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*Licensing and alignment : a conspiracy in harmony**

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1 Introduction

Harmony is a phonological pattern in which a sequence of vowels and/or consonants must have the same specification for a particular feature, descriptively referred to as the harmonic feature. In the clear cases, whenever the harmonic feature occurs in a word, the expected manifestation of the harmony pattern is also encountered. For example, in Capanahua (Loos 1969) where [nasal] is the harmonic feature, a nasal consonant always shares nasality with a preceding sequence containing vowels, semivowels and/or laryngeals (i.e. [h ʔ]).

(1) h̃ãmawi 'step on it'
hãmõʔõna 'coming stepping'
wirãnai 'I pushed it'

There are apparently no instances where the feature [nasal] demonstrably fails to trigger harmony in this language.

In contrast with the Capanahua situation, there are cases of harmony in which only some occurrences of a harmonic feature trigger the process. Nasal harmony in Applecross Gaelic is an example. The process is triggered by a lexical feature which is independent of its occurrence as a property of a nasal consonant; the latter is not a trigger of harmony (Ternes 1973, van der Hulst & Smith 1982). Notice the contrast between (2a) and (2b).

(2) a. mur 'sea'
mara:v 'dead person'
b. mũxk 'pig'
mãh̃ãr̃ 'mother'

Among the patterns in which a segment seems to bear the harmonic feature but is neutral to the process itself are cases where harmony is morphologically induced (Cole 1987). The relevance of morphology lies in the fact that the relevant feature is introduced by some affix. The Arawakan language, Terena, offers an example of this type of harmony (Harden 1946, Bendor-Samuel 1960, 1966). In this language, 1st person singular is marked by an affix which induces nasalisation, but root nasals never initiate the process. There is a number of references to this case in

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the phonological literature. Nevertheless, the reason why the affix induces harmony has not been fully explained.

This article proposes an analysis which explains why Terena root nasals are not participants in the harmony. It develops the thesis that the phenomenon is morphologically governed but rejects the conventional view that it is just another instance of assimilation. Two ideas are central to the analysis. The first is a hypothesis that the edges of roots and affixes are sometimes required to coincide. The second is the conventional assumption that the segmental exponents of morphemes are present in surface representations, unless some specific prohibition dictates otherwise. The first idea is elaborated in the theory of Generalised Alignment (McCarthy & Prince 1993b). The second idea has recently been expressed by means of a family of universal 'faithfulness' constraints in the framework of Optimality Theory (Prince & Smolensky 1993); these constraints demand that input or underlying elements be parsed or retained in the output (= surface) representation. However, the presence of an input segment in an output depends on whether or not it is licensed to appear. Specific demands of edge alignment and licensing are responsible for the fact that the Terena 1st person affix induces harmony. I hypothesise that other morphologically governed harmonies are responses to these types of requirements.

My analysis is presented in a framework which assumes that surface phonological patterns are determined by a set of constraints or well-formedness conditions on representations. The approach has a fairly long history in generative phonological studies but it has recently gained much wider acceptance (Kisseberth 1970, Kaye *et al.* 1985, Piggott & Singh 1985, Singh 1987, Paradis 1988, Scobbie 1991, 1993, Prince & Smolensky 1993). There are important differences in constraint-based theories of phonology, primarily with regard to the issue of how constraint interaction is provided for in particular grammars. Optimality Theory (Prince & Smolensky 1993), which seems to have emerged as the dominant model, assumes that Universal Grammar provides a set of constraints on which individual grammars impose an arbitrary ranking. The surface representations in a particular grammar are those which best satisfy the ranking. The evaluation metric allows constraints to be violated. An older model of constraint interaction assumes that Universal Grammar provides a set of constraints which are invariant across all grammars (i.e. the principles) and a set of arbitrary choices which individual grammars may make (i.e. the parameters of variation) (see Chomsky 1981 for a full explication of this approach). Piggott (1995) is an example of how the principles and parameters approach can be applied to phonology. I adopt the latter model in this paper, but I assume the optimality-theoretic position that serial derivation plays no role in phonological analysis. However, I am not directly concerned with the question of which model of constraint interaction is correct. I believe that my analysis can be restated in other constraint-based frameworks but without any gain in explanatory adequacy.

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Regardless of the framework, phonologists generally subscribe to the position that a universal Locality Condition requires the units related by rules or constraints to be adjacent at the relevant level (cf. Steriade 1995: 121). I therefore assume that, within a span where segments are required to be in harmony for a feature, no segment can be skipped.

2 The positioning of elements in surface structure

The two types of constraints (alignment and licensing) account for certain differences between the underlying position of an element and its appearance in surface structure. I will argue below that this type of repositioning occurs in Terena. It is therefore crucial that we understand how such differences between inputs and outputs are commanded. Hence an overview of the subtheories of alignment and licensing at this point should make it easier to follow the analysis.

2.1 Alignment

McCarthy & Prince (1993b) introduce the basic tenets of a theory which regulates patterns of alignment between the edges of grammatical categories. The constraints sanctioned by this theory of Generalised Alignment (GA) take the following form.

(3) *Alignment*

ALIGN(Cat 1-L/R, Cat 2-L/R)

The left (L) or right (R) edge of every occurrence of Cat 1 is aligned with the left or right edge of an occurrence of Cat 2.

The grammatical categories include both prosodic (PCat) and morphological (MCat) types. The syllable (σ), the foot (Ft) and the prosodic word (PWd) are examples of PCat, while MCat may be affixes, roots, stems, etc.

In many cases, the two categories that are required to be edge-aligned are restricted to prosodic constituents. For example, a stress foot might have to be right-aligned with the right edge of a prosodic word, thereby demanding that the last syllable in the word be the same syllable as the last syllable in the foot. The constraints may also demand that the edges of the two morphological categories coincide. Consequently, a prefix can be described as an affix which prefers to be left-aligned in a stem (ALIGN-AFFIX(Affix-L, Stem-L)), while a suffix favours right-alignment (ALIGN-AFFIX(Affix-R, Stem-R)). Assuming that the category Stem is defined recursively (Selkirk 1982), each member of a sequence of affixes may be either at the left or right edge of a stem. Other patterns of edge alignment involve those cases where an edge of a morphological category is required to be aligned with an edge of a prosodic category. Some of the most illuminating insights of GA theory come from cases in which the two categories which must be edge-aligned are combinations of morphological and prosodic. In the earliest illustrations of the workings of Optimality

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Theory, some phonological patterns in Lardil (Prince & Smolensky 1993) and Axininca Campa (McCarthy & Prince 1993a) are convincingly argued to follow the demands of a constraint which requires the right edge of a stem to coincide with the right edge of a syllable (ALIGN(Stem-R, σ-R)).

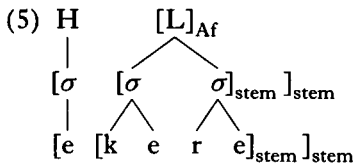
While it is accepted that the linear positioning of affixes in words can be defined in terms of the tenets of GA theory, there has been very little discussion of how phonological features figure in the alignment of morphological categories. To understand the import of this question, we must first recognise the variety of forms morphemes may take. In the familiar cases, the content of a morpheme is a sequence of segments each of which contains a set of features. Most roots and affixes in a language like English take such a form. However, there are also clear cases in which a morpheme is just a feature. Tonal morphemes are among the best examples. Consider how tense is marked in Efik (Ward 1933, Gleason 1955). These data are a selection of 2nd and 3rd person singular forms.

(4) *Efik tense morphemes*

	present	*future*	*past*	
a.	èdèp	èyédép	èkédép	'buy (2SG)'
	édèp	éyédép	ékédép	'buy (3SG)'
b.	èkèrè	èyékéré	èkékéré	'think (2SG)'
	ékèrè	éyékéré	ékékeré	'think (3SG)'
c.	èkèrè	èyékèrè	èkékèrè	'be called (2SG)'
	ékèrè	éyékèrè	ékékèrè	'be called (3SG)'
d.	èbè	èyébě	èkébě	'pass (2SG)'
	ébè	éyébě	ékébě	'pass (3SG)'
e.	èfèhè	èyéfèhé	èkéfèhé	'run (2SG)'
	éfèhè	éyéfèhé	ékéfèhé	'run (3SG)'

From such data, it can be deduced that the future and past tense morphemes are the prefixes *yé* and *ké*, respectively. By comparison, there is no segmental exponent of the present tense morpheme. However, the presence of this morpheme is still detectable. An invariant property of present forms is a Low tone on all tone-bearing positions in the root. Each form in (4) therefore contains the following combination of morphemes: person marker + tense marker + root. Assuming that syllables are the bearers of tones, the surface representation of *ékèrè* 'he thinks' is captured by (5); the square brackets mark the location of edges of relevant categories, and the morphological division is indicated by the hyphen.[1]

(5)



Since every root–affix combination is a stem, the Low-tone exponent of the present tense morpheme is obviously associated with the first tone-

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bearing position in the stem. The three tense-marking morphemes in Efik therefore occur in stem-initial positions and meet the requirements of the following constraint.

(6) *Efik tense affix alignment*

ALIGN-AFFIX(Tense affix-L, Stem-L)

Consider now what the realisation of the present tense morpheme contributes to our understanding of the satisfaction of alignment constraints. The Low tone is obviously associated with the left edge of the affix, because it is the sole exponent of the morpheme. With regard to its realisation within the stem, this tone is also at the left edge. Consequently, the left edges of the two morphological categories, Affix and Stem, are aligned.[2] To generalise the Efik pattern to other cases of the edge alignment between morphological categories, we must assume the following appendix to GA theory:

(7) *MCat alignment*

Edge α of Cat 1 is aligned with Edge β of Cat 2, where Cat 1 and Cat 2 are morphological categories, if some feature at Edge α of Cat 1 is parsed into a unit at Edge β of Cat 2.

This interpretation is limited, for the purpose of this paper, to the alignment of morphological categories, but it is probably applicable to relations involving other categories.

2.2 Licensing

The other subtheory that determines the appearance of elements in surface structure is licensing. This term is used in a variety of ways in current phonological literature (see, for example, Itô 1986, Goldsmith 1990, Kaye *et al.* 1990, Kaye 1990, Harris 1994). Common to all usages is the conception of licensing as a relation which binds one unit to another. The contractual relations of Dependency Phonology (Anderson & Ewen 1987) can also be described in such terms. For Itô and Goldsmith, licensing is defined hierarchically as a bond between one unit to a superordinate element of prosodic structure. Kaye *et al.*, on the other hand, postulate a set of syntagmatic relations that bind certain adjacent positions. The theory adopted in this article is an elaboration of the Itô–Goldsmith idea, but I also assume that licensing relations of the other type are valid, although they play no role in explaining any of the patterns I discuss.

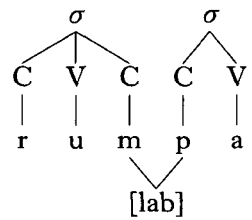
According to the hierarchical conception of licensing, elements may appear in surface representations only if they are parsed as constituents of the prosodic hierarchy; features must be linked to segments, segments to syllables, syllables to feet/prosodic words, etc. The restrictions imposed by the prosodic hierarchy prevent features from being linked directly to syllables and segments from being linked directly to feet. However, there is more to the principle of prosodic licensing than ensuring that elements

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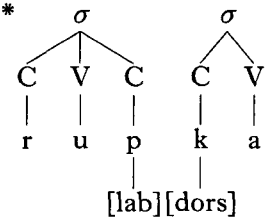
are in the appropriate hierarchical order. The core of Itô's proposal is the hypothesis that elements must be licensed in the position where they occur, although the licenser may be in a different position.

The type of evidence that is usually invoked as support for the licensing hypothesis takes the form of a variety of restrictions imposed by languages on the features which may appear in the coda position of a syllable. One restriction for which there is wide cross-linguistic support is a ban on place features. When this ban is in effect, languages limit coda segments to those that can be classified as placeless (e.g. glottal stop), or those bearing a 'default' place specification (e.g. coronal, velar), or those that share place specification with a following consonant (i.e. geminates and partial geminates). Languages enforcing this ban include Japanese, Selayarese, Diola Fogny and Ponapean. Geminates and partial geminates circumvent the restriction, because the place features are not uniquely parsed as attributes of a segment in the coda position. A representation like (8a) is tolerated in these languages, but (8b) is illicit.

