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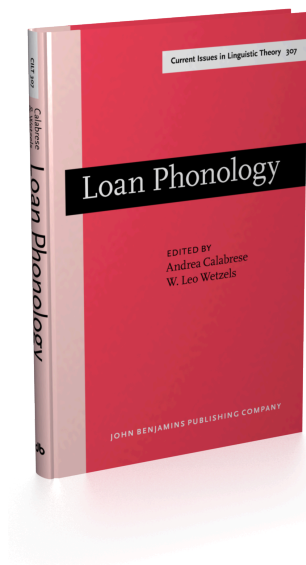
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Nasal harmony and the representation of nasality in Maxacalí

Evidence from Portuguese loans

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Popovich (1971) claimed that nasality in Maxacalí is contrastive for both consonants and vowels. Rodrigues (1980) proposes to eliminate nasality entirely from the set of phonological features of Maxacalí and to represent all voiced, prenasalized and nasal consonants as voiced consonants in the lexical representation. In this paper, we take up this discussion and present an alternative analysis that is intermediate between the proposals by Popovich and Rodrigues. On the basis of evidence drawn from the adaptation of Brazilian loanwords in Maxacalí, it is concluded that nasality is contrastive for vowels.

1. Introduction

Maxacalí, a member of the Macro-Jê linguistic family, is spoken in the border area of the states of Minas Gerais and Bahia, Brazil.¹ A 1997 census report from the *Instituto SocioAmbiental* suggests that there are roughly 802 Maxacalí. These people live in an area that is suffering from significant deforestation and overgrazing. The Maxacalí, who still teach the traditional language to their children, are largely monolingual, though some have a very rudimentary Portuguese ability. The survival of their language and culture is uncertain because of the precarious conditions under which they live; large-scale malnutrition arising from their belief that it is possible to survive by hunting and gathering without planting coupled with massive alcoholism call into question the long-term physical survival of this people. A detailed account of Maxacalí, and the most comprehensive

1. Many thanks to Gabriel Araujo, Andrea Calabrese, and especially Harold Popovich, for comments on an earlier version of this paper. All errors in fact and interpretation are my own.

description to date as far as the phonology is concerned, became available with the publication of a paper by Gudschinsky, Popovich and Popovich in *Language* 46.1 (1970), henceforth referred to as GPP.^{2,3} In their paper, GPP discuss the intriguing process of (pre)vocalization: in Maxacalí all coda consonants may develop a vocalic pre-articulation, which may take on the status of a full vowel and even entirely replace the consonant. In this study we will address the process of nasal harmony and the question of the representation of nasality in Maxacalí. We will compare two proposals that account for the distribution of nasal vowels and consonants in this language, one by GPP and one by Rodrigues (1980). Despite the radical differences in the underlying system posited in each of these proposals, both provide an observationally adequate account of the surface distribution of nasal sounds in Maxacalí. Thereafter, we will turn our attention to a set of data that appear to conflict with Rodrigues' analysis, because they indicate (at least a measure of) phonological contrast for vowels. In order to determine the relevance of these facts, we will look at how Maxacalí adapts loanwords from Portuguese that contain nasal vowels and/or nasal consonants. We conclude that the facts that conflict with Rodrigues' analysis do not represent a subset requiring exceptional lexical marking for vocalic nasality, but are indicative of a general nasal contrast for vowels.

2. Drawing on material collected by Harold and Francis Popovich, Davis (1968) classified Maxacalí as a member of the Macro-Jê stock of South American indigenous languages. A more recent report on the classification of the Brazilian indigenous languages by Rodrigues (1986a) confirms Davies' hypothesis. Information about the history and the people of the Maxacalí can be found in Rubinger, Amorim & Marcato (1980). F. Popovich (1980) presents a study of the social organization of the Maxacalí.

3. Almost all subsequent work focusing on the theoretical interpretation of the Maxacalí phonological facts is based directly or indirectly on GPP. McCawley (1967) and Hyman (1975:46, 191), make mention of the process of prevocalization. In Reighard (1972:540–1), glide formation and (pre)vocalization are briefly discussed. Drawing on Reighard (1972), Clements (1991) uses glide formation occurring between the underlying vowel and the (pre)vocalized coda consonant to support his proposal for defining place of articulation in consonants and vowels with a single set of articulator features. In Hume & Odden (1996), Maxacalí is briefly mentioned. A formal (feature- geometry) analysis of (pre)vocalization based on secondary consonant features was proposed by Wetzels (1993) and a slightly different analysis based on primary consonant features by Wetzels & Sluyters (1995). Araujo (2000) provides a more recent study of Maxacalí phonology and morphology (partly) based on independent fieldwork. Operstein's (to appear) cross-linguistic study of prevocalization also extensively discusses Maxacalí data, based on GPP, Wetzels (1993) and Sluyters and Wetzels (1995), reinterpreting Wetzels' (1993) analysis in a gestural framework.

2. Sources

Many of the examples on which our analysis is based are taken from Popovich & Popovich (2004). A further source of information is the unpublished paper Popovich (1983a). A more extensive discussion of Maxacalí prosody, with little attention for the segmental and syllable levels, is presented in Popovich (1985), a work that also contains 75 pages of phonetic transcription from which further examples were taken. Other examples were drawn from a study by Rodrigues (1980), which is based on data drawn from two unpublished papers by Popovich & Popovich (2004),⁴ as well as from Popovich (1971) and GPP. Specifically with respect to the problem of nasality, we have also used an unpublished reaction to Rodrigues' analysis of Maxacalí nasality by Popovich (1983b) and an unpublished paper by Araujo (ms).

3. The consonants and vowels of Maxacalí

3.1 Vowels

Maxacalí distinguishes five oral vowels underlyingly, which are front high /i/, back high (non-labial) /u/, front non-high /e/, back non-high (labial) /o/, and the low vowel /a/, all of which have a nasal correspondent. According to GPP, nasality is contrastive for vowels.

(1) Maxacalí Vowel Inventory

	front	central	back	
			non-labial	labial
high	/i/		/u/	
mid	/e/			/o/
low		/a/		

Both oral and nasal vowels show a wide range of surface variants.⁵ The degree of aperture of the front high vowel /i/ varies freely from relatively close [i] to more open [ɪ] or even [e]: /tihic/ → [tɪhey] 'man'. Mid /e/ can be [e], but also more open [ɛ], or often even [æ]: /pepi/ → [pæpi] 'above'. The phonetic range of underlying /a/ extends from central low [a], to mid central [ə] and to very low

4. For which no references are provided.

5. In GPP (1970:80) the low vowel /a/ is assigned to the same aperture class as /e/ and /o/ at the contrastive phonological level. Here, we will treat /a/ as the sole member of the class of low vowels.

back [a]: /-kaʔok/ → [kaʔo^uk^ɿ] or [kaʔo^ux] ‘strong’; interestingly, the backmost variants of /a/ occur between alveolar consonants. The vowel /o/ is relatively stable, and invariably surfaces as back mid [o]. Lastly, back high /u/ has the widest range of surface variants, ranging from high back to centralized mid front: /pipkup/ → [pipku^ɿp^ɿ] or [pipkɪ^ɿp^ɿ] or [pipkɛ^ɿp^ɿ] ‘nail’. In the processes of prevocalization and vocalization, other vowels may arise, as will be discussed in Section 3.2 below.

3.2 Prevowels

Maxacalí shows a large discrepancy between the lexical representation of words and the way in which they are actually pronounced. The most frequently cited phenomenon of Maxacalí sound structure is the seemingly free variation that exists between consonants and vowels at the end of syllables⁶:

(2)

- a. /t/, /n/ are optionally pronounced as mid central [ɜ], [ẽ], respectively:
 /pat.kup/ ~ [paɜ.kɪɾ] ‘rib’
 /tõ.mãn/ ~ [tõ.mãẽ] ‘tomato’
- b. /p/, /m/ are optionally pronounced as the mid non-round back vowels [ɤ], [ẽ̃], respectively:
 /pap.tuc/ ~ [paɤ.tui] ‘drunk’
 /mi.hĩm/ ~ [mĩ.hĩẽ̃] ‘wood’
- c. /k/, /ŋ/ are optionally pronounced as the high, centralized back vowels [u], [ũ], respectively:
 /kuɕakkik/ ~ [kuɕaukiu] ‘capybara’
 /ɲã.ɲã.mõŋ/ ~ [ɲã.ɲã.mõũ] ‘uncle has gone’
- d. /c/, /ɲ/ are optionally pronounced as [i], [ĩ], respectively:
 /ko.kac/ ~ [ko.kai] ‘lizard’
 /mã.ʔãɲ/ ~ [mã.ʔãĩ] ‘alligator’

Maxacalí seems unique in allowing the complete set of syllable-final consonants to be realized as vowels. According to GPP, this (pre)vocalization is most prominent in ‘stressed or prolonged syllables’ (1970:82).⁷ More concretely, in unstressed

6. In the examples in (2) and below, it is provisionally assumed that nasality is phonological for both consonants and vowels. We will return to this issue later.

