</td>
<td>V cl. fricatives</td>
<td>V cl. stops</td>
<td>V cl. fricatives</td>
<td>V cl. stops</td>
</tr>
<tr>
<td>e.g. Epera, Orejon, Parintintin</td>
<td>V cd. fricatives</td>
<td>V cd. stops</td>
<td>V cl. fricatives</td>
<td>V cl. stops</td>
</tr>
<tr>
<td>e.g. Tuyuca, Tucano, Barasano</td>
<td>V cl. fricatives</td>
<td>V cl. stops</td>
<td>V cl. fricatives</td>
<td>V cl. stops</td>
</tr>
</tbody>
</table>

Examination of the languages in which nasalization spreads through obstruents will further the production of these segments.

Cross-linguistic variation in nasalization is illustrated by comparison of the patterns in (37).

<table>
<thead>
<tr>
<th>blocking</th>
<th>V cd. fricatives</th>
<th>V cd. stops</th>
<th>V cl. fricatives</th>
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<td>V cd. fricatives</td>
<td>V cd. stops</td>
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<tr>
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<td>V cl. fricatives</td>
<td>V cl. stops</td>
<td>V cl. fricatives</td>
<td>V cl. stops</td>
</tr>
<tr>
<td>e.g. Epera, Orejon, Parintintin</td>
<td>V cd. fricatives</td>
<td>V cd. stops</td>
<td>V cl. fricatives</td>
<td>V cl. stops</td>
</tr>
<tr>
<td>e.g. Tuyuca, Tucano, Barasano</td>
<td>V cl. fricatives</td>
<td>V cl. stops</td>
<td>V cl. fricatives</td>
<td>V cl. stops</td>
</tr>
</tbody>
</table>

Examination of the languages in which nasalization spreads through obstruents will further the production of these segments.
with the glottal articulation (see Walker and Pullum 1997 and references therein; also discussion in 2.2.3; cf. Cohn 1993a). Further, as noted in discussion of the 'rhinoglottophilia' phenomenon (Matisoff ... Arawakan language of Brazil. Terena marks first person forms with nasalization of a morpheme from left to right, and \[h\] and \[/h\] pattern with the obstruents in blocking nasal spread. Bendor-Samuel (1960: 349) analyzes these segments as true fricatives (rather than glides, for example), noting that \[/h\] is actually produced with an alveolar constriction and that both \[h\] and \[/h\] function phonologically in the same way as \[s\] and \[ã\]. For glottal stop, blocking occurs in the Austronesian language, Rejang, spoken in South Sumatra. McGinn (1979: 187) observes that glottal stop patterns with the obstruents in blocking the rightward spread of nasality from a nasal stop, e.g. \[/ma)/a/\] 'approach'; cf. \[/ni’jo)a)/\] 'coconut'. Harrison and Taylor (1971: 17) note that in Kaiwá, a Tupí-Guaraní language of Brazil, nasalization spreads through glottal stop in normal speech, but in slow speech \[/\] blocks nasal spreading. It is also conceivable that the dispreference in some languages for a nasalized glottal stop has an acoustic/perceptual basis. Ní Chiosáin and ... of these segments with obstruents rather than glides or perhaps the perceptibility of nasalization.

The implicational hierarchy is a good predictor of the likelihood of segments to undergo nasalization, but the nasal harmony database finds that other factors can also contribute to patterns of nasalization that nasalization tends to obscure the perceptibility of vowel height contrasts, evidenced, for example, by the universal generalization that the number of nasal vowels in a language never exceeds the number of oral vowels (Ruhlen 1975, 1978; ... mid-low, low) and three vowel heights in its nasal vowels (high, mid-low, low); thus, the oral mid-high vowels \[e, ´, o\] are missing phonemic nasal counterparts. This contrast-driven gap in the nasal vowel inventory is also apparent in nasal spreading: the oral ... is reported to produce heavy nasalization of high and low vowels, but light nasalization in the mid vowels \[e, E, o, ç\] (Ward 1952: 13).

Vowel backness also appears to interact with blocking in some cases. In Guaymi, spoken in Panama, the left-to-right nasalization which marks a near past completed action in class II verbs is blocked by \[/v\] when vowels are nasalized in a previous word and vowel nasalization in the mid vowel \[e\] (as \[/ç\]). This nasalization is resisted to certain vowel heights (see above), in Espanola Island Tariana, four vowels are nasalized in terms of nuclear accent, and no vowels have high nuclear accent. In these cases, nasalization occurs more strongly in words in the same word, e.g. \[p\] and \[c\] in words with an underlying nasal consonant. Ward reports two words, \[/çmç\] 'child' and \[/mç\] in which \[ç\] has strong nasalization.
The nasal trigger and directionality of nasalization

Influential nasalization appears to be much more common than nasalization in the
phantom vowel. Each of these is well-attested: however, nasal spreading is uncommon.