(8) a.



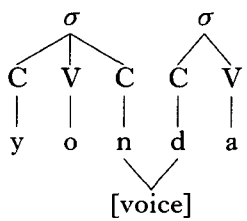
b. *



In a language that sanctions (8a) but prohibits (8b), the function of licensing the Labial specification must be discharged by the onset position in syllable structure. This is essentially the conclusion reached by Itô (1986), and encoded as a Coda Condition.[3]

The theory of prosodic licensing therefore has two components: (a) a requirement that every surface element must be parsed (i.e. hierarchically organised); (b) a requirement that every surface element must have a licenser. A good example of the explanatory power of a theory that makes such a distinction is provided by Itô *et al.* (1995). They show how it is possible for the feature [voice] to be redundant for sonorants but still be responsible for the voicing of postnasal obstruents. In their analysis of postnasal voicing, [voice] is parsed as a feature of a nasal consonant, but it is licensed by the obstruent. The following representation of the Japanese word *yonda* 'read (PAST)' captures the relevant relations:

(9)



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In addition to endorsing the standard conception of prosodic licensing, I propose that the licenser of a unit is not necessarily the category that immediately dominates it in the hierarchy. The relation can be less direct. In particular, I contend that, although a segment is invariably parsed into a syllable, the licenser may be the prosodic word. There is actually very good support for this claim. The evidence involves the status of word-final consonant. It is widely recognised that consonants in this position often do not fit the profile of codas. For example, Diola Fogny, a West Atlantic language described by Sapir (1965), limits word-internal consonant sequence to geminate nasals or homorganic sonorant–obstruent sequences, the signature of a language in which the coda does not license place features.

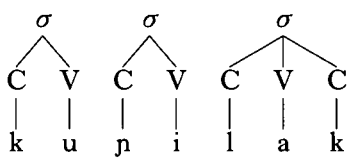
(10) ninennen 'I placed'
kundon 'large rat'
salte 'be dirty'

The word-internal restrictions contrast with the freedom of sonorants and obstruents to appear word-finally.

(11) nikɔkɔb 'I waited' nalanlan 'he returned'
ijaut 'I did not come' kubombon 'they sent'
kuɲilak 'children' lekujaw 'they won't go'

The lack of restrictions on word-final consonants in Diola Fogny is attributed by Itô (1986) to the fact that they are not licensed by the syllable. They are considered to be licensed as extraprosodic elements. It is clear, however, that extraprosodic licensing is just a diacritic. In the two-stage theory of syllabification assumed by Itô, the designation of a final consonant as extraprosodic prevents it from being syllabified as a coda at one stage. At a later stage, equivalent to the surface representation, the designated consonant is assigned to a coda position. Hence, (12) corresponds to the surface syllabification of *kuɲilak* 'children', although the final consonant does not fit the profile of a coda segment.

(12)



In a theory where serial derivation plays no role and licensing constraints evaluate output or surface representations, Itô's proposal cannot be maintained, because it assumes that licensing by extraprosodicity does

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not apply to surface forms. Nevertheless, we must still explain why the appearance of final consonants in a language like Diola Fogny is much less restricted than that of consonants that occur in the position of word-internal codas. The difference can still be explained in terms of licensing, if the consonants in the two positions have different prosodic licensers. I propose that the 'extrametrical' consonants are licensed by the prosodic word, while word-internal codas are licensed by the syllable.[4] This distinction can be maintained regardless of whether or not the word-final consonant is syllabified in a coda position, because the prosodic licenser of an element may be more remote than the position into which it is parsed.[5] However, I assume that the power of the prosodic word to license a unit which it does not immediately dominate is constrained. The limit is set by the following principle:

(13) *The implementation of PWd licensing*

A feature or segment which is licensed by the prosodic word is parsed into the rightmost or leftmost constituent at the relevant level within the word.[6]

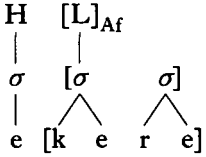
The restriction of the host position for the PWd-licensed element to the constituent at the relevant edge ensures that a segment is parsed into the edgemost syllabic position and a feature F is associated with the edgemost F-bearer. The above principle has some similarity to the familiar autosegmental rule of Initial Association (Goldsmith 1976, Clements & Ford 1979). As originally formulated, the latter is supposed to apply to floating features, elements that are likely to be licensed by a suprasegmental category since they are not lexically linked to a segment.

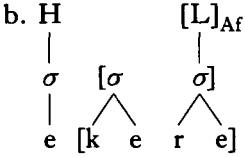
In languages like Diola Fogny, PWd licensing allows words to end in consonants. However, this licensing option may play an even more active role in grammars. Some languages not only allow for word-final consonants but command their presence. McCarthy & Prince (1990) draw attention to this feature of Arabic nouns and verbs. Piggott (1991) argues that the restriction is also applicable to Yapese, where it is considered to compel the loss of final vowels (i.e. apocope). Viewed from a conventional perspective, a requirement that words must end in consonants seems to be completely unrelated to any other grammatical property. It takes on a different appearance in a theory which allows the prosodic word to function as the licenser of word-final consonants. We can attribute it to the satisfaction of a constraint demanding that a segment at the right edge of a word must be licensed by the word. If it is assumed that vowels do not qualify for such a status because they are always syllable heads, word-final segments would then have to be restricted to consonants.

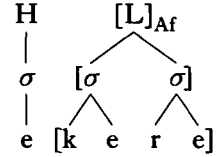
The principle in (13) governs the licensing of both features and segments. Hence, it applies to the present tense marker in Efik, illustrated in (5). Earlier, I inferred from the position of the past and future tense affixes that the present tense morpheme is a prefix and therefore required by the morphology to be at the left edge of the stem. The appearance of

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the Low tone at the right edges of the words can now be accounted for. The scope of this tone cannot be attributed to routine tone spreading, because a lexically linked Low tone such as the one associated with the 2nd person affix does not spread. Given a principle like (13), the present tense morpheme can be described as a 'floating' Low tone which is licensed by the prosodic word and parsed into the rightmost tone-bearing constituent of the word. This affix is therefore commanded by the morphology to be at the left edge of the stem, while the licensing requirement imposed by the phonology forces the Low tone to appear at the right edge of the word. The morphological demand is satisfied by a representation like (14a), while the phonological demand is met by (14b). Only (14c) satisfies both sets of requirements.

(14) a. 

b. 

c. 

The positioning of the present tense affix in Efik is therefore the result of the combined requirements of alignment and licensing.

I will bring to the analysis of Terena nasalisation the conclusion drawn from the Efik facts that morphology may require an element to appear in one position in a string but phonology may require that the same element appear in a different position. This paper is concerned with one of the ways in which this tension between competing demands is dealt with.

3 An overview of Terena nasalisation

The surface appearance of the Terena 1st person affix is partly dependent on the segmental composition of the root. Before the representative data are presented, it is useful to have a picture of the inventory of underlying segments in the language.

(15) a. *consonants*

stops	p	t	k	
fricatives	s	š	h	hy
nasals	m	n		
liquids	l	r		
semivowels	w	y		
glottal stop	ʔ			

b. *vowels*

i e a o u

The segments transcribed as /h/ and /hy/ are classified as fricatives rather than laryngeal glides; they pattern with fricatives in the manifestation of nasal harmony. Among the other consonants, the liquids /l r/ are considered by Bendor-Samuel (1960) to be quite rare. The vowels constitute a common five-vowel set, with only oral exemplars.

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When the root segments are restricted to vowels, semivowels, nasals, liquids and laryngeal glides, nasality spreads through the entire word in the 1st person form. As is often the case, 3rd person is not overtly inflected.

(16)	*3rd person*	*1st person* (SG)	
a.	emoʔu	ẽmõʔũ	'word'
	anu	ãnũ	'neck'
b.	ayo	ãỹõ	'brother'
	yono	ỹõnõ	'walked'
c.	arunoe	ãr̃ũnõẽ	'girl'
	arine	ãr̃ĩnẽ	'sickness'

Nasalisation in the 1st person form is more limited when the root contains an obstruent. The first obstruent in the root is prenasalised and all segments to the left of the prenasal must bear nasality.

(17)	*3rd person*	*1st person* (SG)	
a.	piho	ᵐbiho	'went'
	owoku	õw̃õᵑgu	'house'
	nokone	nõᵑgone	'need'
	tuti	ⁿduti	'head'
	iwatako	ĩw̃ãⁿdako	'sat'
	otopiko	õⁿdopiko	'chopped'
b.	simoa	ⁿzimoa	'came'
	šeʔeša	ⁿžeʔeša	'son'
	iwuʔišo	ĩw̃ũʔĩⁿžo	'ride'
c.	haʔa	ⁿzaʔa	'father'
	ahyaʔašo	ãnžaʔašo	'desire'

A review of the facts in (16) and (17) yields the following observations about Terena nasalisation:

(18) a. Nasalisation is triggered by the 1st person singular affix.
b. Sonorants are nasalised, but obstruents become prenasals.
c. Prenasalisation is restricted to the first obstruent in a root.
d. Prenasalisation triggers voicing of the obstruent.
e. Root nasals are not triggers.
f. Root nasals are transparent to nasalisation.

The restriction of nasal harmony to a morphologically derived environment makes it look like a lexical process in the sense of Kiparsky (1985). Normally, these processes do not apply in environments which are wholly contained within roots. However, an analysis that tries to derive the restrictions on Terena nasalisation by postulating that it is a lexical

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process would still have to explain why it is not blocked by root nasals. Another problem that would have to be addressed is the fact that the process is not structure preserving; it creates nasal contours, nasalised approximants and nasal vowels, all of which lack counterparts in the underlying inventory of Terena segments. According to Kiparsky's original proposal, lexical processes are not supposed to produce novel segments. The structure preservation problem does not arise in the analysis presented in this article, because it does not depend crucially on the characterisation of nasalisation as a lexical process. The pattern emerges in response to constraints which must be satisfied at the level of surface representation and have no relevance at any other level.

3.1 The identity of the 1st person affix

One element of the analysis of Terena nasal harmony is the determination of the underlying or lexical properties of the 1st person morpheme. From the surface facts, it seems clear that this affix contains the feature [nasal]. In principle, the affix might be represented as bare nasality, or this feature might be part of a segment specified for other features like sonorancy or even voicing.[7] I will first advance three arguments against the first option, based on the occurrence of prenasalised consonants in 1st person forms. Then I will show that a body of cross-linguistic evidence supports the second option.

The postulation of the feature [nasal] as the sole exponent of the Terena 1st person morpheme is difficult to reconcile with the observation that nasal harmony is marked by the prenasalisation of obstruents. These contour segments would have to be derived by some type of nasal spreading that allows nasality to 'leak' from a nasal vowel to a following obstruent. However, there is no independent evidence that the spreading of the feature [nasal] produces a pattern of prenasalisation like that which occurs in Terena. Since Terena harmony is morphologically governed, genuinely independent evidence would have to come from purely phonological processes in which [nasal] spreads from nasal segments. The latter pattern of nasal harmony is well documented in the literature (Cohn 1987, Piggott 1992). For example, Malay (Onn 1976) and Warao (Osborn 1966) manifest long-distance nasalisation patterns in which nasality spreads from nasal segments through a sequence of vowels, semivowels and laryngeals. In both languages, the process is arrested by obstruents. None of the cases where long-distance nasalisation is initiated by a nasal segment produces the pattern of prenasalisation attested in Terena.

The voicing of obstruents in 1st person forms constitutes a second problem for the hypothesis that the sole exponent of the affix is the feature [nasal]. The description of voicing in terms of this hypothesis would have to claim that the nasal leakage which is responsible for prenasalisation also triggers voicing. Again, there is no independent evidence that nasal spreading causes voicing. The hypothetical data in (19a) have counterparts

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in many languages with nasal harmony, but the pattern in (19b), where nasal spreading is accompanied by prenasalisation and voicing of obstruents, has not been reported.

(19) a. mayata [mãyãta] b. mayata *[mãyã^{n}da]
maʔasa [mãʔãsa] maʔasa *[mãʔã^{n}za]

If the 1st person forms in (17) were derived by spreading [nasal] rightward, the absence of the patterns in (19b) in any language with purely phonologically governed nasal harmony is difficult to explain.