7. Syllables are prolonged under emphatic stress as in calling or pedantic repetition (cf. GPP: 81). Also, as Harold Popovich points out (p.c.), the concept of ‘augmentation’ is signaled by stress and length realized either on the nuclei of all the syllables of the word or on the last syllable only.

syllables prevocalization never results in a fully-fledged vowel, whereas this does happen when the syllable is prolonged. If a coda consonant shares its active articulator (place of articulation) with the immediately following onset, be it word-internally or across word boundaries, it is always vocalic and very often no consonantal closure takes place in the coda. The quality of the vocalic element that develops is predictable from the nature of the underlying consonant, whether prevocalization or complete vocalization occurs. The surface qualities of the (pre)vowels derived from coda consonants are provided in (3):⁸

(3)	Prevowel quality		
	Front	Central	Back
High	i/_{c,n}		u/_{k,ŋ}
upper			ʊ/_{p,m}
Mid			
lower		ɜ/_{t,n}	

3.3 Consonants

Maxacali has ten consonantal segments at the contrastive phonemic level. Observe the absence of liquids and (phonemic) fricatives. The system includes two laryngeals: the glottal stop /ʔ/ and the glottal fricative /h/. As for the supralaryngeal consonants, GPP posit two series of underlying segments, voiceless and nasal stops, both of which are realized at four distinctive places of articulation, as in (4) below (see GPP:80):

(4)	Labial	Alveolar	Palatal	Velar	Laryngeal
Oral	p	t	c	k	ʔ, h
Nasal	m	n	ɲ	ŋ	

At the phonetic level, voiced non-nasal consonants and prenasalized consonants may occur, as in [kadop] from underlying /kanop/ ‘to mix dry substance with liquid’ and [ʔʰokoba] from /ʔokoma/ ‘below’. Both plain and prenasalized voiced stops are analyzed by GPP as surface variants of underlying nasals, which are denasalized partially or completely by contiguous oral vowels. GPP’s analysis also posits a lexical contrast with respect to nasality for vowels, as in /pāhām/ ‘bread’ versus /paptuuc/ ‘drunk’.

8. All (pre)vowels derived from consonants are non-labial. When derived from a nasal consonant, the (pre)vowel always surfaces as nasalized. In both GPP and in Popovich (1983), the (pre)vowel appearing with velars is defined as back, whereas in Popovich (1985) it is considered central. In Wetzels & Sluyters (1995), it is classified as dorsal.

4. Nasal harmony⁹

In Maxacalí, nasal sounds usually do not stand on their own, but co-occur with other nasal sounds, as in the words in (5):

(5)	[mãpõn]	‘sun’	[mõŋ]	‘to go’
	[kõmãn]	‘stepmother’	[nãn]	‘fall (singular subject)’
	[ʔũŋãŋ]	‘nervous’	[ũmõŋ]	‘choose’
	[muũnuũŋ]	‘deer’	[ŋĩmãn]	‘wing’
	[mãhãm]	‘fish’	[pĩn(ẽŋ)]	‘sound made by jumping’
	[pẽnãn]	‘see’	[kõmẽn]	‘city’
	[pãhãm]	‘bread’	[ŋũmuũŋ]	‘all of us’
	[ŋãmĩŋ]	‘spirit’	[mĩhĩm]	‘wood’
	[muũnuũn]	‘ant’	[ŋãnãm]	‘light’

In the words above, the only non-nasal segments are voiceless consonants. Otherwise, all segments are nasal. Comparatively, the words in (6) are completely oral.

(6)	[tihiç]	‘man’	[potaʔ]	‘to cry’
	[kaʔok]	‘strong’	[pacok]	‘corn’
	[kokeç]	‘dog’	[kot]	‘manioc’
	[kabah]	‘also’	[cokakkak]	‘chicken’
	[codat]	‘soldier’	[caʔ]	‘to fall (plural subject)’
	[puwtop]	‘to bite’	[tapet]	‘paper’
	[puwtuç]	‘heavy’	[capuwp]	‘pig’
	[pepi]	‘above’	[pohoc]	‘arrow’
	[pihep]	‘reservoir’	[⁽ⁿ⁾ ʔokoba]	‘below’
	[kadop]	‘to mix in liquid’	[topaʔ]	‘to fly’

Maxacalí possesses a number of roots that contain disharmonic sequences, as in (7):

(7)	[kacũŋ]	‘like this’	[puwcõŋ]	‘worm’
	[kiʔuũn]	‘parallel lines’	[cuwkãŋ]	‘above’
	[patĩŋ]	‘could be’	[kocãm]	‘fish hook’
	[caʔãm]	‘slug’	[tokãn]	‘toucan’
	[kacõŋ]	‘praise the lord’	[kacĩŋ]	‘thus’
	[muũtik]	‘with’	[ʔã ^m bũhũ]	‘wind’

Under specific conditions, voiced consonants are optionally realized as prenasalized stops. This happens when the voiced stop appears word-initially as the onset of an oral syllable, as shown by the examples in (8) below:

9. In this section and below, the effect of (pre)vocalization as well as other low level phonetic facts will be disregarded when irrelevant for the exposition.

- | | | |
|-----|---|----------|
| (8) | [^(m) boj] (<Port <i>boi</i> [boj]) | ‘ox’ |
| | [⁽ⁿ⁾ doʔok] | ‘wave’ |
| | [⁽ⁿ⁾ ʃokoba] | ‘below’ |
| | [⁽ⁿ⁾ gahap](<Port <i>garrafa</i> [ga'hafa]) | ‘bottle’ |

The great majority of Maxacalí roots ends in a consonant and usually does not contain more than two syllables. Nouns are mostly bisyllabic of the type CVCVC, whereas function words as well as verbs may be monosyllabic. Words longer than two syllables can be derived by compounding, a very productive process in Maxacalí. Polysyllabic words may also be derived by affixation, mostly suffixation. Prefixes are rare. The majority of the suffixes start with a voiceless consonant; very few start with a voiced or nasal consonant or with a vowel. Affixes may be inherently nasal or oral. In derived words, nasal roots or affixes freely combine with oral roots, as is illustrated in (9):¹⁰

- | | | | |
|-----|---------------|----------------------|------------------------|
| (9) | [puwtuc+nāŋ] | bird+diminutive | ‘little bird’ |
| | [mīm+tuut] | wood+structure | ‘house’ |
| | [capup+nāŋ] | pig+diminutive | ‘white-lipped peccary’ |
| | [hām+cop+bac] | work+collective+good | ‘good things’ |
| | [māpōŋ+hec] | sun+female | ‘moon’ |
| | [mīn+cop] | leaf+collective | ‘leaves’ |
| | [mīm#koc] | wood#hole | ‘canoe’ |
| | [tik#kuīm] | man#sister | ‘daughter’ |
| | [mīm#koc#ʃok] | wood#hole#straight | ‘straight canoe’ |
| | [īm+pata#cac] | my+foot#skin | ‘my toe nail’ |
| | [īm+pa#ce] | my+eye#hair | ‘my eyelashes’ |

So far, we have seen that in Maxacalí voiced [b,d,ʃ,g], voiceless [p,t,c,k], and nasal [m,n,ɲ,ŋ] consonants occur on the phonetic surface. Word-initially as well as word-internally, the voiced and voiceless consonants contrast in the onset of syllables that contain an oral nucleus, whereas the nasal consonants may not occur in the onset of such syllables:

- | | | | | | | |
|------|---|----------|-----------|---|----------|-------------|
| (10) | p | [tapet] | ‘paper’ | b | [kabah] | ‘also’ |
| | t | [puwtuc] | ‘heavy’ | d | [kadop] | ‘scatter’ |
| | c | [citet] | ‘spotted’ | ʃ | [ʃokoba] | ‘down’ |
| | k | [kapec] | ‘coffee’ | g | [goc] | ‘to ambush’ |

10. Through this work, the symbol + represents an affix boundary, # a compound-internal boundary, and ## a word boundary.