In the case of nasals, the nasal trigger (phonological, lexical, or stress) is important.

Finally, we may observe that a difference in nasal harmony is the direction of nasal
spread.

Rate of speech and stress may affect patterns of nasalization. Two languages in
the study report that nasalization spreads through more segments in faster speech. In
Kaiwá, glottal stop blocks nasal spreading only in stressed syllables. In English and
Spanish, nasalization spreads through less segments. Leaving the nasal trigger (phonological, lexical, or stress) in place, nasalization spreads through the stressed syllable and more segments in fast speech. In Kaiwá, nasalization spreads through more segments in faster speech. In

The study of nasalization in phonetics is needed.

For a further discussion of the factors involved in this phenomenon, more
references are needed. For instance, the role of features involved in this phenomenon
and may be independent of nasalization. However, it is

Also, it may have some neutralizing effect on the perception of nasal vowels.
2.4.2 The nasal harmony database (condensed version)

i. Vowels (Glottals) Glides Liquids Fricatives Obstruent stops

Language: Triggers: Thru: Dir: Comments: Selected Refs:

Barasano (Northern dialect; Tucanoan; Colombia) Nasal vowels Right This restrictive right-spreading pattern is quite different from full spreading in the Southern dialect and should be reverified.

Stolte & Stolte 1971; Steriade 1993a

Guahibo (Guahibo-Pamaguan; Colombia, Venezuela) Nasal stops, nasal vowels

Kondo & Kondo 1967

Mixtec (Ayutla dialect; Mixtecan; Mexico) Nasal stops, nasal vowels

Pankratz & Pike 1967

Mixtec (Mixtepec dialect; Mixtecan; Mexico) Nasal stops, nasal vowels

Pike & Ibach 1978

Mixtec (Molinos dialect; Mixtecan; Mexico) Nasal stops, nasal vowels

Hunter & Pike 1969; Beddor 1983

Mixtec (Silacayoapan dialect; Mixtecan; Mexico) Nasal stops, nasal vowels

North & Shields 1977; Marlett 1992

Pame Otomi (Otopamean; Mexico) Nasal vowels, h, /

Gibson 1956; Schourup 1973; Beddor 1983

Sundanese (Hesperonesian; Indonesia) Nasal stops, nasal vowels


Tinrin (Melanesian) Nasal stops; prenasalized stops; nasal vowels

Osumi 1995

ii. Vowels (Glottals) Glides Liquids Fricatives Obstruent stops

Language: Triggers: Thru: Dir: Comments: Selected Refs:

Acehnese (Hesperonesian; Indonesia) Nasal stop (nasal V?)

Durie 1985

Aguaruna (Jivaroan; Peru) h)