The third and perhaps the strongest reason for rejecting the identification of the Terena 1st person morpheme as the feature [nasal] is the inability to derive from it an explanation for the prenasalisation of fricatives. If [nasal] spreads to a fricative, current theories of segment structure predict that the outcome would be a nasalised fricative rather than a prenasalised consonant. This prediction emerges most clearly from the theory of nasal contours put forward by Steriade (1993). According to this proposal, [nasal] is a monovalent feature which is linked to a position in segment structure called aperture nodes. Stops contain two such nodes, a closure node (A_0) and a release node (A_{max}), while fricatives contain one node (A_f). This model of segment structure allows prenasalised stops to be derived by spreading [nasal] to the A_0 node. The A_{max} node would then represent the oral component of the segment. However, since a fricative contains only the A_f node, a spreading nasal feature should either fail to attach to such a node or, if it does dock, the result should be a nasalised fricative rather than a nasal contour.[8] The clear conclusion must be that representing the Terena 1st person affix as a bare nasal feature yields no obvious explanation for the observation that fricatives are prenasalised and also arrest the spread of nasality.

In summary, the three drawbacks to the identification of the Terena 1st person affix as the feature [nasal] are as follows: (a) prenasalisation cannot be linked to independently attested cross-linguistic patterns; (b) no obvious source for the voicing of obstruents is provided; (c) prenasalisation of fricatives does not seem to be possible. Individually, none of these weaknesses is sufficient to force reconsideration of the representation; collectively, they provide a powerful argument for giving it up.

Let us now consider how the problems summarised in the above paragraphs are addressed if the second option for representing the Terena 1st person morpheme is adopted. This option describes the morpheme as an underlying nasal consonant (Piggott 1988). Such a proposal permits prenasalisation in Terena to be the result of combining a nasal with a following consonant. We must now ask whether there is any cross-linguistic support for such a derivation of prenasalised stops, and the answer is very clear. There is unambiguous evidence that contours are derived in many languages from nasal–oral consonant combinations. Some of the clearest cases come from languages of the Bantu family. Both

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Herbert (1975, 1977, 1986) and Clements (1986) cite evidence from Luganda (= Ganda) in support of an analysis of prenasalised consonants as nasal–consonant sequences. The following data from a number of Bantu languages give examples of combinations that produce contours. The sources are primarily Polomé (1967), Herbert (1975, 1977, 1986) and Mugane & Gerfen (1993).

(20) *Prenasalisation in Bantu*

a.	N-bala	[^{m}bala]	'I count' (Ganda)
b.	N-gaba	[^{ŋ}gaba]	'I divide' (Ganda)
c.	N-limi	[^{n}dimi]	'tongues' (Swahili)
d.	N-reɣa	[^{n}deɣa]	'refuse me' (Gikuyu)
e.	N-disi	[^{n}dizi]	'banana' (Swahili)
f.	iN-puno	[i^{m}buno]	'nose' (Ndali)
g.	iN-tunye	[i^{n}dunye]	'banana' (Ndali)
h.	iN-ku^{n}da	[i^{ŋ}gu^{n}da]	'dove' (Ndali)
i.	N-šona	[^{nˇ}ǰona]	'lick me' (Gikuyu)

While there is disagreement over the appropriate representation of nasal contours (cf. Piggott 1989, Steriade 1993), no-one disputes the evidence that these entities are often the surface manifestations of sequences produced by affixation.

Representing the 1st person morpheme as a nasal consonant also provides a source for the voicing which is assimilated by obstruents. The phenomenon of postnasal voicing (PNV) of obstruents is well documented; Herbert (1986) cites many examples. Data in (20) from Ndali (f–h) and Gikuyu (i) illustrate the assimilation process. Similar data from languages as diverse as Japanese and Zoque are also available. As pointed out earlier, the explanation of PNV by Itô *et al.* (1995) requires that [voice] be a feature of a nasal consonant but be licensed by a following obstruent. While PNV is well established, postvocalic voicing as a phonological process is not well documented in the linguistic literature.

Finally, let us consider the cross-linguistic evidence for the prenasalisation of fricatives. Again Herbert (1986) documents a number of cases. The Gikuyu form in (20i) is the result of such a process. Other examples (21) are from Venda (Ziervogel *et al.* 1972).

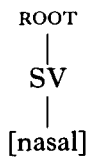
(21) N-vuledza [^{m}bvuledza] 'fishing'
N-zwima [^{n}dzwima] 'hunting'

Steriade (1993) argues that the result of this type of prenasalisation is invariably a stop; in other words, the derived segment is considered to be a prenasalised affricate, even if the affricate is not phonetically overt. Whether the Steriade generalisation is valid or not, there is no mistaking the evidence that the input to the process in the clear cases is a sequence of a nasal consonant plus a fricative.

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Accepting that the Terena 1st person morpheme is a nasal consonant, the only remaining question about its identity is its specification for place features. When this segment appears in surface forms (17), it is followed by an obstruent with which it invariably shares place features. The pattern of alternation makes it obvious that the place features belong to the obstruents. From these observations, we must conclude that the nasal lacks independent place features. The literature provides many examples of this type of segment as the exponent of morphemes. It represents a 1st person pronominal prefix in Kpelle (Welmers 1973: 67, Sagey 1986: 37) and in Zoque (Wonderly 1951a–c); it also seems to be the form of a noun-class marker and the 1st person affix in many Bantu languages (Herbert 1986). While there may be some dispute as to how to represent the underlying properties of this segment, there is general agreement that it is a nasal consonant. In this article, I adopt the position of Trigo (1988) and Humbert (1995) that the segment is underlying placeless.[9] I will identify it by the conventional symbol N, but I assume that it has the feature-geometric properties in (22), where SV encodes the property of sonorancy and voicing as proposed by Rice & Avery (1989), Tourville (1991), Piggott (1992) and Rice (1992, 1993).

(22)



Let me now summarise what I have shown in this section. If we postulate that the Terena 1st person morpheme is bare nasality, we would be forced to treat prenasalisation and voicing as phenomena which are quite unrelated to attested patterns of prenasalisation and voicing in other languages. Moreover, the behaviour of fricatives would be quite unpredictable. On the other hand, the hypothesis that the exponent of the 1st person morpheme is a nasal consonant allows us to relate the features which surface in 1st person forms to independently attested phenomena. The more plausible point of departure for the analysis of Terena nasalisation must therefore be the second hypothesis. The questions which the analysis must answer are why the nasal consonant seems to surface in different positions within a word (17) and why it is sometimes fails to appear as a full consonant (16). These questions are answered as part of my explanation of how harmony emerges in Terena.

4 The emergence of nasal harmony

From a conventional perspective, nasal harmony in Terena would be attributed to a process which spreads the feature [nasal] rightward. It was pointed out above that the prenasalisation and voicing of all obstruents are

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difficult to reconcile with such an analysis. But its viability is further undermined by the fact that the harmony process would have to carry the arbitrary restriction that the spreading feature must be part of the 1st person affix. Since such a rule could not be limited to Terena, it would predict a harmony pattern in some language where the triggering morpheme is an overt sequence like /ma/, yielding hypothetical outputs like those illustrated below.

(23) *Hypothetical nasal spreading*

ma-piho	[mãᵐbiho]	ma-nokone	[mãnõⁿgone]
ma-owoku	[mãõw̃õⁿgu]	ma-emoʔu	[mãẽmõʔũ]

I know of no cases of morphologically governed harmony that resembles the above pattern. Even if such cases were identified, it would still be desirable to explain their properties in terms of general principles of linguistics rather than by appealing to diacritics. In my analysis such rule features are unnecessary. Nasal harmony in Terena is shown to follow from the identity of the exponent of the 1st person affix as the placeless nasal consonant N, the position the affix occupies in a stem, and phonological restrictions on where N is licensed.

4.1 The role of prenasalisation

Since nasal harmony can only be initiated by the 1st person morpheme, it is necessary to establish what type of affix it is. This is an important consideration, because an understanding of how harmony progresses through a word is obviously dependent on where the initiator of the process is located.

Morphology has a role to play in determining the position of an affix which triggers harmony. This role is vested in an Alignment constraint which locates the affix in a stem-initial (prefix) or stem-final (suffix) position. We know from the data in (16) and (17) that a stem containing the Terena 1st person affix begins with a nasal vowel (e.g. [ẽmõʔũ]) or a nasal consonant (e.g. [nõⁿgone]) or a nasalised approximant (e.g. [ỹõnõ]) or a prenasalised stop (e.g. [ᵐbiho]). The feature [nasal] which is part of the expression of the 1st person morpheme is therefore always present at the left edge of the a stem. From the interpretation of alignment in (7), we can conclude that the Terena 1st person affix is always left-aligned in a stem. The relevant constraint, adapted from McCarthy & Prince (1993b), is the following:

(24) ALIGN-IN-STEM: Align($[1\text{SG}]_{\text{Af}}$-L, Stem-L)
The left edge of the 1st person singular morpheme is aligned with the left edge of a stem.

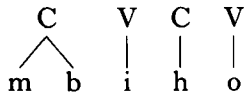
When the stem begins with a prenasalised consonant (e.g. [ᵐbiho]), the nasal consonant which is the full expression of the 1st person affix is stem-

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initial. This assumption factors in the weight of the cross-linguistic evidence that the nasal contours are combinations of nasal and oral segments. *Prima facie*, the only change the nasal consonant undergoes is in the acquisition of place features from the following consonant. I will use the notation shown in (25b) to represent the nasal–consonant (NC) combination that is interpreted as a nasal contour.

(25) a. *underlying*
N-piho

b. *surface*



Since a stem-initial contour contains the nasal exponent of the affix, the ALIGN-IN-STEM constraint (24) is satisfied.

Determining the position of a morpheme is only part of the description of its appearance in surface structure. The segmental content of the Terena 1st person affix also has to meet the licensing conditions imposed by the phonology. As indicated in §2.2, the prosodic hierarchy demands that segments be invariably parsed into syllables, and it is normally assumed that this confers on the syllable (or one of its constituents) the function of licensing the segment. Since the prosodic hierarchy is universal, the following constraint must be active in all grammars:

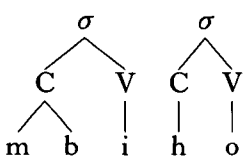
(26) SEGMENTLICENSER/SYLLABLE (SEGLIC/σ)
The licenser of a segment is a syllable.

The theory of licensing outlined in §2.2 does not require that (26) apply to every segment, however. I propose instead that the link between the prosodic hierarchy and licensing is expressed in terms of markedness:

(27) *The unmarked licenser*
In the unmarked case, the licenser of category α is the category β that immediately dominates it.

When a Terena root begins with an obstruent, prenasalisation yields an output in which the exponent of the 1st person morpheme is parsed into a syllable, and the phonological demand of licensing is met. In a representation like (28), the licenser of the nasal segment can be assumed to be the syllable.

(28)



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This syllabification of the word [^{m}biho] reflects the fairly uncontroversial assumption that the nasal and oral elements of a prenasalised consonant are in the same syllable. There is very strong support for this assumption, even if there is disagreement about other aspects of the structure of contours. Feinstein (1979) argues that the syllabification of a nasal–obstruent sequence is the basis for distinguishing between a prenasalised consonant and a cluster; the nasal–obstruent sequence is tautosyllabic in the former but not in the latter. Padgett (1991) takes a similar position. Evidence for such a distinction is found in Selayarese (Mithun & Basri 1986). In this language, a process of tonic lengthening affects stressed vowels of words like those in (29a) but not those of (29b).

(29) a. sá:sa 'cut (grass)'
kó:^{m}ba 'large, fragrant type of vine'

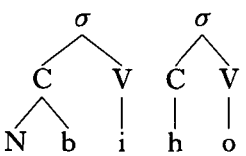
b. sássa 'wash'
sámbaŋ 'trip'

Since tonic lengthening generally applies to vowels in open syllable, the nasal–oral sequence in a word like [kó:^{m}ba] must be organised together in an onset.

The analysis of nasal contours as onset elements is not particular to Selayarese and Terena. All languages that allow contours to be formed from combinations of nasal and oral consonants syllabify the derived units in onsets. This probably reflects some preference for non-vowels (i.e. segments which are not specified for V-Place features) to be parsed as onsets.