On the other hand, in the onset of syllables containing a nasal nucleus, voiceless stops contrast with nasal consonants, whereas non-nasal voiced stops are not allowed in this position:

- (11)
- | | | | | | |
|---|---------|-------------|---|-----------|-------------|
| p | [pām] | ‘bread’ | m | [mãʔãŋ] | ‘alligator’ |
| t | [tōmān] | ‘tomato’ | n | [nāmtuut] | ‘bow’ |
| c | [kacūŋ] | ‘like this’ | ɲ | [mãɲõn] | ‘sun’ |
| k | [kãŋã] | ‘snake’ | ŋ | [ɲõŋ] | ‘to smoke’ |

The surface distribution of voiceless, voiced and nasal onset consonants in the native vocabulary of Maxacalí is summarized in (12) below:

- (12) Co-occurrence restrictions between nucleus and onset

σ	σ
/	/
{p,b} V	{p,m} V
[oral]	[nasal]

The distribution of consonants in the syllable coda is even more restricted: after an oral nucleus only voiceless consonants occur, while after a nasal nucleus only nasal consonants are permitted, as exemplified in (13) below:¹¹

- (13)
- | | | | | | |
|---|---------------------|-----------------|---|-----------------------|---------------------------|
| p | [tu ^p] | ‘new’ | m | [āmō ^m] | ‘Amom (name of a spirit)’ |
| t | [ābo ^t] | ‘sand’ | n | [ū(hū) ⁿ] | ‘Maxacalí woman’ |
| c | [cacic] | ‘to die’ | ɲ | [cū ^ɲ] | ‘to suffer’ |
| k | [āpak] | ‘to hear about’ | ŋ | [ɲīmā ^ŋ] | ‘wing’ |

The distribution of coda consonants is provided in (14):

- (14) Co-occurrence restrictions between nucleus and coda

σ	σ
\	\
V p	V m
[oral]	[nasal]

11. This is true at some intermediate level of representation, which we consider to represent the output of the lexical phonology. Phonetically, partial or complete denasalization of the coda consonant may occur in the sequence $C]_{\sigma\sigma}$ [C-voice, when the coda and onset consonants do not share their place of articulation: compare [mī(hī)m] ‘wood’ and [mīnta] ‘fruit’ with [mīptut] ‘house’ and [mīpkōj] ‘canoe’. Equally, voiceless consonants are optionally voiced before nasal consonants, as in /taknõŋ/ → [tagnõŋ] ‘brother’.

Since voiceless stops contrast with both voiced and nasal stops in onsets, voiceless stops must be distinguished as a separate phonological class. In contrast, in the syllable onset, voiced and nasal consonants are in complementary distribution, suggesting that one class may be derived from the other. As we have seen, non-nasal voiced stops do not occur in the syllable coda. In this position, voiceless and nasal stops are in complementary distribution.

As mentioned previously, GPP assume that in Maxacalí nasality is distinctive for both consonants and vowels. Voiced oral stops that occur in the onset of syllables with an oral nucleus are derived by a rule of consonant denasalization: /penec/ → [pedec] ‘tree frog’. Partial denasalization derives nasal-oral contour segments from nasal consonants in word-initial onsets when followed by an oral vowel: /nac/ → [ⁿday] or [day]. In the onset of a syllable containing a nasal vowel and in codas after a nasal nucleus, nasal consonants remain nasal.

4.1 GPP versus Rodrigues

We note that in all the words given in (5), as well as in the individual morphemes contained in the derived words in (9), a nasal span ends at its right edge in a nasal consonant that is located in the syllable coda. It is this observation that was at the basis of Rodrigues’ (1981) analysis of Maxacalí nasalization, to which we turn next.

In a reaction to GPP and Popovich (1971), Rodrigues (1980) made the interesting claim that nasality in Maxacalí is predictable for both consonants and vowels given that nasal spans almost invariably end in a word-final nasal consonant and voiced non-nasal stops and nasal consonants are in complementary distribution. He proposes the elimination of nasality from the set of Maxacalí contrastive features and the representation of all voiced, prenasalized and nasal consonants as voiced consonants in the lexical representation. According to Rodrigues, voiced stops are obligatorily nasalized when they occur at the right edge of the word, and it is from this position that they spread their nasal feature from right to left within the word domain, until blocked by a voiceless consonant. He also allows for a limited use of contrastive nasalization in vowels in cases where the nasal quality of the vowel cannot be obtained from a following nasalized consonant, as in /hã/ ‘manner’ vs. /ha/ ‘is’. Prenasalized consonants are considered positional, word-initial variants of underlying voiced consonants.

Compared to the position taken by GPP, Rodrigues’ proposal leads to a drastic simplification of the lexical representations of Maxacalí words, such that non-sonorant voiced and voiceless consonants freely occur in both onsets and codas of syllables, which contain only oral vowels. His analysis explains why nasal syllables cannot contain voiced non-nasal obstruents, as the latter would either trigger nasality projection (coda) or, along with the vocalic nucleus, be a target for nasal spreading (onset). Furthermore, the fact that all underlying vowels are

oral explains why only voiceless stops can surface as oral in the coda of syllables containing an oral nucleus. Finally, it is predicted that voiced and voiceless consonants may contrast in the onset before oral vowels, but that voiceless stops must contrast with nasal consonants before a nasal nucleus. In other words, all of the positional variation in the surface consonant system represented in (12) and (14) fall out naturally from the analysis.¹² Thus, it is possible to summarize Rodrigues' proposal as follows:¹³

- (15) *A voiced consonant in the syllable coda is obligatorily realized as a nasal sonorant which spreads its nasality leftward within the word-domain, until it is blocked by an intervening voiceless consonant (/p,t,c,k/).*¹⁴

In Maxacalí, the notions of 'word' and 'morpheme' overlap to a large extent. Morphemes, especially nouns, are most commonly bisyllabic and CVCVC-type. Words that consist of a single closed syllable $C_x V_i C_y$ ¹⁵ regularly have a corresponding bisyllabic form $C_x V_i ? V_i C_y$ or $C_x V_i h V_i C_y$; the short variant occurs when it is part¹⁶ of a larger morphological structure and the long form is used when the word appears in isolation. Compare, for example, the noun phrase in (16a) with the compound in (16b):¹⁷

12. The different positions adopted by GPP and Rodrigues (1981) are not only due to a difference in theoretical paradigm, i.e. Pikean phonemics vs. classical generative phonology, but are also related to a difference in objective. Whereas GPP, and especially Popovich (1983), are interested in developing a writing system for Maxacalí, Rodrigues (1980) approaches the problem from a strictly phonological perspective, aiming his description at a redundancy-free lexical representation of Maxacalí words.

13. Compared to the original proposal by Rodrigues, the spreading principle stated in (15) differs with regard to the structural position of the trigger of nasality. According to Rodrigues (1980), the (voiced) consonant triggering nasalization must be word-final. Even if the notion 'word' is understood in the sense defined below, this would imply that non-derived words of the type (C)VNTVC, i.e. a hypothetical form *[mãntup], with a morpheme-internal nasal coda consonant, should not exist. Although such words are usually composite, we wish to leave open the possibility that not all words of this type are synchronically transparent. We have therefore preferred to rephrase the spreading principle in such a way that it refers to the end of syllables rather than to the end of words. For our specific purpose, which is to test Rodrigues' hypothesis concerning the underlying source for surface nasality in Maxacalí, this modification is not crucial.

14. The sound [ʔ] likely also serves to block nasal spread. The behaviour of the glottal consonants is elaborated in Section 4.2 below.

15. Subscripts indicate segment identity or the lack thereof.

16. In the examples we have encountered, the short form is always the left element in the sequence. We suppose that this is a further condition on its distribution.

17. The examples in this paragraph are adapted from Araujo (2000).

- (16) a. _{NP}[mīhīm##koj] wood##hole 'perforated wood'
 b. _N[mīm#koj] wood#hole 'canoe'

Compare also the sequences in (17a–b), where the suffix /+tɛ/ represents the ergative marker:

- (17) a. [tīhik##mōŋōn] the man##sleep 'the man sleeps'
 b. [tik+tɛ?##cānāhān] the man+ERGATIVE##call 'the man calls'

In Maxacalí, the great majority of bisyllabic words in which the first syllable is closed are either compound structures, as in (16b); structures containing suffixes, such as [tik+tɛ?] in (17b); or prefixed words, like /iN+pata/ 'my+foot' → [īm+pata?].

As is shown by the sequences /ce+nān/ → [cēnān] 'hair+DIMINUTIVE', or /iN+pa+nān/ → [īm+pā+nān] 'my+eye+DIMINUTIVE', nasality that originates in a suffix spreads leftwards onto the preceding base. This means that in Maxacalí the domain for nasal spreading is not the morpheme, but a larger structure. The question then arises as to whether nasality that originates on the right part of a compound propagates into the part(s) on the left. Vowel-final root morphemes are relatively rare in Maxacalí. Nevertheless, some compounds of the relevant type were encountered, which seem to show that the nasal feature does not spread across a compound boundary, as in /ku#ŋāmām/ [kuŋāmām] 'light, lamp', which very probably contains the root /ku(hu)/ 'firewood'. While it could be argued that, in this word, nasal spreading is blocked by an underlying voiceless stop – /kuhu/ has a variant /kuhuk/ in Maxacalí – the presence of a blocking consonant is more difficult to justify for the verb [penāhā] 'to look', where [pe] most likely represents the noun /pa/ 'eye'. We will therefore assume that the notion 'word' in the statement (15) refers to a bare or affixed lexical category.¹⁸

The operation of the principle in (15) is illustrated with the following examples (periods indicate syllable boundaries):

- (18) a. /ba.ʃod/ → [mā. ɲōn] 'sun'. In this word, syllable-final /d/ is realized as [ŋ] and spreads its nasality leftward. Since there is no voiceless consonant in the word, nasality spreads over the whole sequence.
 b. /puu.cɔf/ → [puu.cōŋ] 'worm'. Here, syllable-final /f/ is realized as [ŋ]. Nasality spreads leftward until it is blocked by voiceless [c].
 c. /tot.cic.pec/ → [tot.cic.pec] 'watermelon'. This word does not contain a syllable-final voiced consonant. Consequently, it surfaces with oral segments only.

