

NASALIZATION PROCESSES IN LUNG'IE

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- **ABSTRACT:** This study describes and analyses vocalic nasality triggered by nasal elements in codas and onsets in Lung'ie, a Portuguese-based Creole spoken in São Tomé and Príncipe. We observed the language's phonotactic behavior and investigated the occurrence of vocalic nasalization processes according to their segmental and suprasegmental aspects. In this regard, we considered the lexical stress and the possibility of segmental resyllabification. We designed a perceptual test in order to identify the way in which coda nasality was perceived by native speakers. By omitting a consonant in the onset position of the next syllable in relation to the nasalized syllable, speakers interpreted the nasal appendix as a full consonant [n]. The nasal consonant in the coda was therefore resyllabified into an onset position. This syllabic restructuring is an indication of a biphonemic interpretation of nasality in Lung'ie (AGOSTINHO, 2015; BALDUINO et al., 2015; BANDEIRA, 2017). The phonotactic analysis indicates lexical stress as an essential factor in the performance of the nasalization process triggered by an onset. On the other hand, nasalization processes triggered by the coda are possible in stressed and unstressed syllables. The importance of the stress in the application of this process supports a mixed suprasegmental system in Lung'ie constituted by lexical stress and tones, albeit stress is the primary suprasegmental category (AGOSTINHO, 2015).
- **KEYWORDS:** Nasality. Lung'ie, Suprasegments. Stress.

Introduction

This study aims to describe the processes of nasal codas and nasal onsets in Lung'ie (ISO code 639-3: PRI). Based on a study by Moraes (2003) on vowel nasality in Brazilian Portuguese (BP), we also seek to discuss the phonological status of nasality spreading from coda. Thus, we intend to present a phonological analysis of

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this process by comparing previous discussions (AGOSTINHO, 2015). Lung'le (LI) is a Portuguese-based Creole language spoken in the Democratic Republic of São Tomé and Príncipe.¹ According to Agostinho (2015), LI has a mixed tone and stress system. Mixed prosodic systems have been described in the literature (HYMAN, 2014), however, they are sparsely studied (MICHAEL, 2011), and continue to represent descriptive and theoretical challenges (HYMAN, 2006).

In phonological terms, vocal nasality is basically interpreted in two ways: (i) as a phonological process triggered by a nasal consonant or (ii) as phonological vowels (MORAES, WETZELS, 1992; MEDEIROS, 2007). We will focus on the nasalization process promoted by a nasal consonant in this theoretical review.

As a result of spreading a nasal feature from a tautosyllabic or heterosyllabic consonant, vowels may have the [+nasal] feature. In general, even though the process is the same, acoustic differences underlie the phonetic correlates of different types of nasalization. In vocal nasality caused by a nasal onset, there is no segmental loss, nor is the murmur identified. Moreover, from the point of view of duration, the vowel nasalized from coda position, precisely because it contains a part equivalent to the nasal appendix, tends to be longer in relation to the vowel nasalized by onset. Because nasal vowels present a low value for the first formant as a result of the elevation of the mandible during the production of nasality, they are even shorter compared to oral vowels (MORAES; WETZELS, 1992, for BP; BALDUINO, 2018, for Santomense Portuguese (STP) and Príncipe Portuguese (SP)). Finally, in their production, these types of nasalization respond, distinctly, to lexical contrast and lexical stress. In general, coda-driven nasality produces a distinct meaning among opposing pairs, and it does not depend on lexical prominence, whereas this is an essential factor for the application of onset nasalization in Portuguese (see CÂMARA JR, 1970; WETZELS, 1997; MIGUEL, 2006). Based on this discussion, this study aims to describe and discuss the phonotactic distribution of nasalized vowels in LI, focusing on the entire nasalization process, whether promoted by a coda or by an onset. In order to do so, we will consider previous studies that agree with the presence of [+nasal] vowels in LI in relation to nasality triggered by codas however differ in respect of the phonological interpretation attributed to that phenomenon. In general, for Maurer (2009), nasality is interpreted as a phonological feature. Works such as those of Agostinho (2015), Balduino *et al.* (2015) and Bandeira (2017) interpret it as a biphonemic unit, formed by the underlying structure /VN/. Thus, this study analyses the manifestation of this phenomenon based on different LI data. It also seeks to evaluate, via perceptual tests, how LI speakers identify this type of nasalization, based on the role of the nasal murmur in this judgment. Finally, for nasalization triggered by onsets, we agree with Agostinho (2015) on the importance of lexical stress in delimiting its application. Considering, then, LI's linguistic ecology, we intend to describe and analyses the nasality triggered by nasal codas and onsets in this language.