When a nasal and oral consonant combine to form a contour, the nasal invariably acquires the place features of the oral consonant (Padgett 1991, Humbert 1995). Consequently, prenasalisation in Terena ensures that the underlying placeless nasal is specified for place in the output. On the basis of evidence from the phenomenon of debuccalisation, Trigo (1988) and Rice (1996) conclude that a nasal which lacks place specification at the surface level is phonetically interpreted as a velar. In the least controversial cases, the placeless consonants that are interpreted in such a manner are coda segments. Systematic debuccalisation never appears to affect nasals in onsets, and there seems to be a more general preference for the occurrence of specified place in onset nasals. I therefore conclude that there must be some constraint requiring onset nasals to have a place specification (cf. Rice 1996: 505), although this may not be universal.[10] Such a restriction on outputs in Terena excludes the possibility that prenasalisation could result in a configuration like (30), with the surface interpretation indicated.

(30) a. *



b. *[ᵑbiho]

The place features which a nasal must have in order to be part of a well-formed nasal contour always comes from the following oral consonant.

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The only other source of place specification, according to Rice (1996), is a default insertion of Coronal. However, this process or constraint is not always active. Rice (1996: 505) attributes the difference between word-final coronal and velar nasals in Castilian and Andalusian Spanish, respectively, to 'whether or not the Coronal default rule operates'. Again, the evidence for the activation of the Coronal default rule most often seems to involve coda consonants. It is, therefore, not unreasonable to expect that this rule would be inapplicable to onsets in most (probably all) languages. As a conservative position, I assume that this restriction applies in Terena. The implication is that the exponent of the 1st person affix cannot appear alone in an onset. The input–output pairs shown below are impossible.

(31)	*input*		N, anu 'my neck'	N, ayo 'my brother'
	output	Coronal default	*nanu	*nayo
		phonetic inter-pretation	*ŋanu	*ŋayo

The inapplicability of Coronal default means that place features which are missing from the underlying placeless nasal can be acquired in an output only by assimilation.

In summary, prenasalisation in Terena serves three purposes: (a) it allows the placeless nasal representing the 1st person morpheme to be parsed; (b) it allows the parsed nasal to achieve the unmarked state of being licensed by a syllable; (c) it provides a source of place features for the nasal, thereby ensuring that it is part of a well-formed onset.

While prenasalisation has the effects summarised above, we might still ask why the phenomenon occurs. We must explain why the input /N-piho/, provided by the morphology, does not correspond to the output [piho]. The explanation is actually fairly clear. Generative phonological analysis has always been guided by the assumption that an underlying segment must be phonetically realised unless some specific rule or constraint dictates otherwise. Until the emergence of Optimality Theory, this requirement was considered to be part of the metatheory and therefore did not have to be incorporated in specific grammars. Hence, in rule-based frameworks, deletion rules target specific classes of segments which are not permitted to surface, but segments which are not targeted appear freely in surface representations. The effect of deletion is obtained in constraint-based frameworks by invoking a constraint banning certain occurrences of segments. For example, the enforcement of a constraint against codas (NoCoda) might result in the underparsing of underlying consonants that cannot be syllabified in onset.

The spirit of the traditional assumption that underlying segments are syllabified in outputs unless specifically prohibited from doing so is expressed in the following formulation:

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(32) PARSESEGMENT (PARSESEG)

An input segment is parsed, *modulo* the structural well-formedness of the output.[11]

I maintain the traditional view that this constraint is part of phonological metatheory; in other words, it has the status of a principle of universal grammar. Individual grammars do not require that underlying segments must be parsed; they just have the power to block their parsing. Grammars regulated by a principle or metaconstraint like (32) would force underlying segments to be syllabified and licensed in a particular grammar wherever they can be. Consequently, since universal grammar permits prenasalisation, we do not have to explain why underlying /N-piho/ yields [^{m}biho]. Rather, if prenasalisation failed to occur, we would have to account for the blockage.

In Terena, prenasalisation facilitates the syllabification of the exponent of the 1st person morpheme, and it is expected to exercise this function wherever it is attested. Only obstruents undergo the process in this language. As a result, in the derivation of a surface form like [õw̃õ^{n}gu] 'my house' from underlying /N-owoku/, the placeless nasal must move to combine with the first obstruent in the root. The repositioning of N from a stem-initial position in the input to a stem-internal position in the output is illustrated graphically below.

(33) N-owoku → owoNku

Segment movement is familiar from cases of metathesis, but morpheme movement has also been recently endorsed. McCarthy & Prince (1993b) attribute the latter to the conflicting demands of morphological and phonological constraints. An interesting illustration of this repositioning is the case of the Tagalog morpheme *um*. This affix precedes verb roots which begin with vowels (34a), but surfaces as an infix when roots begin with consonants (34b, c).

(34)	a.	aral	um-aral	'teach'
	b.	basa	b-um-asa	'break'
	c.	gradwet	gr-um-adwet	'graduate'

According to McCarthy & Prince, the 'movement' of the affix into the stem (34b, c) is commanded by a phonological preference for codaless syllables. In this case, the morphology prefers that the affix be stem-initial, but the phonology overrides this preference in some instances.

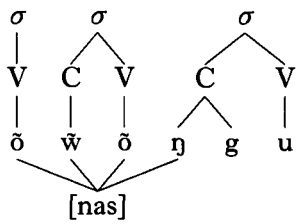
In general terms, the factors that determine morpheme movement in Tagalog are also at work in Terena. The morphological constraint ALIGN-IN-STEM (24) demands that N be at the left edge of a stem, but the

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satisfaction of the metaconstraint PARSESEG (32) requires the segment to move away from the left edge, when the first obstruent is stem-internal. These apparently conflicting demands are reconciled in the Terena grammar. The exponent of the 1st person affix moves in order to be licensed, but it also leaves a 'trace' at the left edge of the stem to satisfy the alignment requirement. Nasal harmony emerges from the resolution of the conflicting demands of the morphological and phonological constraints.

(35) a. *input* b. *output*

N-owoku



According to the interpretation of alignment in (7), the 1st person affix is left-aligned in the stem in (35b). The universal Locality Condition guarantees that all segments between the nasal consonant in its licensed position and the left edge of the stem must be nasal bearers.

The emergent harmony in (35b) is expressed as a relation between segments. In other words, the feature [nasal] is associated with a sequence of segments. This pattern shares with the nasal harmony found in languages like Warao, Malay and Terena the restriction that obstruents cannot occur inside the nasal span.[12] This restriction combines with the Locality Condition to explain why prenasalisation always targets the first obstruent in a Terena word. Consider the following examples of affixation to roots containing more than one obstruent:

(36)

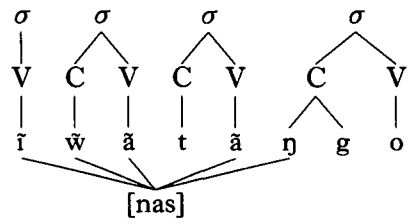
3rd person	*1st person*	
tuti	^{n}duti, *tu^{n}di	'head'
iwatako	ĩw̃ã^{n}dako, *iwata^{n}go	'sat'
otopiko	õ^{n}dopiko, *oto^{m}biko, *otopi^{ŋ}go	'chopped'

In each of these examples, the leftmost obstruent is prenasalised. Movement of the nasal consonant further to the right would make it impossible for the affix to maintain a presence at the left edge of the stem. In the hypothetical output (37b) below, the skipping of the oral obstruent produces a violation of the Locality Condition; (37c) is the only acceptable output.

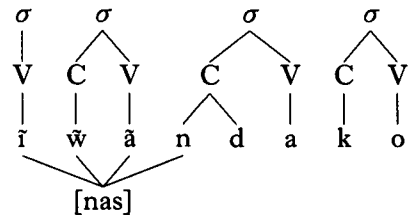
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(37) a. *input*
N-iwatako

b. * *output*



c. *output*



4.2 The role of licensing by the prosodic word

When Terena roots are obstruentless, prenasalised segments do not occur in 1st person forms. This is not surprising if roots contain only vowels and laryngeals. Glottal stop in a consonant system like that in (15) is considered by most phonologists to be a placeless segment and therefore not a possible source of the place specification which would permit the nasal to appear as part of an onset. Vowels, in contrast, are not placeless, but these are also ruled out as sources of place features for underlying N. There is a wide consensus, based on strong cross-linguistic evidence, that consonants do not assimilate primary place features from vowels; we would not expect to find prenasalised vowels (cf. Steriade 1993). While prenasalisation never targets vowels or laryngeals, it does apply to approximants in some languages (see Herbert 1986). When this occurs, the approximant invariably hardens to a stop (e.g. w → b, y → d^y, l/r → d). It is probably a ban on the hardening of approximants to stops, Postnasal Hardening, that prevents underlying approximants from serving as a host for parasitic N in Terena.

The conclusion is that underlying N cannot be licensed by a syllable when it is affixed to roots lacking obstruents. However, the theory of licensing provides another option; the nasal may be licensed by the prosodic word. Terena chooses this option.

(38) NasalLicenser/ProsodicWord (NasLic/PWd)
The licenser of a nasal consonant is a prosodic word.

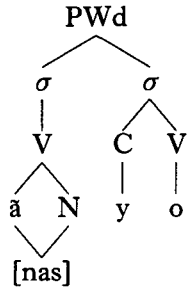
In accordance with the principle in (13), the PWd-licensed nasal must be parsed into a constituent at the left/right edge of the word.

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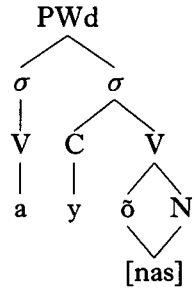
The satisfaction of NasLic/PWd is achieved by either (39b), (39c) or (39d), if the input is (39a). The phonetic realisation of each of these outputs is paired with its prosodic structure.

(39) a. *input*
N-ayo

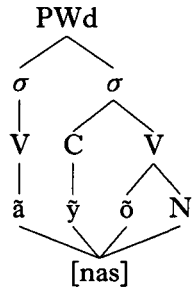
b. *output* [ãyo]



c. *output* [ayõ]



d. *output* [ãỹõ]

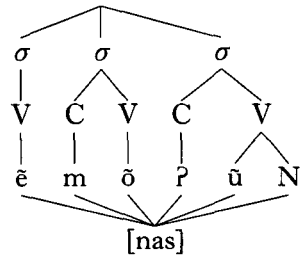


The above representations are all considered to be well-formed from the perspective of phonological theory, but only (39b) and (39d) meet the morphological requirement that the 1st person affix must be left-aligned in the stem. Of these, (39d) evidently corresponds to the attested surface form [ãỹõ] 'my brother' (see (16b)). Consequently, we must conclude that Terena exercises the option of licensing N at the right edge of the word.[13] Since Terena is a codaless language, the nucleus of the final syllable is the only available host for a segment which is licensed by the prosodic word.

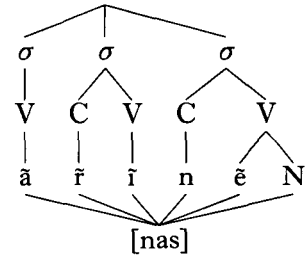
It should now be obvious why root nasals are not involved in Terena nasal harmony; they neither trigger nor block the process. This neutrality follows directly from the way in which harmony is initiated. Since it emerges from the morphological and phonological demands imposed by the 1st person affix, we would not expect root nasals to be triggers. When the exponent of the affix is licensed to be the right of such a segment, the presence of [nasal] in the root should not affect the left-alignment of the affix. To satisfy both the licensing and left-alignment demands, the feature [nasal] of the 1st person morpheme can be superimposed on the underlying nasality of the root nasals in the manner illustrated in (40). Since there is no principled reason for the root feature to impede the distribution of the affix feature, I assume that the former is simply absorbed. The absorption option can be readily attributed to the enforcement of a constraint like the Obligatory Contour Principle.

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(40) a.

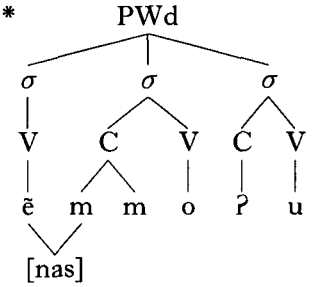


b.