18. From the phonetic transcriptions in Popovich (1985), we conclude that nasal spreading across compound and word boundaries may happen in informal speech styles. Unfortunately, a detailed account of Maxacalí morphology and a fine-grained analysis of the stylistic factors involved in nasal harmony are still lacking. We will therefore limit the discussion to obligatory nasal harmony, which, in the theoretical frame used here, corresponds with the lexical part of the harmony process (see also Footnote 11).

When considered exclusively from a phonological perspective, Rodrigues' analysis looks superior to the one proposed by GPP. It almost entirely eliminates nasality from the lexical representation. Both the range of surface distributions of voiced, voiceless and nasal stops, as well as the nasal/oral variation in vowels results from the free distribution of voiced and voiceless stops in lexical entries and from the projection of nasality in the syllable coda combined with the leftward propagation of the nasal feature.

GPP's proposal, on the other hand, must posit a wholesale underlying oral/nasal contrast for consonants and vowels. It must account for optional prenasalization and obligatory consonant denasalization and also include some spreading mechanism to explain alternations between oral and nasal vowels in words that contain oral vowels underlyingly, such as /ce/ 'hair', which surfaces with a nasal vowel when combined with the diminutive suffix /nāŋ/:[cēnāŋ]. Both the elegance of the proposal and its capacity to account for the great majority of Maxacalí words have led us to adopt Rodrigues' analysis in our earlier studies of Maxacalí phonology,¹⁹ despite the fact that, as far as we are aware, Maxacalí would be the only language known in which surface nasality is derived for both consonants and vowels from underlying representations in which nasality is entirely lacking. The existence of a seemingly small residue of words for which nasality could not be derived from a coda consonant, such as /hã/ 'manner' vs. /ha/ 'is', did not seem alarming because the generalization expressed in (15) holds for all words that have a nasal, i.e. an underlyingly voiced coda consonant. Moreover, one could conjecture that the original conditioning factor for the nasality in words like /hã/ had become lost in the current state of the language, but was present at some earlier stage.

In an unpublished reaction to Rodrigues' analysis, Popovich (ms.) pointed out that the set of words containing nasal vowels that cannot be derived by the principle in (15) is relatively large.²⁰ The example sets (19a–b), taken from Popovich (*ibid*) and other sources contain such words:

- | | | | | | |
|------|----|----------------------------|------------------|-------------------------|--------------|
| (19) | a. | [hāmā ⁿ diccok] | 'play' | [ʔā ^m buc] | 'needle' |
| | | [hāmbedac] | 'sell' | [ʔā ^m buuuh] | 'wind' |
| | | [kānā ⁿ dok] | 'viper species' | [ʔā ^m buuk] | 'to cook' |
| | | [kāmā ⁿ dok] | 'horse' | [ʔā ⁿ fihik] | 'non-Indian' |
| | b. | [hōmāh] | 'remote time' | [nōkāmuŋ] | 'side' |
| | | [nānā] | 'uncle' | [nōā] | 'finish' |
| | | [māʔac] | 'will eat 3p sg' | [mākak] | 'heron' |

19. Wetzels (1993; 1995), Wetzels and Sluyters (1995).

20. Many thanks to Aryon Rodrigues for providing me with a copy of Popovich's reaction.

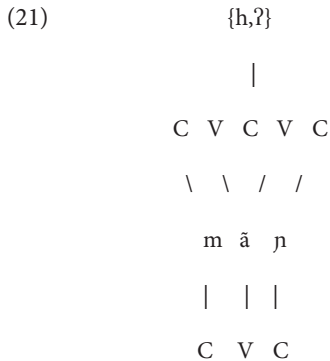
c.	[mãñõn]	‘sun’	[mõñ]	‘to go’
	[kômãn]	‘stepmother’	[nãn]	‘fall (singular subject)’
	[ʔũñǎp]	‘nervous’	[ũmõp]	‘choose’
	[muñnuĩp]	‘deer’	[nõʔõm]	‘that one’
	[mähām]	‘fish’	[pĩn]	‘sound made by jumping’
	[pēnãn]	‘see’	[kômēn]	‘city center’
	[pām]	‘bread’	[mãʔǎp]	‘alligator’
	[ñāmĩp]	‘spirit’	[mĩ(hĩ)m]	‘wood’
d.	[kiʔuĩn]	‘parallel lines’		
	[caʔām]	‘slug’		
	[kuʔĩn]	‘bands’		
	[mãʔǎp]	‘alligator’		

The words in (19a) are different from the ones given in (5), repeated here as (19c), to the extent that in the examples of (19c) all coda consonants can be (pre)vocalized, whereas the nasal consonants that are transcribed with superscript symbols in the words in (19a) never are. Since in Maxacalí all coda consonants may develop a (pre)vowel, (pre)vocalization provides us with a reliable test for determining the syllable position of a segment. The fact that the relevant nasal consonants in (19a) cannot develop a (pre)vowel shows that they are not located in the coda, but represent the nasal part of a single prenasalized onset segment (created by progressive spreading of nasality from the preceding nasal vowel). The words in (19a–b) demonstrate that nasal vowels may occur inside a word without the presence of a nasal coda from which their nasality can be derived.

The words in (19d) deserve special attention, because the glottal stop [ʔ] exhibits contradictory behavior as it blocks nasal spreading in the first two examples but not in the last one. As observed earlier (cf. 16/17), monosyllabic $[C_x V_i C_y]$ -type morphemes regularly have a corresponding bisyllabic form $[C_x V_i ʔ V_i C_y]$ or $[C_x V_i h V_i C_y]$, where the short variant occurs as a part of a larger morphological structure, while the long form is used when the word appears in isolation. Rodrigues (1986:82) suggests that the long forms are derived from the short ones, proposing, for example, /bib/ as the underlying form of [mĩhĩm]. In Wetzels & Sluyters (1995), following GPP and Popovich (1985:45), it was proposed that short forms were derived from long forms, because the occurrence of the type of glottal sound, [ʔ] or [h], was believed to be unpredictable. However, according to Araujo (2000), the glottal sound that occurs in the long forms, although it is usually realized as [h], alternates freely with [ʔ]. Some examples are given in (20):

- (20) [mähām] ~ [mām] ‘fish’
[mĩhĩm] ~ [mĩm] ‘wood’
[mähǎp] ~ [mǎp] ‘alligator’
[pohok] ~ [pok] ‘marsh’
[tuhtut] ~ [tut] ‘bag’

In (21) the way in which the segments of the short forms correspond with those of the long forms is shown for the morpheme [mãɲ] ~ [mãhãɲ] ‘alligator’:



Araujo’s observation that the glottal stop and the fricative are in free variation in these words is important, since it allows us to circumvent the question as to whether the long form is derived from the short form or vice-versa. Given the predictability of the glottal sound in the long forms, we can explain the ‘transparency’ of the glottal sounds irrespective of the directionality of the derivational process. If the short forms are the lexical base from which the long forms are derived, the words in which these consonants look transparent result from the lengthening process illustrated in (21), not from spreading: /CVC/ → /CV{h,?}VC/, with the mapping of the melody to the unspecified C and V positions. If the long form is the starting point of a shortening process, we may assume a mechanism like /CV_xV_xC/ → [CV_xC], and a rule of default onset insertion between V_xV_x in the long form. In both scenarios, we do not need to assume that glottal sounds are transparent to nasal harmony.²¹

4.2 The nativization of BP loans in Maxacali

Considering the examples in (19a–b), one is led to conclude that, for almost all the nasal vowels in these words, nasality cannot be derived from a nasal coda consonant. The question thus arises as to whether these words suggest a different

21. The fact that not all monosyllabic words have long forms could be interpreted as an argument in favour of a shortening process. However, there are also words of the type XV_i{h/?}V_iC that have no short forms. Interestingly, BP loans which satisfy the conditions for shortening are never shortened, whereas monosyllabic BP morphemes are usually lengthened, a fact which suggests the existence of a lengthening rule: BP *garrafa* [ga'hafa] ‘bottle’ > Max /gahap/ [ʔgahaʔp], never *[ʔgaʔp]. Compare this with BP [ʔfav(i)] *chave* ‘key’ > Max /cahap/ [tʃahaʔp]. As will be illustrated in Section 4.2, the latter word is the lengthened version (/cahap/) of an intermediate */cap/, after deletion of the word-final vowel in the BP input sequence. In contemporary Maxacali the only form in use is /cahap/, which cannot be shortened.

analysis of nasality in general; for example, one in which coda consonants are not triggers but targets of nasal spreading. In order to shed light on this question, we will turn to a set of Maxacalí words that are of Brazilian Portuguese (BP) origin. In particular, we will see how BP words that contain nasal vowels and/or nasal consonants are integrated in the Maxacalí sound system. Accordingly, a short excursus into the phonology of nasality of BP is necessary.