Payne 1974; Bivin 1986; Trigo 1988; Walker & Pullum 1997
<table>
<thead>
<tr>
<th>Language</th>
<th>Triggers</th>
<th>Thru:Dir</th>
<th>Comments</th>
<th>Selected Refs</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Arabela</strong></td>
<td>Nasal stops, h)</td>
<td>V, j, w</td>
<td>Right Glottal fricative is nasal in all environments.</td>
<td>Rich 1963; Howard 1973; Beddor 1983; Walker &amp; Pullum 1997</td>
</tr>
<tr>
<td><strong>Bariba</strong></td>
<td>Nasal stops, Nasal vowels V, j</td>
<td>Left</td>
<td>Spreading seems to be restricted to the syllable.</td>
<td>Welmers 1952; Beddor 1983</td>
</tr>
<tr>
<td><strong>Breton</strong></td>
<td>Nasal vowels V, w</td>
<td>Left</td>
<td>No glottals in the language. Patterning of [j] is unclear.</td>
<td>Ternes 1970; Dressler 1972; Schourup 1973; Walker &amp; Pullum 1997</td>
</tr>
<tr>
<td><strong>Capanahua</strong></td>
<td>Nasal stop V, j, w, h, /</td>
<td>See note: Nasality spreads to left, but if nasal C is deleted, spreading is bidirectional.</td>
<td>Loos 1969; Halle &amp; Vergnaud 1981; van der Hulst &amp; Smith 1982; Safir 1982; Piggott 1987, 1992; Trigo 1988</td>
<td></td>
</tr>
<tr>
<td><strong>Chinantec</strong></td>
<td>Nasal stops, Nasal vowels V, j, w, weak velar (semi)-cons.</td>
<td>Right</td>
<td>Spreading is syllable-bound.</td>
<td>Westley 1971; Walker &amp; Pullum 1997</td>
</tr>
<tr>
<td><strong>Dayak</strong></td>
<td>Nasal stops (?) V, glottals, glides</td>
<td>Right</td>
<td>Description from Court (1970) citing Dunselman.</td>
<td>Dunselman 1949; Court 1970</td>
</tr>
<tr>
<td><strong>Dayak</strong></td>
<td>Nasal stops V, j, w, h, /</td>
<td>Right</td>
<td>Glottal stop is described by Scott as a 'junction feature'. Glides/glottals block in some words.</td>
<td>Scott 1964; Court 1970; Schourup 1973</td>
</tr>
<tr>
<td><strong>Dayak</strong></td>
<td>Nasal stops V, j, w, h, /</td>
<td>Right</td>
<td>Glides/glottals block in some words.</td>
<td>Court 1970</td>
</tr>
<tr>
<td><strong>Dayak</strong></td>
<td>Nasal stops V, j, w, glottals (?)</td>
<td>Right</td>
<td>Scott 1957; Kenstowicz &amp; Kisseberth 1979</td>
<td></td>
</tr>
<tr>
<td><strong>Konkani</strong></td>
<td>Nasal stops; Nasal vowels V, j</td>
<td>Left</td>
<td>Spreading also to right but just to word-final segments.</td>
<td>Fellbaum 1981; Ghatage 1963; Beddor 1983; Walker &amp; Pullum 1997</td>
</tr>
<tr>
<td><strong>Lamani</strong></td>
<td>Nasal vowels V, j, w</td>
<td>Right</td>
<td>Trail is not explicit about the behavior of [h] in nasalization.</td>
<td>Trail 1970</td>
</tr>
<tr>
<td><strong>Madurese</strong></td>
<td>Nasal stops V, j, w, h, /</td>
<td>Right</td>
<td>Glides spread through are not phonemic; phonemic glides are rare. There is an interesting interaction between nasal harmony and reduplication.</td>
<td>A. Stevens 1968, 1985; Mester 1986; McCarthy &amp; Prince 1995</td>
</tr>
<tr>
<td><strong>Malay</strong></td>
<td>Nasal stops V, j, w, h, /</td>
<td>Right</td>
<td>Glottal stop is not phonemic.</td>
<td>Dyen 1945; Court 1970; Kenstowicz &amp; Kisseberth 1979; Onn 1980; Pulleyblank 1989; Piggott 1992</td>
</tr>
<tr>
<td><strong>Marathi</strong></td>
<td>Nasal stops V, j, w</td>
<td>Left</td>
<td>Nasalization is limited to the syllable. There is no glottal stop. [h] is described as voiced. Whether [h] can be nasalized is unclear.</td>
<td>Pandharipande 1997</td>
</tr>
<tr>
<td><strong>Maxakali</strong></td>
<td>Nasal stops V, j, w, h, /</td>
<td>Bidir.</td>
<td>Gudschinsky et al. 1970; Anderson 1976; Walker &amp; Pullum 1997</td>
<td></td>
</tr>
<tr>
<td>Language</td>
<td>Triggers</td>
<td>Thru: Dir: Comments</td>
<td>Selected Refs</td>
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</tr>
<tr>