Nasalisation takes the form illustrated above partly because Terena does not allow the exponent of the 1st person morpheme to be licensed as part of a geminate nasal. Hence, a representation like (41) below is illicit. This is not surprising, because geminates are not normally syllabified as onsets.

(41) *



We must also assume that Terena disallows outputs resulting from the fusion of N and a root nasal. If the output of nasal fusion was licit in this language, underlying /N-nokone/ and /N-emoʔu/ would surface, respectively, as [nokone] and [ẽmoʔu] rather than the correct [nõ^{n}gone] and [ẽmõʔũ]. In §5.2, I will claim that this type of fusion is not universally banned.

4.3 The interaction of licensing constraints in Terena

The ranking of constraints is not a central concern of this paper. Nevertheless, this issue must be addressed briefly, because the analysis postulates that there are two potential segment licensers for the exponent of the 1st person morpheme, the syllable and the prosodic word. When the nasal is attached to the final nucleus, it is not licensed by the syllable and therefore does not conform to the demands of SEGLIC/σ (26). On the other hand, the occurrence of the nasal as part of a prenasalised stop violates NASLIC/PWD (38). I must therefore explain how the Terena grammar can tolerate the two conflicting constraints.

The conflicting demands vested in the two licensing constraints is just what Optimality Theory is supposed to handle well. In this framework, it

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would be assumed that SEGLIC/σ outranks NASLIC/PWD. *Ceteris paribus*, it would then be better for the nasal segment to be licensed by a syllable rather than by the prosodic word. However, the domination of SEGLIC/σ by constraints prohibiting prenasalisation of vowels, glides and liquids would produce situations where the former is violated. When the satisfaction of higher-ranked constraints forces violations of SEGLIC/σ, the option of licensing N by the prosodic word would emerge as optimal.

While language-particular ranking may yield the best account of constraint interaction in some cases, it is not demonstrably so in the description of Terena nasalisation. An alternative explanation of the interaction of the two licensing constraint is possible. It comes in two parts. Consider first the observation that nasal is licensed syllabically, only when it is part of an onset and is specified for place features. Cross-linguistically, place specification seems to play an important role in regulating the appearance of segments. In many languages, apart from the laryngeals, placeless consonants are either banned or restricted to a peripheral position in a root, stem or word (cf. Rice 1996). From this fact, I infer that the following parameter is available to grammars and is operative in Terena.

(42) *Place Prominence*

Apart from laryngeals, a consonant which is licensed by a syllable is specified for place.

The activation of this constraint in Terena is sufficient to ensure that underlying N will be syllabically licensed in an output only when it acquires place features from an adjacent consonant. The link between consonantality and place specification is an important insight of the theory of segment structure defended by Humbert (1995).

A more general principle than (42) underlies the second part of the explanation for the tolerance of the two licensing constraints in a grammar. As pointed out earlier, we can derive from the prosodic hierarchy the fact that the syllable is the unmarked licenser of a segment. Correlated with this hypothesis is the observation that there is no language in which SEGLIC/σ fails to apply, but there are languages which provide no evidence for an active NASLIC/PWD constraint. The implication is that unmarked properties are robust and must emerge unless specifically prohibited. This assumption, which has informed phonological analyses for the past three decades, is captured in the following principle.

(43) *The Dominance of the Unmarked*

Unmarked grammatical properties must be realised, unless specifically prohibited by language-particular constraints.

The unmarked grammatical properties are those features which are manifested in some way in every grammar (or at least in every grammatical subsystem that exemplifies a particular well-defined phenomenon). In the

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framework of this paper, they are the features characterised by the principles of Universal Grammar. For example, the hypothesis that vowels are parsed as syllable heads is a principle which is instantiated in every grammar, even if there are particular instances in which vowels cannot be parsed. Foot binarity is another example of an unmarked property. Every system in which foot structure is a relevant component will contain binary feet, although monosyllabic feet are sometimes tolerated. Constraints like SEGLIC/σ (26) and PARSESEG (32) are among the grammatical principles rather than the parameters of variation. On the other hand, a constraint requiring that segments or a class of segments be licensed by the prosodic word is a parameter.

Let us now see how (43) determines the satisfaction of the licensing constraints in Terena. Because the syllable is the unmarked segment licenser, it is expected to fulfil this role unless some restriction dictates otherwise. When the morphology prefixes N to a root containing an obstruent, no specific constraint of Terena prevents prenasalised consonants from being formed, and therefore there is no override of the unmarked licensing option (26). In contrast, when N is affixed to an obstruentless root, there is no source of place features within the word and hence it is impossible for the underlying placeless nasal to be licensed by a syllable.[14] Since the unmarked licensing option is not available in such a situation, NASLIC/PWD (38) comes into play. The general principle, the Dominance of the Unmarked, is the regulator of the precedence of SEGLIC/σ over NASLIC/PWD. The fact that SEGLIC/σ always takes precedence over NASLIC/PWD provides us with a second reason why the input /N-iwatako/ could not yield *[iwatakõ] as the correct output. The nasal consonant in this representation is not left-aligned in the stem, and it is licensed by the prosodic word when licensing by the syllable is an option.

Other preferences that are regulated by the Dominance of the Unmarked include the syllabification of consonants as onsets rather than in other syllable positions. If the syllabification of consonants in onsets is unmarked, this pattern will emerge unless it is suppressed by some language-specific constraint. For similar reasons, vowels will be syllabified as nuclei and be licensed by the syllable. Vowels have a special status as occupants of syllable heads. This is undoubtedly what ensures they are always licensed by syllables. It is not unreasonable to infer that there is an over-arching principle demanding that the head of a category be licensed by that category. We would not expect to find language-specific constraints requiring that vowels be licensed by the prosodic word.

5 Beyond Terena

Nasalisation in Terena is now fully accounted for. However, the description of any phenomenon can be considered to be explanatory only if

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there is independent support for the essential elements of the proposed analysis. To this end, I have provided cross-linguistic evidence that nasal contours are formed from sequences of nasal and oral consonants, and postnasal voicing of obstruents often accompanies prenasalisation. Building on the theory of prosodic licensing proposed by Itô (1986), Goldsmith (1990) and others, I have correlated prenasalisation with a demand that segments be licensed by a syllable. The Terena placeless nasal moves to a licensing site to be satisfactorily parsed. Finally, I have exploited the theory of Generalised Alignment (McCarthy & Prince 1993b), which plays a role in determining the surface appearance of affixes in all languages. The positioning of the 1st person affix in accordance with this theory is crucial to explaining why it must have a presence at the left edge of stems even when N is licensed elsewhere in a word.

To further enhance the explanatory value of my analysis, I will claim, in the following three subsections, that other elements are also supported by facts beyond Terena nasal harmony. First, I will point out that the concept of a nasal vowel as a vowel–nasal sequence is both explicit and implicit in the phonological literature. Furthermore, it is possible to interpret some experimental findings in the psycholinguistic literature as validating such a representation. Secondly, I will introduce evidence from the distribution of nasal vowels in the Ecuadorian language, Auca, to show how an underlying nasal glide that is responsible for vowel nasalisation can be detected. Finally, I will discuss the case of Zoque as support for the claim that a morpheme can take the form of a nasal consonant which surfaces phonetically only if it can share place features with an adjacent consonant.

5.1 Nasal vowels as complex segments

There is general acceptance of the fact that a surface nasal vowel can be derived from an underlying sequence of a vowel plus a nasal consonant. Traditional descriptions usually postulate that the consonant is deleted after transferring nasality to the vowel. The alternative adopted in this paper rejects the claim that the nasal consonant is completely deleted. The VN configuration, illustrated, for example, in (39) and (40), is an explicit proposal that, at the phonological level, the input postvocalic nasal consonant has a segmental presence in the output. This proposal has an equivalence in the Correspondence Theory elaborated by McCarthy & Prince (1995). For example, according to their analysis of Chumash (McCarthy & Prince 1995: 314), the coalescence of the input sequence /k-ʔ/ yields an output [k′], which is formally evaluated as containing both of the input segments (under the correspondence relation). Consequently the MAX-IO constraint, which bans segmental deletion, is not violated. McCarthy & Prince recommend the use of a system of subscripted indices to identify correspondents. Hence, input /$k_1ʔ_2$/ and output [$k'_{1,2}$] are a pair of correspondents in which both input segments have a presence in

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the output. The use of the diacritics is not trivial, because the output [k′$_{1,2}$] must be distinguished from another competing output [k′$_1$], where only one of the two inputs has a correspondent in the output. The proposal to represent a surface nasal vowel as containing correspondents of both an input oral vowel and an input nasal consonant is therefore in the spirit of Correspondence Theory, the only difference being my assumption that the nasal consonant still has a presence in the formal representation of the output. Clearly, then, even if the VN representation of nasal vowels is not readily embraced, the substance of my analysis can still be maintained. In a framework like Correspondence Theory, an output nasal vowel can be analysed as a simplex segment, resulting from the fusion of an input vowel + nasal consonant. The input nasal would be licensed as part of the nasal vowel.

The two-segment representation of nasal vowels also provides a formal underpinning for the concept of 'nasal absorption' proposed by Trigo (1988). She discusses a number of cases in which the process of debuccalisation (loss of consonantal place specification) is accompanied by vowel nasalisation. According to her analysis, the nasal (the nasal glide, in her terminology) resulting from debuccalisation is supposed to be sometimes 'absorbed' by a preceding vowel, thereby triggering vowel nasalisation. Nasal absorption can be formalised as the anchoring of a nasal glide to the same prosodic position as a preceding vowel.

The conception of a surface nasal vowel as a VN sequence has been part of phonological thinking for more than two decades. It is adopted by Dell (1970) and Prunet (1986). In Prunet's analysis of French nasal vowels, he accepts the standard position that these are derived from underlying vowel–nasal sequences but does not adopt the conventional analysis which requires that the postvocalic nasal be deleted. He assumes instead that the nasal consonant always has a presence in the surface representation. The vowel and nasal may combine in a nucleus in a configuration that is ultimately interpreted as a nasal vowel. This assumption allows Prunet to maintain that the underlying final nasal in a morpheme like the masculine, possessive pronoun *mon* 'my' is present in a phrase like *mon chapeau* [mõšapo] 'my hat' as well as in a phrase like *mon ami* [mɔ̃nami] 'my friend'.

Paradis & Prunet (1996) argue that additional support for the two-segment representation can be found in the way in which these vowels are sometimes decomposed when they are borrowed into various languages. They point out that the nasal vowels of one language are often reproduced as VN sequences in another language when the latter (i.e. the borrowing language) lacks nasal vowels. For example, when Fula speakers adapt a French word containing a nasal vowel, the adaptation contains a corresponding vowel–nasal sequence, subject to certain restrictions on syllable structure (e.g. French *canton* [kãtõ] *vs.* Fula [kantɔŋ]). If speakers' judgements are accepted as sources of insight into grammatical features, then the nativisation strategy employed by Fula speakers is an indication that the two-segment representation of nasal vowels can be sustained. At

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the very least, it shows that the phonetic facts are not incompatible with such a representation.

Lahiri & Marslen-Wilson (1991) also show that some speakers interpret the presence of nasality on a vowel as an indication that a nasal consonant is present. They conducted an experiment to test the ability of native speakers of English and Bengali to recognise words in their respective languages on the basis of incremental presentation of the phonetic stimuli (the gating procedure). When English speakers are presented with a target word containing a nasal vowel, they show a very strong tendency to respond to the stimulus as if it contains a postvocalic nasal consonant. The tendency increases in proportion to the increase in the presentation of the phonetic signal up to the offset of the vowel. Bengali speakers, in comparison, behave differently. Their responses indicate that they do not infer from the nasality of a vowel that it is followed by a nasal consonant. The difference in the responses of the two groups of speakers is attributed by Lahiri & Marslen-Wilson to the fact that nasal and oral vowels are non-contrastive in English but contrastive in Bengali. The results can be interpreted as evidence that, for the Bengali speaker, nasal vowels are simplex segments, specified for the feature [nasal], while English speakers assume that a nasal consonant is part of the representation of every nasal vowel.[15]

By themselves, the Fula nativisation strategy and the response of English speakers to nasal vowels do not constitute proof of the correctness of the VN hypothesis. However, they show that, while a nasal vowel is a simplex segment at the level of phonetic realisation, it is not necessarily composed of a single segment at the phonological level.