The BP system of consonantal phonemes is much more complex than the Maxacalí one, as table (22) shows:

(22) BP Consonantal Phonemes

Labial	Alveolar	Palatal	Velar
p	t		k
b	d		g
f	s	ʃ	
v	z	ʒ	
m	n	ɲ	
l		ʎ	
	ɾ		x

The lateral [l] is pronounced [ω] in the syllable coda of the large majority of BP dialects. The alveolar tap [ɾ] and the velar fricative [x] are in complementary distribution, except intervocalically²² where they contrast: *caro* 'expensive' ['karu] ↔ ['kaxu]²³ *carro* 'car'. Word-initially, in the syllable coda, and syllable-initially following a consonant, only [x] occurs: ['xatu] *rato* 'rat', [max] *mar* 'sea', ['ʒeNxu] *genro* 'son-in-law'. The tap occurs as the second element of a complex onset, a position from which [x] is banned: ['krizi] *crise* 'crisis'. In the BP dialect that is spoken in the area where the Maxacalí live, [x] is pronounced [h]. The coronal stops /t, d/ are realized as the affricates [tʃ, dʒ] before [i]. In BP, nasal consonants contrast with both voiced and voiceless non-nasal stops in the onset of oral and (surface) nasal syllables: /paR/²⁴ *par* 'pair', /baR/ *bar* 'bar', /maR/ *mar* 'sea'; /paNda/ ['pãdɐ] *panda* 'panda', /baNda/ ['bãdɐ] *banda* 'band', /maNda/ ['mãdɐ] *manda* 'sends-3p'.²⁵ In the syllable coda, only sonorant sounds (glides, liquids, N) and /s/ are allowed.

22. In Wetzels (1997), the contrast between /ɾ/ and /x/ is represented phonologically as one between /R/ and /RR/, respectively, unspecified for place features. In positions where there is no contrast, /R/ is posited.

23. In these examples and henceforth, the symbol ' marks the following syllable as having primary word stress.

24. /R/ is predictably realized as either [x] or [ɾ], depending on its syllable position: *mar* 'sea' [max] ~ [maɾis] *mares* 'sea-PL'.

25. In the preceding examples, N represents a nasal mora not specified for place of articulation (see Wetzels (1997) for extensive discussion of nasality in BP).

BP has seven contrastive vowels under primary stress /i, e, ε, a, ɔ, o, u/. In unstressed position or when nasalized, the distinction between upper and lower mid vowels is neutralized. The phonetic quality of unstressed oral mid vowels is subject to dialectal variation, ranging between upper and lower mid, whereas nasal mid vowels are usually pronounced as upper mid. Two types of nasality must be distinguished for vowels. The traditional division is between ‘allophonic nasality’ and ‘contrastive nasality’, although, for both types, nasality is predictable from a following nasal consonant. Allophonic nasalization targets vowels before syllable-initial nasal consonants, as in /banana/ ‘banana’, which is pronounced [ba’nɛnɛ] or [bɛ’nɛnɛ], depending on the dialect.²⁶ Contrastive nasality results from the obligatory spreading of the [nasal]-feature from a nasal consonant (or mora) in the syllable coda to the preceding nuclear vowel, as in /kaNpo/ [kɛ̃pɔ] *campo* ‘countryside’ or /paNkada/ [pɛ̃kade] *pancada* ‘hit’.²⁷ Moreover, BP has a number of nasal diphthongs, the most frequent of which is [ɛ̃ɔ̃], as in /televizãũ/ [televi’zɛ̃ɔ̃] *televisão* ‘television’. Nasality thus appears to be a pervasive feature of both the source and the borrowing language. Nevertheless, the differences in the surface distribution of both oral and nasal sounds are considerable. As we have just seen, BP shows a free distribution of the different consonant types (oral or nasal) in the onset. Also, the nasality of a syllable nucleus is not contingent on a (surface) nasal coda, as in the first syllable of [kɛ̃.pɔ] < /kaNpo/ *campo* ‘countryside’. On the assumption that the productive constraints of Maxacalí phonology are somehow visible in the process of nativization of BP words, the way in which the sounds and sound sequences of BP are adapted to the phonotactic structure of Maxacalí should allow us to verify the correctness of the rules proposed by GPP and Rodrigues.

Above it was observed that the Maxacalí consonant system lacks liquids and supralaryngeal fricatives. When these sounds occur in BP loans, liquids and /f, v/ are changed into plosives, whereas BP [s, ʃ, tʃ, z, ʒ, dʒ] are usually pronounced as affricates, such that [s, ʃ, tʃ] correspond to Maxacalí [tʃ] and BP [z, ʒ, dʒ] correspond

26. The difference in pronunciation is characterized in terms of different conditions on the spreading rule, which is stress-sensitive in some dialects and stress-insensitive in others. In the dialect spoken by the non-indigenous populations in the area where the Maxacalí live, allophonic nasality is obligatory for stressed vowels and optional for unstressed ones.

27. Hence, the term ‘contrastive’ must be interpreted here as ‘surface contrastive’. Nasalization of the syllable nucleus is obligatory before a nasal consonant coda and the nasal consonant is usually not pronounced, creating surface contrastive pairs like [kɛ̃pɛ] *capa* ‘bell’ vs. [kape] *capa* ‘cape’ or [mɛ̃te] *manta* ‘blanket’ vs. [mate] *mata* ‘forest’ (the centralization of nasalized /a/ is predictable in BP). If contrastive nasality is derived from a partially specified nasal consonant in the syllable coda as proposed here, nasal spreading is obligatory, regardless whether the target is stressed or stressless.

to Maxacalí [d³] in contexts where these affricates exist as (prevocalic) allophones of the palatal stops /c, ʃ/. In the syllable coda, these segments are borrowed as stops. In the process of nativization, BP consonants that are foreign to Maxacalí preserve their place of articulation. BP [r, l] become [t, d, n] and [f, v] become [p, b, m], while the choice of laryngeal and manner features is to a large extent determined by their position in the Maxacalí syllable and the nature of the syllable nucleus (be it oral or nasal). Interestingly, the nucleus from a BP loan in Maxacalí will be nasal if the BP source has a nasal nucleus and/or a nasal onset. As it turns out, the laryngeal (voiced or voiceless) specification of the BP coda consonant never accounts for the oral or nasal character of the syllable nucleus in the corresponding Maxacalí word. The words in (23) illustrate the different ways in which BP [f, v] are adapted in Maxacalí. The starred examples involving the variables X and/or Y represent sequences that contain [f, v] in contexts not attested in the borrowed vocabulary. They show how we would expect these consonants to be adapted based on the treatment of other BP consonants, as demonstrated below.

- (23) a. BP [f] ~ Max [p]
 i. before oral and nasal nucleus
 fogão [fu'gãõ] ~ [pu^hgãm] 'stove'
 *XfVY ~ *XpVY
 ii. after oral nucleus
 garrafa [gahaf(ə)] ~ [ᵑga'hap] 'bottle'
 b. BP [f] ~ Max [m]
 after nasal nucleus
 *XVf ~ *XVm
 c. BP [v] ~ Max [(^m)b]
 before oral nucleus
 vaqueiro [va'kejɾ(ə)] ~ [(^m)ba'ket] 'cowboy'
 canivete [kani'vetʃ(i)] ~ [kudi'bet] 'pocketknife'
 d. BP [v] ~ Max [m]
 i. before nasal nucleus
 *XvVY ~ *XmVY
 ii. after nasal nucleus
 *XVv ~ *XVm
 e. BP [v] ~ Max [p]
 after oral nucleus
 chave [ʃ'av(i)] ~ [tʰa'hap]²⁸ 'key'

28. The word [tʰa'hap] is a lengthened form. See Footnote 21.

In the process of nativization, the BP word-final vowel is usually deleted when unstressed, which is why these vowels are put in parentheses in the BP examples above and below. When the BP word ends in a nasal diphthong, the final vowel is often interpreted as the vocalized surface manifestation of an underlying nasal consonant, as can be observed for the words *fogão* 'stove' [fu'gɔ̃ɔ̃] → Max [pu^hgã̃m] or [pu^hgã̃^hm], as well as in *calção* 'shorts' [kaɔ̃'sɔ̃ɔ̃] → Max [kot'tʃã̃m]. Also, a word-final syllable that is stressed in BP may be closed with a consonant in Maxacali, as in *café* 'coffee' [ka'fɛ] → Max [ka'pɛc]. The corresponding pairs in (23) show that the labial fricatives of BP are nativized as labial stops. The laryngeal specification is preserved in the process of borrowing except when it conflicts with the phonotactic constraints of Maxacali. This is clear from the example in (23e), where, in the absence of any language-specific distributional restrictions, one would expect *[tʰa'hab] instead of [tʰa'hap]. In conformity with the constraint expressed as (14) above, only voiceless stops may close a syllable containing an oral nucleus, which explains why [b] is borrowed as its voiceless counterpart [p] in this word. This example is particularly revealing, because, on the basis of Rodrigues' analysis of nasality, one would expect the voice character of /b/ in the hypothetical form */cab/ to be crucial in the adaptation process, as one observes for word-initial voiced consonants, as in [ᵐboj] < BP *boi* 'ox' or [ᵑgahap] < BP *garrafa* 'bottle', [ᵑdʒɛdʒuɲj] < BP [ʒɛ'zujs] *Jesus*, where voicing automatically triggers prenasalization. We would therefore expect BP *chave* ['ʃavi] to appear as *[cã̃m] (or *[cã̃h̃m] by lengthening), which would be in full agreement with the phonotactic requirements of Maxacali, but, from the perspective of the oral/nasal distinction, in the opposite manner. As it turns out, the determining factor in the nativization of the word ['ʃav(i)] is the orality of the syllable nucleus, not the voicedness of the coda consonant. The same treatment of BP voiced consonants can be observed in the words provided in (24), where the relevant segments appear in boldface:

(24)			BP		Maxacali
a.	Maxacali	'Maxacali'	[maʃaka'li]	~	[mãtʰaka'dij]
	Gabriel	'Gabriel'	[gabɾi'ɛɔ̃]	~	[gabidi'et]
	relógio	'watch'	[he'lɔʒ(iə̃)]	~	[he'doc]
	retrato	'picture'	[hetɾat(ə̃)]	~	[heta'dat]
b.	martelo	'hammer'	[mah'tɛl(ə̃)]	~	[ᵐbah'tɛt]
	vaqueiro	'cowboy'	[va'ke(j)r(ə̃)] ²⁹	~	[ᵐba'ket]
	(na)feira	'market'	[na'fe(j)r(ɐ̃)]	~	[nã'pɛt]

29. The optional monophthongization of the diphthongs /ej/ and /aj/ is a process that occurs throughout Brazil. It happens most frequently before /r/, but also before the palatal fricatives

c.	compadre	'godfather of my child'	[kũ'padr(i)]	~	[ko'pat]
	soldado	'soldier'	[soʊ'dad(ʊ)]	~	[tʃo'dat]
	Margarida	'Margarida'	[mahga'rid(ɐ)]	~	[mãʲga'dit]
	capado	'castrated pig'	[ka'pad(ʊ)]	~	[ka'pat]

The examples in (24a) show that [l, r] appear as voiced coronal stops in the onset of syllables with an oral nucleus. When these sounds occur in the coda after an oral vowel they are devoiced, in conformity with constraint (14), as can be seen in (24b). As expected, the same occurs with syllable-final BP [d], as in the words in (24c).

We conclude that the nativization of BP words in Maxacalí shows that nasality in this language is not derivable from the [+voice] specification of a (non-nasal) coda consonant. We must therefore consider other options, for example, that nasality is a lexical property of consonants, as proposed by GPP. In this analysis, the underlying representation of a word like [muñuñnnāmtit] 'goat' would be /muɲuɲnnamtit/. Nasal coda consonants trigger nasal harmony and nasal onsets are transparent for spreading. Since leftward spreading is independently necessary to account for alternations like [ce] ~ [cēnān], this possibility is worth considering. However, under this analysis, it would still not be possible to account for the nasal vowels in words that have no coda, such as *nānā* 'uncle', *nōā* 'finish', and others, as in (19a,b) above. One may next consider the hypothesis that nasality spreads bidirectionally: right-to-left, to account for words like *pām* 'bread' and for alternations like [ce] ~ [cē+nān]; and left-to-right, from a nasal onset to the following nucleus (and coda) in words like *nānā* 'uncle', *nōā* 'finish'. Left-to-right spreading is moreover suggested by the borrowings in (25) below, where we observe that when a BP syllable has a nasal onset, even in the presence of an oral nucleus, the syllable containing it appears as entirely nasal in Maxacalí, while eligible BP voiced and voiceless consonants indiscriminately appear as nasal coda consonants.

(25)		BP		Maxacalí
	comércio	'city center'	[kõ'mɛhs(iə)]	~ [kõ'mɛ̃n]
	tomate	'tomato'	[tũ'matʲ(i)]	~ [tõ'mã̃n]
	janela	'window'	[ʒĩ'nɛl(ɐ)]	~ [tʲĩ'nɛ̃n]
	caneta	'ballpoint'	[kã'net(ɐ)]	~ [kã'nɛ̃ɲ]
	carneiro	'sheep'	[kah'ne(j)r(ʊ)]	~ [kah'nɛ̃n]
	remédio	'medicine'	[he'mɛdʒ(iə)]	~ [heh'mɛ̃n]

Yet, one would not wish to conclude on the basis of the way the BP words in (25) are adapted that nasality is a lexical property of onset consonants in Maxacalí.

/ʃ, ʒ/, and more frequently in stressed syllables than in unstressed ones (for discussion and references, see Wetzels 2007).

The reasons for rejecting this hypothesis are several. One is that there would be no explanation for the nasal vowels in words like those below:

- (26) [hã^mbedac] ‘sell’
 [ʔã^mbuk] ‘wind’

In the words in (26) there is no nasal onset (nor a nasal coda³⁰) from which nasality could spread. Furthermore, if nasal onset consonants were underlying and were allowed to spread their nasality to their right, it would not be possible to account for the complementary distribution between voiced non-sonorant consonants, which occur exclusively in the onset of oral syllables, and nasal consonants, which are prohibited in this environment (cf. words like *kabah* ‘also’, *kadap* ‘scatter’, and the words in (26), among many others). As a matter of fact, the voiced consonants in these words, if derived from an underlying nasal consonant, show that there can be no rightward nasal spreading, because the spreading of nasality to the tautosyllabic vowel would bleed the rule of consonant denasalization. Let us therefore consider the possibility that nasality is contrastive in vowels.

The BP words that are part of the corresponding sets provided below contain at least one nasal vowel or diphthong.

(27)		BP	Maxacalí
a.	quinhentos ‘five hundred’	[kĩ'ñēt(ωs)]	~ [kĩ'ñēn]
b.	macarrão ‘pasta’	[maka'h3ō]	~ [mākā'hām] (= /mā'+kām/?)
c.	feijão ‘beans’	[fej'ʒ3ō]	~ [pē'nōn]
d.	tucano ‘toucan’	[tu'kân(ω)]	~ [to'kân]
e.	calção ‘shorts’	[kaω's3ō]	~ [kot't'ām]
f.	santo ‘saint’	['sāt(ω)]	~ [t'ân]
g.	compadre ‘godfather of my child’	[kũ ^m padr(i)]	~ [kõm'pat]

From the point of view of the distribution of nasality, the BP word in (27a) represents a perfect Maxacalí word, except for the voiceless consonant following the nasal nucleus, which must be changed into the corresponding nasal stop. The BP word in (27b) is adapted to Maxacalí in a way that suggests that [h] is transparent. However, this conclusion might not be warranted, because the word could be interpreted as being derived from a monosyllabic morpheme underlyingly, as indicated. The activity of nasal spreading is particularly observable in (27c), where the nasal feature that is restricted to the word-final vowel in the BP noun is spread throughout the corresponding noun in Maxacalí, affecting all segments except the initial voiceless consonant. The word pairs in (27d–g) show the blocking effect of

30. For the prenasalization of [b] in these examples, recall our earlier discussion following the example set in (19a).

Maxacalí words.³² This comes as a surprise if Maxacalí has a productive rule that denasalizes nasal consonants in the onset of oral syllables, as was suggested by GPP. To be clear, there are some rare examples in which BP nasal onsets are oralized in Maxacalí, as in the examples below:

(31)		BP		Maxacalí
	martelo	‘hammer’	[mah'telə]	~ [(^m)bah'tet]
	canivete	‘pocketknife’	[kani'vetʃi]	~ [kuudi'bet]

The fact that similar BP words are nativized in different ways shows that the borrowing process is primarily oriented towards making BP surface patterns unknown to Maxacalí compatible with the phonotactics of that language. The words in (29–31) do not necessarily show that either denasalization or left-to-right nasal spreading from syllable onsets are productive processes of Maxacalí phonology, but only that these are alternative strategies to repair ungrammatical surface sequences. Clearly, the preferred strategy is the nasalization of the oral vowel that is tautosyllabic with the BP nasal onset. In other words, confronted with a BP syllable containing a nasal onset and an oral nucleus, the Maxacalí speaker interprets the nasal onset as an indication of the nasality of its nucleus. This is what one would expect if nasality is contrastive in vowels and if spreading occurs from right to left. Note also that in the words in (30), only the vowel immediately to the right of the nasal consonant appears as nasal in Maxacalí. It is clearly not the case that the nasal feature is ‘set afloat’ in order to dock on the rightmost nasalizable segment in a sequence that does not contain a voiceless consonant. Were this true, we would expect, for example, the Maxacalí form corresponding to BP [ma'rizɐ] ‘Marisa’ to be [mā'nĩɲā], rather than [māⁿdĩɲa]. The attested outcome for [ma'rizɐ] is the one we would expect in view of the fact that in Maxacalí a nasal span may be followed by an oral span, as in the words /muĩtik/ ‘with’, [ʔā^mbuihu] ‘wind’, etc. The repair that is applied is minimal, but sufficient to bring the sequence [ma'rizɐ], and others like it, in agreement with the phonotactic requirements of the language.