<td>Melanau (Mukah dialect; Austronesian; Sarawak)</td>
<td>Nasal stops, j, w, h, /</td>
<td>Right</td>
<td>Piggott 1992; McGinn 1979; Coady &amp; McGinn 1982</td>
<td></td>
</tr>
<tr>
<td>Orejon (dialect described by Velie &amp; Velie; Tucanoan; Peru)</td>
<td>Nasal vowels, j, h</td>
<td>Right Nasalization is contrastive only in initial syllable. Behavior of glottal stop is unclear.</td>
<td>Velie &amp; Velie 1981; Cole &amp; Kisseberth 1995</td>
<td></td>
</tr>
<tr>
<td>Oriya (Colloquial variety; Indo-Aryan; India)</td>
<td>Nasal stops, j, w</td>
<td>Bidir. Nasalization of vocoids occurs under deletion of a nasal stop in colloquial speech.</td>
<td>Patnaik 1984; Piggott 1987</td>
<td></td>
</tr>
<tr>
<td>Rejang (Austronesian; South Sumatra)</td>
<td>Nasal stops, j, w</td>
<td>Right Glottal stop blocks nasal spread. Patterning of [h] is unclear.</td>
<td>McGinn 1979; Coady &amp; McGinn 1982</td>
<td></td>
</tr>
<tr>
<td>Saramaccan (Surinam)</td>
<td>Nasal stops, j, ã</td>
<td>Right Nasality in syllable rhyme spreads across laminal (palatal) sonorants.</td>
<td>Rountree 1972</td>
<td></td>
</tr>
<tr>
<td>Seneca (Iroquoian; Canada, USA)</td>
<td>Nasal stops, nasal vowels, glides, glottals</td>
<td>Bidir. Chafe reports that [sw] does not block spreading. Some complications in left spreading.</td>
<td>Holmer 1952; Chafe 1967; Beddor 1983</td>
<td></td>
</tr>
<tr>
<td>Terena/o (Arawakan; Brazil)</td>
<td>First person morpheme, j, w, /</td>
<td>Right Nasalization is morphemic (marks 1st pers). [h, hJ] pattern as fricatives, not glottals. It is not clear whether /l, r/ block or undergo.</td>
<td>Bendor-Samuel 1960; Leben 1973; Hart 1981; Bivin 1986; Piggott 1987; Cole &amp; Kisseberth 1995</td>
<td></td>
</tr>
<tr>
<td>Warao (Isolate; Venezuela; Guyana)</td>
<td>Nasal stops, nasal vowels</td>
<td>Right There is no phonemic glottal stop in the language.</td>
<td>Osborn 1966; Schourup 1973; Piggott 1987; Piggott 1992</td>
<td></td>
</tr>
<tr>
<td>Urdu (Indo-Iranian; Pakistan, India)</td>
<td>Nasal stops, nasal vowels, j, w, h</td>
<td>Bidir. There is no phonemic glottal stop in the language.</td>
<td>Hoenigswald 1948; Poser 1982; Walker &amp; Pullum 1997</td>
<td></td>
</tr>
<tr>
<td>Edo (Kwa, Nigeria)</td>
<td>Nasal vowels, l, r ([+son])</td>
<td>Right Nasal spreading targets sonorants in suffixes after a nasal stem vowel (glides/glottals do not occur in relevant affixes).</td>
<td>Aikhionbare 1989</td>
<td></td>
</tr>
<tr>
<td>English (Midwestern dialect; Germanic; USA)</td>
<td>Nasal stops, j, w, h, l, r</td>
<td>Left Description from Schourup (1972, 1973) citing Stampe (p.c.). Nasalization spreads only up to a stressed syllable.</td>
<td>Schourup 1972, 1973</td>
<td></td>
</tr>
<tr>
<td>Epena Pedee (Saija; Choco; Colombia)</td>
<td>Nasal vowels (Nasal stops if posited in UR)</td>
<td>Right The flap undergoes nasalization but the trill blocks. Patterning of glottal stop is unclear.</td>
<td>Harms 1985, 1994; Bivin 1986</td>
<td></td>
</tr>
<tr>
<td>Epera (Choco; Panama)</td>
<td>Nasal morpheme, glides, glottals, liquids</td>
<td>Right This describes cross-morpheme spreading. Patterning of voiced fricatives is unclear.</td>
<td>Morris 1977; Bivin 1986</td>
<td></td>
</tr>
<tr>
<td>Ewe/Gbe (Kwa; Ghana, Togo, Benin, Nigeria)</td>
<td>Nasal vowels, j, w, Á, l, R, r, ã, b</td>
<td>Left There are no glottals. Spreading is in the syllable. [ã, b] alternate with [n, m] and might be treated as sonorants.</td>
<td>Capo 1981</td>
<td></td>
</tr>
<tr>
<td>Hindi (Indo-Iranian; India, Pakistan)</td>
<td>Nasal vowels, j, w, h, }</td>
<td>Left Nasalization of consonants is supported by nasograph data (M. Ohala 1975).</td>
<td>M. Ohala 1975</td>
<td></td>
</tr>
</tbody>
</table>