5.2 The profile of a placeless nasal

In many cases (e.g. French, Capanahua), the assumption that a nasal consonant is the underlying source of vowel nasalisation is supported by evidence from alternation. However, it is possible to detect the presence of an underlying postvocalic nasal glide just on the basis of evidence from the distribution of nasal vowels. This type of evidence is provided by Auca. According to the description of this language by Saint & Pike (1962), there are contrasting series of oral and nasal vowels (i.e. /i e æ o a/ *vs.* /ĩ ẽ æ̃ õ ã/).

(44) *Nasal–oral contrast in vowels*

pekã 'he calls'	ãmo 'I say'
kõwẽ 'always'	ãmõ 'collared peccary'
yæyæ̃ 'root'	

Since the nasality of the vowels in the above examples cannot be derived from the context, we must assume that it is specified underlying. It is my

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contention that it is represented in the form of a postvocalic nasal consonant. This consonant is not directly visible, but, like a collapsed star ('a black hole'), it manifests itself through its effect on its neighbours. Several features of Auca point to the presence of the nasal consonant.

Saint & Pike report that an underlying voiceless stop following a nasal vowel is either merely prenasalised or both prenasalised and voiced.[16]

(45) *Auca prenasalisation*

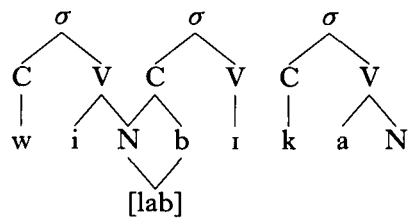
ĩ^{n}tapa, ĩ^{n}dapa	'it was'
awæ̃^{m}pa, awæ̃^{m}ba	'club'
awĩ^{ŋ}ka, awĩ^{ŋ}ga	'eye'

The prenasalisation alone is not evidence for the latent nasal, but the voicing of postvocalic obstruents is. This postnasal voicing in Auca cannot be attributed to the postvocalic context, because it is not reported after oral vowels. However, both prenasalisation and obstruent voicing can be given straightforward explanations if nasal vowels are derived from underlying vowel–consonant sequences.

Another observation of Saint & Pike (1962) also finds a plausible explanation if it is assumed that a nasal vowel is always followed by a nasal consonant in Auca. They note that there is an 'optional nasal at the beginning of voiced stops [^{m}b, ^{n}d, ^{ŋ}g] when utterance initial' (e.g. *bekã* [^{m}bɪkã], [bɪkã] 'he drinks'). This type of prenasalisation is a phonetic property of voiced stops in a number of languages (Anderson 1976, Piggott 1992, Steriade 1993). However, Saint & Pike observe that, when voiced stops follow nasal vowels in Auca, 'the nasal attack... becomes stronger, leading to nasal segments of the length of regular segmental phonemes...; in this environment the nasal attack is obligatory' (1962: 8). If the nasal component of a voiced stop only has a phonetic source, the identification of the nasal element between a nasal vowel and a voiced stop with a 'regular' nasal component is not expected. However, it is a predictable outcome, if there is indeed a nasal consonant in the underlying representation of nasal vowels.

Prenasalisation in Auca, as in Terena, facilitates the licensing of the nasal in an onset position. In a structure like (46), the first nasal must also share place features with the following voiced stop:

(46)



[wĩ^{m}bɪkã] 'he does not drink'

Since the heterosyllabic nasal consonant in such a representation is licensed as a segment, it is not surprising that it is interpreted as a 'regular segmental phoneme' and not just a phonetic epiphenomenon.

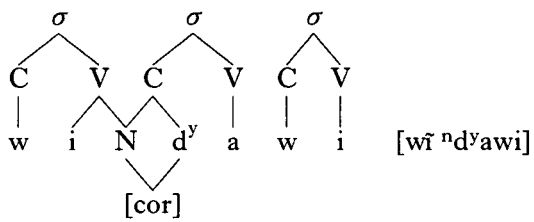
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Saint & Pike (1962: 10) identify another Auca phenomenon which provides more support for positing a nasal consonant after every nasal vowel. They report that 'the phoneme [y] has a nasal attack' after a nasal vowel. In other words, there is obligatory prenasalisation and hardening of the approximant /y/ to the palatalised contour [^{n}d^{y}] (e.g. /wĩ yawi ĩba/ [wĩ ^{n}d^{y}awi ĩ^{m}ba] 'it is not a toucan').[17] The palatal approximant does vary with an oral stop in other contexts. Variation is reported in word-initial position (e.g. [yawi ~ d^{y}awi] 'toucan') where the stop is considered to be more common. Similar variation word-medially is also reported (e.g. [oyõni ~ d^{y}õni] 'in a leaf', [ayabi ~ ad^{y}abi] 'worm'), but the palatal approximant is more common in this context. If the nasal vowel was represented as monosegmental, one would expect it to be followed most often by the palatal approximant. The addition of nasality to this segment would normally be a nasalised approximant (i.e. [ỹ]), rather than a prenasalised stop. It should be noted that there is no ban on nasalised approximants in Auca; they occur medially in apparent free variation with the palatal nasal (e.g. [ĩỹakã ~ ĩɲakã] 'he is born') (Saint & Pike 1962: 12).

The presence of a nasal consonant after a nasal vowel creates an environment in which a following approximant is known to harden to a stop.

(47) a. *input*
wiN yawi

b. *output*



The cross-linguistic evidence indicates that when prenasalisation occurs in a language it may apply to nasal–approximant sequences. Prenasalisation in such cases is always accompanied by postnasal hardening. The obligatory hardening process can be correlated with Steriade's (1993) claim that the contour segments resulting from prenasalisation are always stops.

Like Terena, Auca shows that an underlying postvocalic nasal glide may express itself through vowel nasalisation, voicing of obstruents and hardening of approximants.[18] One difference between the two languages is that in Terena the placeless nasal is licensed by the prosodic word and is restricted to word-final position, while the counterpart segment in Auca occurs more freely, presumably because it is licensed by the syllable.

5.3 Licensing and alignment without harmony

Some of the phonological effects of licensing and alignment which show up in Terena also appear in the Southern Mexican langauge, Zoque. The relevant data are extracted from a series of articles by Wonderly (1951a–c).

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When a Zoque noun root begins with a stop, the 1st person possessor form begins with a nasal homorganic with the stop; the postnasal stop must also be voiced (48a). These sequences fit the profile of prenasalised contours; they are the only syllable-initial combination of consonants with falling sonority. When a root begins with /w y h/, Wonderly indicates that these segments are nasalised (48b). Finally, roots beginning with fricatives, liquids, nasals or glottal stops (48c–e) are unchanged.

(48)

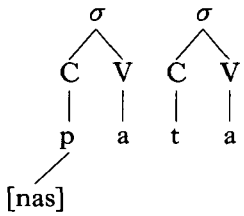
	root	*1st person*			*root*	*1st person*	
a.	pata	ᵐbata	'mat'	c.	ʔane	ʔane	'tortilla'
	buru	ᵐburu	'burro'		mok	mok	'corn'
	tatah	ⁿdatah	'father'		naka	naka	'skin'
	cim	ⁿdzima	'calabash'	d.	faha	faha	'belt'
	kayu	ᵑgayu	'horse'		sʌk	sʌk	'beans'
	gayu	ᵑgayu	'rooster'		šapun	šapun	'soap'
b.	yomo	ỹomo	'wife'	e.	lawus	lawus	'nail'
	wakas	w̃akas	'cow'		rančo	rančo	'ranch'
	hayah	h̃ayah	'husband'				

It appears that roots in Zoque do not begin with vowels. This accidental gap deprives us of a potential context in which the exponent of the affix might be expected to surface as an autonomous consonant.

From the prenasalisation and voicing of obstruent stops in Zoque, it is easy to infer that the exponent of the 1st person affix an underlying placeless nasal (i.e. N). But this language provides an additional bit of evidence against the alternative hypothesis that it is just the bare nasal feature. The latter hypothesis would require that prenasalised consonants and nasalised glides be derived by spreading nasality to root-initial consonants, roughly as in (49).

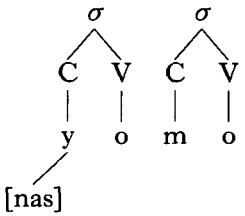
(49) a. *input*
[nas] + pata

output [ᵐbata]



b. *input*
[nas] + yomo

output [ỹomo]



The implication of the above representations is that Zoque nasalisation selectively targets obstruent stops and semivowels but does not affect liquids and fricatives. Such a restriction on nasalisation is in direct conflict

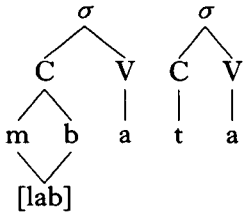
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with the evidence from the study of the manifestation of nasality in nasal harmony patterns. A survey of these patterns (Piggott 1992) reveals that there are very strict entailments on nasalisability of segments such that if obstruents and semivowels are targets, fricatives and liquids would also be targets. The data in (48d, e) show clearly that this entailment does not hold in Zoque. The emergence of the nasal contours and nasalised glides in this language are therefore not indicative of nasal spreading. We must conclude that the evidence from nasalisation is not consistent with the representation of the 1st person affix as a bare nasal feature.

Since the Zoque 1st person affix appears only at the left edge of stems, it is reasonable to assume that it is a prefix, positioned in accordance with the demands of the equivalent of the ALIGN-IN-STEM constraint (24). Prenasalisation of root-initial obstruents facilitates the left-alignment of the affix and the licensing of its segmental exponent.

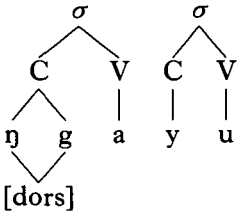
(50) a. *input*
N-pata

output



b. *input*
N-kayu

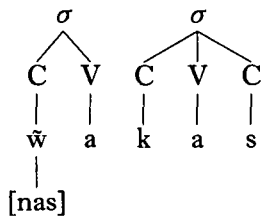
output



The presence of [nasal] on stem-initial glides (48b) also ensures the left-alignment of the affix in these forms. The inputs in (51a, b) must somehow yield the corresponding outputs.

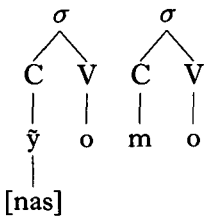
(51) a. *input*
N-wakas

output



b. *input*
N-yomo

output



The nasalised glides in these outputs can be analysed as resulting from the coalescence or fusion of the input nasal–glide sequence. In terms of the

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Correspondence Theory of McCarthy & Prince (1995), the initial surface glide is the manifestation of both input segments.[19]

The hypothesis that fusion plays some role in determining well-formed outputs in Zoque is strengthened when forms containing the 2nd person affix are considered. Wonderly does not provide very extensive data illustrating the occurrence of the latter morpheme. Nevertheless, the pattern is quite clear.

(52)

	root	*2nd person*	
a.	puht	$^{m}b^{y}$uhtu	'you went out'
	tih	$^{n}d^{y}$ihu	'you arrived'
	ciŋ	^{n}ǰiŋu	'you bathed'
	ken	$^{ŋ}g^{y}$enu	'you looked'
b.	wiht	w̃yihtu[20]	'you walked'
	huy	h̃yuyu	'you bought'
c.	nihp	ɲihpu	'you are planting'

Like the 1st person morpheme, affixation of the 2nd person morpheme triggers prenasalisation and voicing of stops (52a), and root-initial glides are nasalised (52b). There are no data on the results of affixation to root-initial fricatives and liquids, but the discussion by Wonderly suggests that these segments are unaffected. In addition to its nasal component, the 2nd person affix has an obvious palatal specification which surfaces as secondary articulation on nasal contours and nasalised glides. The presence of the palatal element also surfaces in (52c) when the affix combines with a root-initial coronal nasal.

The Zoque 2nd person morpheme is like the 1st person affix in being unspecified for primary place features at underlying level, but it bears the palatal specification as a secondary feature (i.e. N^{y}). The transfer of palatality to stem-initial contours (52a) can be subsumed under the general sharing of place features by the two segments. The glides in (52b) must also acquire the palatal feature from underlying N^{y}. If input nasal and glide are fused in the output, palatality would obviously be transferred. But perhaps the strongest indication of fusion is in the emergence of the palatal nasal in (52c). The mechanism that underlies this transfer must be different from the one involved in the formation of prenasalised stops, because nasals are never subject to prenasalisation. (52c) has additional significance. It suggests that in Zoque when two nasals are juxtaposed by morphology fusion occurs. Thus, the initial nasal in the word *mok* 'my corn' (48c) can be considered to be the result of the merger of /N/ and /m/.