5. A different analysis of nasality in Maxacalí

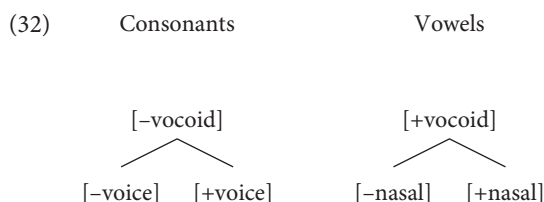
From the way in which BP words containing nasal segments are adapted to the sound structure of Maxacalí, we have concluded that nasality is a contrastive feature

32. Notice that given the words in (30), the allophonic nasality of the pretonic vowels in the BP words in (29) becomes irrelevant for the explanation of the nasality in the corresponding Maxacalí words. It could be claimed that in the Maxacalí words the complete nasal span is derived from the (hypothesized) nasality of the stressed vowel, by coda nasalization and leftward spreading.

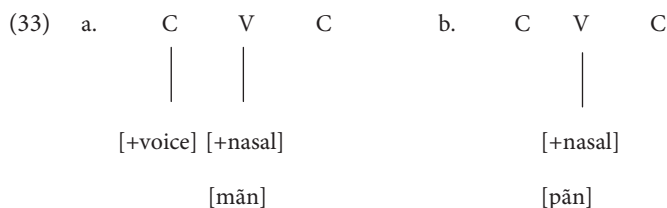
of Maxacalí vowels. We will show next that this hypothesis is sufficient to account for the surface distribution of this feature in both vowels and consonants in the native and borrowed vocabulary of Maxacalí.

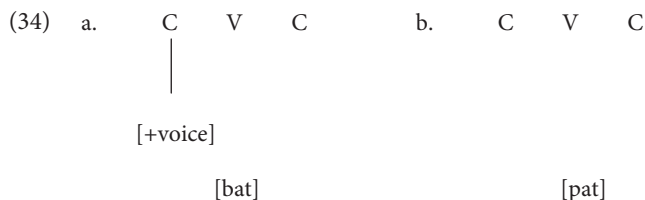
In the analysis proposed below, we assume that predictable features are not part of the underlying phonological structure, but are provided when necessary in the course of the phonological derivation or by the phonetic component (cf. Clements, 2001). We will moreover dispense with unmarked features and feature specifications as long as they are not phonologically active in the grammar or in a specific part of the grammar that is, for independent reasons, distinguished from other parts.

We have seen above that Maxacalí has a series of voiceless consonants and a series of phonemes that has both voiced non-nasal and nasal consonants as its surface allophones. Taking into account the fact that nasal consonants surface only as onsets and codas of nasal nuclei, nasality for consonants is a predictable feature. Voiced and voiceless consonants contrast as onsets of oral syllables and vowels contrast for nasality. Furthermore, Maxacalí has no liquids or fricatives. Disregarding place of articulation in consonants and vowels as well as aperture distinctions in vowels, the remaining contrastive features of Maxacalí are presented as in (32):

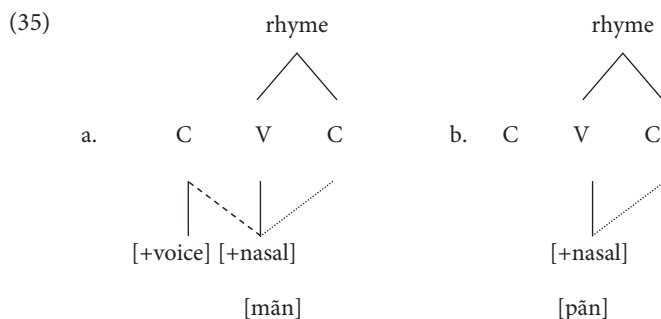


Notice that the major category features [approximant] and [sonorant] are not distinctive in Maxacalí. Moreover, in the syllable coda the opposition between voiced and voiceless consonants is neutralized: a [−vocoid] segment in the coda of a syllable containing an oral nucleus will be realized as a voiceless stop, whereas in the coda of a syllable containing a nasal nucleus, it will surface as a nasal consonant. Dispensing with the unmarked and phonologically inactive features [−voice] and [−nasal], we can set up a lexical representation in which syllables that surface with a nasal vowel are lexically represented as either (33a) or (33b), and syllables that surface with an oral vowel as either (34a) or (34b), where C represents a [−vocoid] segment, V a [+vocoid] segment:





To derive the proper distribution of surface nasal consonants and vowels, we must posit two spreading mechanisms. One, indicated with a dotted association line in (35), spreads nasality from left to right and assures that syllable rhymes are always entirely oral or entirely nasal; and the other, indicated with a striped association line in (35a), iteratively spreads nasality from right to left predicting that possible targets to the left of a nasal vowel always surface as nasal.



The proposed analysis explains why words with a nasal syllable immediately preceded by an oral vowel, nasal syllables with a voiced non-nasal onset, and syllable rhymes that disagree in nasality do not occur. However, an explicit analysis of Maxacalí nasality must account for more. If nasal vowels really had a free distribution, we would expect to find, apart from words like #kacuñ# ‘like this,’ #muñtik# ‘with,’ or #mājññ# ‘sun,’ words of the type # $\tilde{V}C_1\tilde{V}C_2\#$, where C_1 is a voiceless consonant. The non-occurrence of such (non-derived) words shows that each morpheme contains only a single instance of the [+nasal] feature. It follows that morphemes containing more than a single nasal sound are the result of [+nasal]-spreading from a unique segmental source, a nasal vowel in the case of Maxacalí.³³

33. Some surface exceptions to this generalization exist, as the word [mōcãn] ‘to arrive (plural subject)’. However, these words can generally be shown to consist of more than one morpheme. For the case at hand, compare [mōcaha] ‘to arrive,’ [mōcakuc] ‘to enter (plural subject),’ [mōkpok] (</mōñpok/) ‘to send,’ [mōñgāhā] ‘to lead’. From these and other words we establish the presence of a morpheme /mōñ/, which also occurs independently in Maxacalí, meaning ‘to go’.

In light of the preceding discussion, we establish the relevant parameters that account for the surface distribution of nasality in Maxacalí as given in (36):

(36) Relevant parameters for Maxacalí nasal harmony^{34 35}

trigger	nasal vowels	nasal vowels
domain	word, as defined earlier	syllable rhyme
direction of spreading	left-to-right	(right-to-left)
target condition	[C, +voice] ³⁴	C
spreading mode	iterative	(non-iterative)
adjacency	strictly local *N / \ VCV	(strictly local)
OCP	* N N (domain: 'morpheme')	
feature co-occurrence restrictions ³⁵	*ŋ	none

In (36) we follow Peng (2000) and Clements & Osu (2001) for the set of relevant spreading parameters, except that we have defined a target condition for consonants, whereas these authors have chosen for the definition of a class of blocking segments. Nasal harmony in Maxacalí has all the properties of a lexical phenomenon. Our choice to define a class of targets instead of blockers is a consequence of our decision not to specify phonologically inactive features and because, in this part of the phonology of Maxacalí, no rule appears to refer to the feature [–voice]. The absence of vowels from the definition of the set of target segments follows from the general observation that when a language activates a spreading constraint for the nasal feature and when voiced consonants are targets, all segments that are higher on the sonority scale are included in the class of target segments. The conjunction of the locality condition which prohibits non-adjacent nasal consonants, with the OCP, which restricts [+nasal] to one instances per morpheme explains the ungrammaticality of hypothetical (morphologically underived) *#kăcũŋ# on

34. Notice that, in an analysis that would specify voiceless segments with a lexical [–voice] feature, it is possible to limit the target of nasal spreading to just C and to obtain the blocking effect of voiceless consonants through a feature co-occurrence restriction * [+nasal, –voice].

35. Interestingly, [ŋ] does not usually occur as the onset of a nasal nucleus, instead [ŋg] is found: [ŋgõp] ‘to smoke’.

the assumption that well-formed nasal spans are dominated by a single [+nasal] feature. Since the nasality in both syllables of *#kācũɲ# cannot result from spreading - the intervocalic voiceless consonant blocks nasal harmony - this word could only be derived from two tauto-morphemic instances of the nasal feature, a situation prohibited by the OCP. Notice, finally, that the parameters concerning the spreading of nasality in the syllable rhyme are either irrelevant or derivable from the domain specification (rhyme).