**Ejectives Obstruent Stops**

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<th>Triggers</th>
<th>Thru: Dir: Comments</th>
<th>Selected Refs</th>
</tr>
</thead>
<tbody>
<tr>
<td>English (Midwestern dialect; Germanic; USA)</td>
<td>Nasal stops, j, w, h, l, r</td>
<td>Left Description from Schourup (1972, 1973) citing Stampe (p.c.). Nasalization spreads only up to a stressed syllable.</td>
<td>Schourup 1972, 1973</td>
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<td>Nasal vowels, j, w, Á, l, R, r, ã, b</td>
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<tr>
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<td>Nasal vowels, j, w, h, }</td>
<td>Left Nasalization of consonants is supported by nasograph data (M. Ohala 1975).</td>
<td>M. Ohala 1975</td>
</tr>
</tbody>
</table>
Ijo (Kolokumadialect; Kwa; Nigeria)

Nasal stops: j, w, l
Left: /l/ becomes [n] before nasal vowels.
Williamson (1969) reports a similar pattern in Kalabari and Nembedialects. Patterning of [h] is unclear.

Williamson 1965, 1969b, 1987; Piggott 1992

Isoko (Ozoro dialect; Kwa; Nigeria)

Nasal vowels: j, w, R, l

Left: Spreading appears to be syllable-bound. Patterning of [h] is unclear.
Mafeni 1969

Kayan (Uma Jumandialect; Austronesian; Sarawak)

Nasal stops: j, w, h, /, l
Right: Blust notes that it could not be determined whether /r/ permits carry-over of nasalization.
Blust 1977, 1996

Kpelle (Mande; Liberia, Guinea)

Nasal vowels: j, l, ñ
Right: [ñ] represents a velar resonant.
Welmers 1962; Pulleyblank 1989

Mandan (Siouan, USA)

?V, w, h, r

Right: Description from Schourup (1972) citing Hollow (1970)
Schourup 1972 (citing Hollow 1970)

Spanish (South Castilian dialect; Romance)

Nasal segment: [+son]
Bidir.
Clements 1977; Safir 1982

Tucano (Tucanoan; Colombia)

Nasal morpheme: j, w, h, r

Right: This pattern occurs in spreading across morphemes (to alternating affixes). [g] also does not block spreading.
West & Welch 1967, 1972; West 1980; Bivin 1986; Trigo 1988, Noske 1995

Tuyuca (Tucanoan; Colombia, Brazil)

Nasal morpheme: j, w, h, r

Right: This pattern occurs in spreading across morphemes (to alternating affixes). [g] also does not block spreading.
Barnes & Takagi de Silzer 1976; Bivin 1986; Barnes & Malone 1988; Barnes 1996

Urhobo (Kwa, Nigeria)

Nasal vowels, Nasal stops?
Left: [B] represents a bilabial frictionless continuant. There are no glottals in the language.
Kelly 1969; Piggott 1992

Yoruba (Oyo - Standard dialect; Kwa; Nigeria)

Nasal vowels: j, w, R, l
Left: /l/ becomes [n] before nasal vowels. Nasal spreading appears to be syllable-bound.
Ward 1952; Bamgbose 1966b, 1969; Beddor 1983; Pulleyblank 1989

Ennemor (Semitic; Ethiopia)

Unclear: V, j, w, /, r, B, Z

Interesting historical basis to nasalization.
Hetzron & Marcos 1966

Itsekeri (Kwa; Nigeria)

Nasal vowels: j, w, R, ñ
Left: Voiceless fricatives do not undergo. Spreading appears to be syllable-bound. There are no glottals in the language.
Opubor 1969

Scottish Gaelic (Applecross dialect; Celtic; Scotland)

Nasal vowels (in a stressed syllable):
V, glides, glottals, liquids, frics.
Right: (seenote:)
Nasalization also extends to onset of the stressed syllable. Mid-high vowels are never nasalized and block spreading.
Ternes 1973, van der Hulst & Smith 1982; Piggott 1992

UMbundu (Benue-Congo; Angola)

Nasal continuant consonants, Nasal vowels: V, j, w, h, l, v
Bidir: In addition to nasal stops and vowels, UMbundu has /v), l', j', h/). Domain of spreading is complicated — see Schadeberg (1982).
Schadeberg 1982
<table>
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<th>Language</th>
<th>Trigger</th>
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<th>Comments</th>
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<td>Tuyuca (Tucanoan; Colombia, Brazil)</td>
<td>Morpheme-level property (ornasal vowel/stop) All segs behave transparent. This pattern occurs in morpheme-internalspreading.</td>
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Barnes & Takagi de Silzer 1976; Bivin 1986; Barnes & Malone 1988; Barnes 1996.