According to my analysis, the possibility of the fusion of two input segments in Zoque marks an important difference between this language and Terena. Hence, from a Terena input /N-yono/ 'I walked', the interaction of constraints that disfavour fused outputs renders it impossible to satisfy the demands of licensing and alignment by opting for [ỹono] as

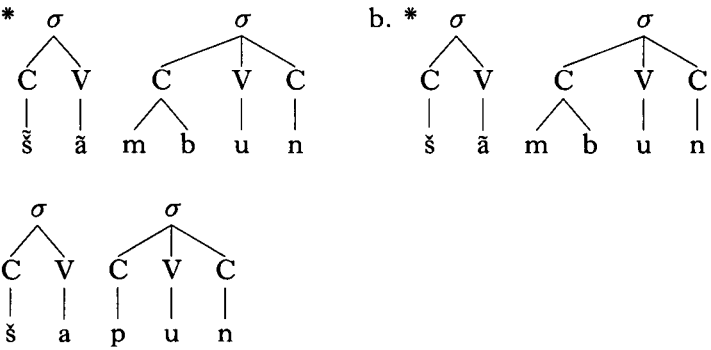
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the surface representation. Another obvious difference between the two languages is that long-distance nasalisation is blocked in Zoque, but not in Terena. Since my analysis of the latter claims that harmony is not commanded by a specific constraint, but emerges from the interaction of licensing and alignment, I must explain why harmony fails to emerge in Zoque.

In Terena, harmony arises only when the root-initial segment does not facilitate the licensing of N by the first syllable in the stem. The nasal then moves to be licensed elsewhere in the stem but must also maintain a presence at the left edge to satisfy the demands of ALIGN-IN-STEM. Consider now when the licensing of N by the stem-initial syllable fails in Zoque. This happens only when the 1st person or 2nd person morpheme is affixed to roots beginning with liquids or fricatives (48d). There is a substantial amount of cross-linguistic evidence that languages may permit the nasalisation of glides but prohibit the nasalisation of both fricatives and liquids (Rosenthall 1989, Piggott 1992, Steriade 1993, Padgett 1994, Walker 1994). This type of prohibition is usually attributed to language-particular feature cooccurrence restrictions. In other words, Zoque is just one of many languages in which [nasal] can only be a feature of vocoids (i.e. vowels/semivowels) or stops. It is reasonable to infer that this restriction prohibits fusion of N with a root-initial liquid or fricative.[21]

When Zoque roots begin with fricatives or liquids, the ban on nasal–fricative and nasal–liquid fusion prevents the placeless nasal from being licensed by the first syllable of the stem. It should now be clear that the same ban is part of a conspiracy to prevent the nasal from being licensed elsewhere in the stem. Compare three potential outputs for the input /N-šapun/ 'my soap'.

(53) a. * b. *



c.

Of these representations, (53a) violates the ban on nasalised fricatives, and (53b) violates the requirement that the 1st person affix must be left-aligned in a stem. Neither the cooccurrence restriction nor the alignment constraint is violated by (53c), which corresponds to the correct surface form. The underlying nasal constraint is missing from this representation, but the failure to parse the segment is not considered to be a violation of

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the metaconstraint (32), because the parsing of segments is regulated by the well-formedness requirements of particular languages. N is parsed only if the resulting output is sanctioned by the parametric choices of the particular grammar.

Harmony would be expected to emerge in a language like Zoque from affixation of the placeless nasal to a vowel-initial root in which the first non-vowel is either an obstruent or a glide. The 1st person form of a hypothetical root like /apa/ should be [napa] or [ãmba]. Unfortunately, there appear to be no vowel-initial roots in Zoque.

6 Summary and conclusions

My analysis of Terena nasal harmony covers the observations in (18) better than any known alternatives. Most previous analyses with which I am familiar share the common assumption that there is some process which distributes the feature [nasal] rightward, a progressive harmony (Gerfen 1993, Cole & Kisseberth 1994). None of them provides an explanation for the fact that the leftmost stop or fricative must be prenasalised and voiced. It might be possible to make a case for the prenasalisation of stops by 'leakage' of nasality from a preceding vowels, but this would not account for the prenasalisation of fricatives. The spread of nasality from a vowel to a fricative should produce a nasalised fricative. It seems unlikely that the analysis of the Terena pattern as progressive nasal harmony can be amended to account for the phenomenon of prenasalisation.

No previous analysis provides a principled account of the behaviour of root nasals (cf. Piggott 1988). Clearly, such consonants do not trigger harmony, even when they are part of a 1st person form (e.g. [nõ^{n}gone] 'my need', *[nõ^{n}gonẽ]). The characterisation of harmony as just feature spreading would have to stipulate that [nasal] as a feature of the 1st person morpheme is the trigger, but as a root feature it is exempt from the process. For nasal spreading to bypass a root nasal, some special amendment would have to be added to the theory of feature spreading to avoid the appearance of the type of line crossing in autosegmental representation that is considered by almost all generative phonologists to be illicit (see Sagey 1988, Archangeli & Pulleyblank 1994). The amendment would have to distinguish this case from other cases in which segments specified for a spreading feature are blockers. It is well-known, for example, that high rounded vowels in Khalkha Mongolian block a progressive labial harmony process. One proposal that might appear to deal with the problem of the inertness of root nasals to Terena harmony is the Morpheme Tier Hypothesis, according to which morphemes may occupy independent tiers (McCarthy 1986). In a morphologically governed process like Terena's, the spreading nasal feature would thereby be on a different plane from [nasal] as a root feature (cf. Cole (1987). Such a proposal is untenable for Terena, because it predicts that nasal spreading would skip obstruents.

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All of the principles and parameters invoked in this paper enjoy broad cross-linguistic support. The leading idea is that two constraints are in competition to fix the position of the 1st person singular morpheme in two different morphological domains. The literature on the morphology–phonology interface provides examples of this type of competition (McCarthy & Prince 1993a, b). To satisfy the alignment demands of the 1st person affix, nasality, an element introduced by the former, must be word-initial. However, a universal demand that an underlying segment must be realised on the surface unless some specific prohibition is in effect forces the segmental exponent of the 1st person affix to be licensed wherever it can be within the word. Hence, the alignment and licensing requirements conspire to produce the effect of a harmony pattern, triggered only by the 1st person morpheme and not by any other occurrences of the feature [nasal] in a word.

The important assumption that the 1st person affix is a nasal consonant is strongly supported by the combination of evidence from prenasalisation and obstruent voicing. In many clear cases of long-distance harmony, where the harmonic feature is indisputably [nasal], opaque obstruents are never systematically prenasalised and voiced. On the other hand, in clear cases where an obstruent is voiced postnasally there is independent evidence that the trigger of voicing is a full nasal consonant. The behaviour of the Terena 1st person affix, therefore, fits into well-attested patterns, if it is underlyingly a nasal consonant.

The other aspects of the Terena pattern follow from a language-particular restriction on nasal-bearers and the locality condition which phonological theory imposes on all phonological relations. All segments between the site where the segmental exponent of the affix is licensed and the left edge of a word must bear the feature [nasal]. Consequently, the leftmost obstruent in a word is the source of place features for the affix nasal, when it is syllabically licensed. Only when a word contains no obstruent is it possible for nasality to extend over all its segments.

It is probably not completely coincidental that the emergent harmony of Terena involves nasality. Movement to satisfy the demands of licensing plays a crucial role in the analysis, and consonants are the segments most likely to move. Among the consonantal features, [nasal] seems to be unique in the scope it can occupy. It can be a property of consonants and vowel. Hence, an affix nasal can be licensed at some distance from the position where it is positioned by the morphology. Nevertheless, we would still expect to find that other features involved in morphologically governed harmonies can be analysed in the terms proposed for nasal harmony in Terena. Glottal harmony in Coeur d'Alene (Reichard 1938) seems to be amenable to such an analysis.

The adoption of my analysis of the Terena pattern forces a re-consideration of the conception of harmony. We would have to give up the traditional characterisation of all harmonies as no more than feature spreading. Although feature spreading may be involved in the Terena pattern, it is a consequence rather than the cause of the harmony.

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Harmony may therefore be an epiphenomenon which emerges from the interaction of phonological and morphological demands.

NOTES

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[1] Tones are associated with syllables in the schemata used in this paper, but it would not affect the present analysis if tones are associated with moras (cf. Archangeli & Pulleyblank 1994).

[2] The fact that the Low tone is not associated with the first segment in the stem is irrelevant, because onset segments are not tone-bearers. The analogy with the left-alignment of the stress foot in a prosodic word is appropriate; onset consonants play no role in determining whether or not such a demand is satisfied.

[3] Licensing constraints formulated in negative terms by Itô (1986) can be readily reinterpreted as positive constraints. For example, the ban on place features in the coda can be restated positively as a requirement that the licenser of place features must be the onset (cf. Itô & Mester 1994a, b).

[4] Other phonologists have also proposed that consonants in the two positions have different prosodic licensers. For example, Kaye (1990) hypothesises that all final consonants are syllabified and licensed as onsets.

[5] Spaelti (1994) also argues that the licenser of 'extrametrical' consonants is the prosodic word. However, he assumes a less restrictive theory of prosodic organisation that allows segments to be parsed directly as constituents of prosodic words. This difference between the two positions is important but cannot be addressed in this paper.

[6] While this statement provides for the option of anchoring at the right or left edge of the word, I can cite no unambiguous evidence that points to left-edge anchoring.

[7] Tourville (1991) considers a number of different feature configurations in which the feature [nasal] might be found in underlying representations.

[8] Gerfen (1993) notices this problem but offers no solution to it.

[9] The postulation of a placeless nasal consonant is based on the standard logic of underspecification theory. Features which are entirely predictable are not part of underlying representation. In reality, whether place features are represented underlyingly or not is not of great consequence, provided that there is some alternative way of capturing the fact that his nasal cannot license place features. Padgett (1994) contains some suggestions as to how to account for the fact that the segment often lacks independent place features in all of its occurrences.

[10] I favour the view that this constraint is universal. However, the defence of such a position is beyond the scope of the present paper.

[11] This constraint is the equivalent of a MAX-IO constraint of Correspondence Theory (McCarthy & Prince 1995).

[12] This is the Type A harmony described by Piggott (1992). The typology of nasal harmony is reanalysed in Piggott (1996a, b) and Piggott & van der Hulst (1997).

[13] This proposal reflects the spirit but not the details of the analysis of Terena by Piggott (1988).

[14] In French and other languages in which a debuccalised nasal is responsible for the appearance of nasal vowels word-medially as well as word-finally, the placeless nasal consonant must be licensed by the syllable. The syllabic licensing of the nasal as part of a nucleus allows nasal vowels to be (randomly) distributed throughout words.

[15] The claim that two representations may have the same phonetic interpretation is not new. Rose (1996) has recently defended this position by demonstrating that

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phonetic laryngeals are sometimes specified as pharyngeals and sometimes they are placeless segments. For Rice (1996), velars also have variable specification.

[16] Steriade (1993) offers a different analysis of nasal contours in Auca than the one proposed here. She attributes the nasal phase to a non-iterative process which spreads [nasal] rightward to stops and approximants. No explanation of postnasal voicing is offered and no consideration is given to the alternative analysis proposed here.

[17] Herbert (1986: 237) describes the hardening of approximants to stops after nasal consonants.

[18] Guaraní (Gregores & Suárez 1967, Piggott & Humbert 1997) provides additional evidence of this type.

[19] The postulation of fusion is phonetically defensible; it can be described as the result of the overlapping of the articulatory gestures of the nasal and the glide. There is also evidence that the process occurs in other languages. Tourville (1991) reports that in a number of Manding languages (e.g. Maukakã, Koyaga, Jula) nasal–glide sequences are fused into nasalised glides (e.g. [w̃ ỹ]) or nasal stops (e.g. [ŋʷ ɲ]).

[20] Wonderly (1951a: 107) describes the sequence transcribed as /wy/ as 'an unrounded bilabial spirant with the tongue in palatal position'.