6. Discussion and conclusion

Maxacali is one of the numerous indigenous South American languages that lack an opposition between non-sonorant voiced stops and plain nasal consonants. Instead, this language establishes a phonetic relation between voicing and nasality through a process of nasality spreading from contrastively nasal vowels to voiced segments.³⁶ In this paper, we have shown that the hypothesis of a phonological contrast between nasal and oral vowels is necessary and sufficient to account for the distribution of nasality at the phonetic surface. The plausibility of the proposed analysis was reinforced by the manner in which BP words are borrowed into Maxacali, in particular by the way in which BP consonants were made to fit the severe restrictions on the shape of Maxacali coda consonants, by reference to the orality or nasality of the nuclear vowel.

- (37) ...**Ṽ**N##
 ...**Ṽ**T## ...**V**T##
 ...**Ṽ**D## ...**V**D##

Of the most frequent input sequences to the Maxacalí nativization procedure given in (37),³⁷ only the boldfaced ones have a direct correspondent in Maxacalí phonotactics. The other three must be adapted for two reasons: First, because nasality vs. orality is homogeneous within the (surface) rhyme; and second, because voiced consonants only occur as onsets of oral syllables. If nasality were predictable from the contrastive voice feature in coda consonants in a system without phonological nasal vowels, we would expect BP voiced consonants in this position to be realized

36. The same surface co-occurrence of voice and nasality is observed in the optional process of word-initial prenasalization of voiced stops followed by an oral vowel.

37. Recall that in the BP input these word-final sequences usually end in a vowel which is deleted in the borrowing process. A BP sequence ...VN(V)## could only be exceptionally part of the input to the nativization process because stress is predominantly prefinal in BP, and, consequently, the left vowel would be obligatorily nasal.

as nasal. One could object to this view by referring to the fact that adaptation strategies do not always mimic the rule system of the language, and that the change VD → VT could be an alternative (and maybe even simpler) way of repairing the illicit input structure. If this were true, one would have to explain why $\tilde{V}T\#\#$ and $\tilde{V}D\#\#$ are not nativized by undoing the nasality of the vowel, a feature which is non-contrastive in a grammar where nasality is derived from non-sonorant voiced consonants. On the other hand, the hypothesis of contrastive nasality for vowels allows us to straightforwardly predict how all BP rhymes are adapted to the nasal/oral categorization of Maxacalí on the basis of the existing underlying vocalic contrasts and rules of the language. We therefore conclude that the nasal segments and sequences in native words that cannot be derived from voiced coda consonants are not exceptions but counterexamples to the claim that surface nasality in Maxacalí is derived from non-sonorant voiced consonants in the coda.

We have found no cases of words borrowed from BP in which coda consonants are adapted to fit the distributional restrictions of Maxacalí without reference to the orality/nasality of the tautosyllabic vowel.³⁸ This is not always the case for BP nasal onset consonants as there are examples that remain unadapted. We also observed that sometimes a nasal onset consonant is oralized instead of the nucleus being nasalized, though this occurs exclusively in unaccented syllables. The BP words found in our loanword corpus in which nasal consonants are onsets of unstressed syllables appear in (38) below.

(38)		BP		Maxacalí
	martelo	'hammer'	[mah'telɔ]	~ [(^m)bah'tet]
	canivete	'pocketknife'	[kani'vetʃi]	~ [kudi'bet]
	Maxacalí	'Maxacalí'	[ma'aka'li]	~ [mãtʃ'aka'dij]
	Marisa	'Marisa'	[ma'rizɐ]	~ [mã ^m diʒa]
	Margarida	'Margarida'	[mahga'rid(ɐ)]	~ [mã ⁿ ga'dit]
	macarrão	'pasta'	[maka'hɜ̃ɔ]	~ [mãkã'hãm] (= /mã'kãm/)
	(na)feira	'market'	[na'fe(j)ɾ(ɐ)]	~ [nã'pet]
	(no)posto	'post'	[no'pɔst(ɔ)]	~ [nõ'pɔc]

In most unstressed syllables, Maxacalí follows the same nativization strategy as in stressed syllables. Few examples were encountered in which a nasal onset was oralized, i.e., BP /NV/ becomes Maxacalí /DV/ instead of /N $\tilde{V}$ /. It is not entirely clear why the first two words in (38) follow a different adaptation pattern. Maybe the slight nasalization of the postnasal vowel in BP /NV/ syllables is actually fully

38. Directly, as in *santo* [sãt(ɔ)] → [tʃãn] 'saint', or indirectly, as in *tomate* [tũ'matʃ(i)] → [tõ'mãn] 'tomato', through the reanalyzed sequence /to'bãC/ with a nasal vowel.

perceived by the native speakers of Maxacalí³⁹ in stressed syllables, but less so in unstressed syllables. Another possibility for the recurrent nasalization of the stressed vowels as opposed to the less frequent nasalization of unstressed vowels could be the perceptibly higher saliency of the nasal onset in stressed syllables. In unstressed syllables either of the strategies could be equally likely, the preference for the nasalization of the nuclear vowel being an artifact of our small sample.

Independently of what the correct explanation is, the way *martelo* ‘hammer’ and *canivete* ‘pocketknife’ are nativized shows that Maxacalí speakers are aware of the vocalic oral/nasal contrast of BP words, even in contexts in which it does not occur in their own language. Similarly, the non-sonorant voiced consonants are perceived as such by Maxacalí speakers before nasal vowels, where they do not occur in Maxacalí words, as in the words listed in (39):

(39)		BP		Maxacalí
feijão	‘beans’	[fe'ʒɜ̃õ]	~	[pe'ʒõŋ]/[pẽŋõŋ]
televisão	‘television’	[televi'zɜ̃õ]	~	[tedebi'dʒãŋ] * [tẽnẽmĩ'ɲãŋ]
fogão	‘stove’	[fu'gɜ̃õ]	~	[pu'ŋgãŋ]
laranja	‘orange’	[la'rɜ̃ʒɐ]	~	[n'da'dãĩ] * [nã'nãĩ]
Lourenço	‘Lourenço’	[lo'rẽsõ]	~	[n'do'dĩŋ] * [nõnĩŋ]
João	‘João’	[ʒõ̃ɜ̃õ]	~	[ʒõ'ãŋ] * [ɲõ'ãŋ]

In borrowings like BP *sabão* [sa'bɜ̃õ] → Max [t'ã'mãm] ‘soap’, BP *feijão* [fe'ʒɜ̃õ] → Maxacalí [pẽŋõŋ] ‘beans’, or BP *comércio* [kõ'mɛʃ(iõ)] → Maxacalí [kõ'mẽŋ] ‘shop’, sequences of voiced segments undergo R→L nasal harmony just as in the native vocabulary of Maxacalí. Aside from the expected [pẽŋõŋ] for ‘beans’, the form [pe'ʒõŋ] also exists and a number of words were encountered that, given leftward harmony, are nativized irregularly. Indeed, the words in (39) show that non-sonorant voiced stops create exceptions to nasal harmony in BP loans.

From the discussion above, we conclude that nasal consonants, voiced oral consonants, and oral vowels are interpreted as such by Maxacalí speakers even in contexts in which they do not occur in Maxacalí. From this perspective, it is relevant to recall that exceptions to rightward spreading do not exist. This discrepancy may be due to the fact that in Maxacalí segments like /p, b/ contrast in the onset of oral syllables, while those like /p, m/ contrast in the onset of nasal syllables (at least superficially). On the other hand, consonants in the syllable coda only contrast for place of articulation. In other words, in the syllable onset, speakers are trained

39. João Moraes (p.c.) pointed out that this slight nasalization of postnasal vowels really exists in BP without being perceived by BP native speakers. It is unclear if the degree of phonetic nasality is different in stressed and unstressed syllables.

to recognize the cues distinguishing /p, b, m/ as relevant to the interpretation of their corresponding lexical phonological categories, which is not the case for the manner and laryngeal features that occur in the syllable coda, where voicelessness and nasality are purely articulatory categories. Should this interpretation prove correct, this would provide evidence for the non-specification analysis proposed above.

BP sounds are directly mapped onto the very limited set of Maxacalí distinctive features and thus distinctions like [$\pm$ approximant], [$\pm$ sonorant] and [$\pm$ continuant] that are non-contrastive in Maxacalí are ignored. During the nativization process, specific features may be deleted or transferred to force illicit sequences to conform to Maxacalí phonotactics. In the BP word *martelo* [mah'telɔ] → [(^m)bah'tet] 'hammer', BP [ma] is (exceptionally) reanalyzed as underlying /ba/ in Maxacalí, whereas, generally, BP [NV] is reanalyzed lexically as Maxacalí /D̃/. In the syllable coda, BP consonantal distinctions other than place of articulation are ignored and realized according to the requirements of the phonological grammar of Maxacalí. As to the nativization of non-sonorant voiced onsets, exceptions are created suggesting that in the borrowed vocabulary the set of target segments for leftward nasal harmony has become restricted to vowels. To the extent that the number of such 'irregular' loans increases and these words come to be perceived as genuine Maxacalí words, the contact with BP will introduce a contrast between /p, b, m/ into the language.

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