[21] I assume that the same restriction is responsible for the ban on prenasalisation of fricatives.

REFERENCES

Anderson, J. M. & C. J. Ewen (1987). *Principles of dependency phonology*. Cambridge: Cambridge University Press.

Anderson, S. R. (1976). Nasal consonants and the internal structure of segments. *Lg* **52**. 326–344.

Archangeli, D. & D. Pulleyblank (1994). *Grounded phonology*. Cambridge, Mass.: MIT Press.

Bendor-Samuel, J. (1960). Some problems of segmentation in the phonological analysis of Tereno. *Word* **16**. 348–355.

Bendor-Samuel, J. (1966). Some prosodic features in Terena. In C. E. Bazell, J. C. Catford, M. A. K. Halliday & R. H. Robins (eds.) *In memory of J. R. Firth*. London: Longman. 30–39.

Chomsky, N. (1981). *Lectures on government and binding*. Dordrecht: Foris.

Clements, G. N. (1986). Compensatory lengthening and consonant gemination in LuGanda. In L. Wetzels & E. Sezer (eds.) *Studies in compensatory lengthening*. Dordrecht: Foris. 37–77.

Clements, G. N. & K. C. Ford (1979). Kikuyu tone shift and its synchronic consequences. *LI* **10**. 179–210.

Cohn, A. (1987). A survey of the phonology of the feature [±nasal]. Ms, UCLA.

Cole, J. (1987). *Planar phonology and morphology*. PhD dissertation, MIT.

Cole, J. & C. Kisseberth (1994). Nasal harmony in optimal domains theory. Ms, University of Illinois.

Dell, F. (1970). *Les règles phonologiques tardives et la morphologie dérivationnelle du français*. PhD dissertation, MIT.

Feinstein, M. (1979). Prenasalization and syllable structure. *LI* **10**. 245–278.

Gerfen, C. (1993). Trigger conditions and nasal harmony in Terena. *BLS* **19**. 159–181.

Gleason, H. A. (1955). *Workbook in descriptive linguistics*. New York: Holt, Rinehart, & Winston.

Goldsmith, J. (1976). *Autosegmental phonology*. PhD dissertation, MIT.

Goldsmith, J. (1990). *Autosegmental and metrical phonology*. Oxford: Blackwell.

https://doi.org/10.1017/S0952675798003443 Published online by Cambridge University Press

Gregores, E. & J. A. Suárez (1967). *A description of colloquial Guaraní*. The Hague: Mouton.
Harden, M. (1946). Syllable structure of Terena. *IJAL* **12**. 60–63.
Harris, J. (1994). *English sound structure*. Oxford: Blackwell.
Herbert, R. K. (1975). Reanalyzing prenasalized consonants. *Studies in African Linguistics* **6**. 105–123.
Herbert, R. K. (1977). Phonetic analysis in phonological description: prenasalized consonants and Meinhof's Rule. *Lingua* **43**. 339–373.
Herbert, R. K. (1986). *Language universals, markedness theory, and natural phonetic processes*. Berlin: Mouton de Gruyter.
Hulst, H. van der & N. Smith (1982). Prosodic domains and opaque segments in autosegmental theory. In H. van der Hulst & N. Smith (eds.) *The structure of phonological representations*. Part 2. Dordrecht: Foris. 311–336.
Humbert, H. (1995). *Phonological segments: their structure and behaviour*. PhD dissertation, University of Leiden.
Itô, J. (1986). *Syllable theory in prosodic phonology*. PhD dissertation, University of Massachusetts, Amherst.
Itô, J. & A. Mester (1994a). Realignment. Ms, UCSC.
Itô, J. & A. Mester (1994b). Reflections on CodaCond and Alignment. In R. Walker, J. Padgett & J. Merchant (eds.) *Phonology at Santa Cruz 3*. Santa Cruz: Linguistics Research Center. 27–46.
Itô, J., A. Mester & J. Padgett (1995). Licensing and underspecification in Optimality Theory. *LI* **26**. 571–613.
Kaye, J. (1990). 'Coda' licensing. *Phonology* **7**. 301–330.
Kaye, J., J. Lowenstamm & J.-R. Vergnaud (1985). The internal structure of phonological elements: a theory of charm and government. *Phonology Yearbook* **2**. 305–328.
Kaye, J., J. Lowenstamm & J.-R. Vergnaud (1990). Constituent structure and government in phonology. *Phonology* **7**. 193–231.
Kiparsky, P. (1985). Some consequences of Lexical Phonology. *Phonology Yearbook* **2**. 85–138.
Kisseberth, C. (1970). On the functional unity of phonological rules. *LI* **1**. 291–306.
Lahiri, A. & W. Marslen-Wilson (1991). The mental representation of lexical form: a phonological approach to the recognition lexicon. *Cognition* **38**. 245–294.
Loos, E. (1969). *The phonology of Capanahua and its grammatical basis*. Norman: Summer Institute of Linguistics.
McCarthy, J. (1986). OCP effects: gemination and antigemination. *LI* **17**. 207–263.
McCarthy, J. & A. Prince (1990). Foot and word in prosodic morphology: the Arabic broken plural. *NLLT* **8**. 209–283.
McCarthy, J. & A. Prince (1993a). *Prosodic Morphology I: constraint interaction and satisfaction*. Ms, University of Massachusetts, Amherst & Rutgers University.
McCarthy, J. & A. Prince (1993b). Generalized alignment. *Yearbook of Morphology*. 79–153.
McCarthy, J. & A. Prince (1995). Faithfulness and reduplicative identity. In J. Beckman, L. Walsh Dickey & S. Urbanczyk (eds.) *Papers in Optimality Theory*. Amherst: GLSA. 249–384.
Mithun, M. & H. Basri (1986). The phonology of Selayarese. *Oceanic Linguistics* **25**. 210–254.
Mugane, J. & C. Gerfen (1993). Aperture geometry, feature cooccurrence and Meinhof's Law in Gikuyu. Paper presented at the 24th Annual Conference on African Linguistics, Ohio State University.
Onn, F. (1976). *Aspects of Malay phonology and morphology*. PhD dissertation, University of Illinois.
Osborn, H. (1966). Warao I: phonology and morphophonemics. *IJAL* **32**. 108–123.

https://doi.org/10.1017/S0952675798003443 Published online by Cambridge University Press

Padgett, J. (1991). *Stricture in feature geometry*. PhD dissertation, University of Massachusetts, Amherst.
Padgett, J. (1994). Stricture and nasal place assimilation. *NLLT* **12**. 465–513.
Paradis, C. (1988). On constraints and repair strategies. *The Linguistic Review* **6**. 71–97.
Paradis, C. & J.-F. Prunet (1996). Nasal vowels as two segments. Ms, Laval University & UQAM.
Piggott, G. (1988). A parametric approach to nasal harmony. In H. van der Hulst & N. Smith (eds.) *Features, segmental structure and harmony processes*. Part 1. Dordrecht: Foris. 131–167.
Piggott, G. (1989). Prenasalization and feature geometry. *NELS* **19**. 345–357.
Piggott, G. (1991). Apocope and the licensing of empty-headed syllables. *The Linguistic Review* **8**. 287–318.
Piggott, G. (1992). Variability in feature dependency: the case of nasality. *NLLT* **10**. 33–77.
Piggott, G. (1995). Epenthesis and syllable weight. *NLLT* **13**. 283–326.
Piggott, G. (1996a). Implications of consonant nasalization for a theory of harmony. *Canadian Journal of Linguistics* **41**. 141–174.
Piggott, G. (1996b). Reconfiguring harmony. *McGill Working Papers in Linguistics* **12**. 61–98.
Piggott, G. & H. van der Hulst (1997). Locality and the nature of nasal harmony. *Lingua* **103**. 85–112.
Piggott, G. & H. Humbert (1997). Representations and constraints: the case of Guarani nasal harmony. Paper presented at the 3rd HIL Phonology Conference, Amsterdam.
Piggott, G. & R. Singh (1985). The phonology of epenthetic segments. *Canadian Journal of Linguistics* **30**. 415–453.
Polomé, E. (1967). *Swahili language handbook*. Washington, D.C.: Center for Applied Linguistics.
Prince, Alan & Paul Smolensky (1993). *Optimality Theory: constraint interaction in generative grammar*. Ms, Rutgers University & University of Colorado, Boulder.
Prunet, J.-F. (1986). *Spreading and locality domains in phonology*. PhD dissertation, McGill University.
Reichard, G. (1938). Coeur d'Alene. In F. Boas (ed.) *Handbook of American languages*. Bureau of American Ethnology, Bulletin 40, Washington, D.C. 517–707.
Rice, K. (1992). On deriving sonority: a structural account of sonority relationships. *Phonology* **9**. 61–99.
Rice, K. (1993). A reexamination of the feature [sonorant]: the status of 'sonorant obstruents'. *Lg* **69**. 308–344.
Rice, K. (1996). Default variability: the coronal–velar relationship. *NLLT* **14**. 493–543.
Rice, K. & P. Avery (1989). On the interaction between sonorancy and voicing. *Toronto Working Papers in Linguistics* **10**. 65–82.
Rose, S. (1996). Variable laryngeals and vowel lowering. *Phonology* **13**. 73–117.
Rosenthall, S. (1989). *The phonology of nasal–obstruent sequences*. MA thesis, McGill University.
Sagey, E. (1986). *The representation of features and relations in nonlinear phonology*. PhD dissertation, MIT.
Sagey, E. (1988). On the ill-formedness of crossing association lines. *LI* **19**. 109–118.
Saint, R. & K. Pike (1962). Auca phonemics. In B. Elson (ed.) *Studies in Ecuadorian Indian languages*. Vol. 1. Norman: Summer Institute of Linguistics. 2–30.
Sapir, J. D. (1965). *A grammar of Diola-Fogny*. Cambridge: Cambridge University Press.

https://doi.org/10.1017/S0952675798003443 Published online by Cambridge University Press

Scobbie, J. (1991). *Attribute value phonology*. PhD dissertation, University of Edinburgh.
Scobbie, J. (1993). Constraint violation and conflict from the perspective of Declarative Phonology. *Canadian Journal of Linguistics* **38**. 155–167.
Selkirk, E. (1982). *The syntax of words*. Cambridge, Mass.: MIT Press.
Singh, R. (1987). Well-formedness conditions and phonological theory. In W. Dressler, H. Luschützky, O. Pfeiffer & J. Rennison (eds.) *Phonologica 1984*. Cambridge: Cambridge University Press. 273–285.
Spaelti, P. (1994). Weak edges and final geminates in Swiss German. *NELS* **24**. 573–588.
Steriade, D. (1993). Closure, release, and nasal contours. In M. Huffman & R. Krakow (eds.) *Nasals, nasalization, and the velum*. Orlando: Academic Press. 401–470.
Steriade, D. (1995). Underspecification and markedness. In John Goldsmith (ed.) *The handbook of phonological theory*. Cambridge, Mass. & Oxford: Blackwell. 114–174.
Ternes, E. (1973). *Phonemic analysis of Scottish Gaelic*. Hamburg: Buske.
Tourville, J. (1991). *Licensing and the representation of floating nasals*. PhD dissertation, McGill University.
Trigo, L. (1988). *On the phonological behavior and derivation of nasal glides*. PhD dissertation, MIT.
Walker, R. (1994). Hierarchical opacity effects in nasal harmony: an optimality-theoretic account. In M. Bernstein (ed.) *Proceedings of the Eastern States Conference on Linguistics*. New York: Cornell University.
Ward, I. C. (1933). *The phonetic and tonal structure of Efik*. Cambridge: Heffer.
Welmers, W. (1973). *African language structures*. Berkeley: University of California Press.
Wonderly, W. (1951a). Zoque II: phonemes and morphophonemes. *IJAL* **17**. 105–123.
Wonderly, W. (1951b). Zoque III: morphological classes, affix list, and verbs. *IJAL* **17**. 137–162.
Wonderly, W. (1951c). Zoque IV: auxiliaries and nouns. *IJAL* **17**. 235–251.
Ziervogel, D., P. J. Wentzel & T. N. Makuya (1972). *A handbook of the Venda language*. Pretoria: University of South Africa Press.

https://doi.org/10.1017/S0952675798003443 Published online by Cambridge University Press