¹ Part of the discussion presented here is in Agostinho's doctoral thesis (2015).

This article is divided into three sections. In section **Lung'le in context**, we explain the social and linguistic context of LI. In section **The process of nasalization in Lung'le – Discussion**, we present the methodological procedures and describe the phenomenon of vowel nasalization, presenting a phonological analysis for two nasalization processes in LI. Finally, the final considerations are presented in the last section.

Lung'le in context

São Tomé and Príncipe (STP) is a multilingual country on the west coast of Africa. Besides Portuguese, the official language of the archipelago since 1975, three native languages are spoken there: Santome (ISO code 639-3: CRI), Angolar (ISO code 639-3: AOA) and LI. Kabuverdianu (code ISO 639-3: KEA) was brought to the islands of STP at the end of the 19th century and throughout the 20th century. Among the native languages, whereas Santome and Angolar are spoken on the island of São Tomé, LI is primarily spoken in Príncipe Island (or Príncipe, as it is referred to by the local population).

Príncipe Island is located 140 km northeast of the São Tomé Island and 200 km from the west coast of Africa. It has a population of 7,542 (INE, 2012). The origin of LI is linked to the process of colonization by the Portuguese Crown in the early 16th century. Initially, the Portuguese based proto-Creole of the Gulf of Guinea (PGG) emerged on the island of São Tomé. Later, this language branched out, giving rise to four daughter languages: Santome (ST), Angolar (AN), LI and Fa d' Ambô (ISO code 639-3: FAB). Thus, having been brought to Príncipe Island and due to because of isolation and new African languages input, PGG evolved to LI (BANDEIRA 2017), a linguistic instrument of a new ethnic group, the Principense (BANDEIRA, 2017). Nowadays, LI has few native speakers and it is classified as an endangered language. Agostinho (2015) affirms that less than 200 people, all over 60 years of age, speak the language and there are no more monolingual speakers.

The decrease in the number of LI speakers dates to the early 20th century, when the island was affected by an epidemic of sleeping sickness. During this epidemic outbreak, the mainstream population was decimated. Solely about 300 people remain (MAURER, 2009). Simultaneously, the expansion of cocoa crops on the island generated a demand for labor in rural agro-industries built in Príncipe. Colonial lords imported a substantial contingent of hired workers, primarily from the Cape Verde Islands (BANDEIRA, 2017). As a result, the number of LI speakers not only suffered a drastic reduction but it was also pressured by the Kabuverdianu language spoken on the island by such hired workers and later by their descendants. For this reason, there are now more Kabuverdianu than LI speakers in Príncipe. In addition to this historical issue, the decrease in the use of LI can be associated with a social scenario in which all natives' languages have little prestige. Portuguese is the official language of STP and has

therefore high prestige in the country. It exerts great pressure on other national languages and promotes an increasing abandonment of these languages (CHRISTOFOLETTI, 2013; BALDUINO, 2018). However, in recent years, Agostinho, Bandeira and Araujo (2016) have pointed out that the attitude of the LI speech community has been modified due to the support of the Regional Government. The link between language and identity has been promoted. Consequently, the awareness that LI reflects the ethnic-cultural heritage of the inhabitants of the island of Príncipe is widespread even among younger generations. Thus, the local population had the opportunity to see their language in prestigious situations such as cultural events, weekly radio broadcasting of programs spoken in LI and by teaching the language in schools on the island, which use LI frequently in various social settings (AGOSTINHO; BANDEIRA; ARAUJO, 2016).

The process of nasalization in Lung'le – Discussion

In this section, we describe vowel nasalization processes from nasal codas and onsets. Both processes are optional, triggered by a [+nasal] consonant and restricted to syllabic rhyme—that is, they fall upon the nucleus and the offglides. However, despite such similarities, some differences are also perceptible. Vowel nasalization of a nasal coda is tautosyllabic. It may produce a distinction of meaning, it occurs regardless of lexical stress, and the nasal consonant in coda is often deleted, which supports the analysis of nasalized vowels as nasal vowels (i.e., as phonological units, see MAURER, 2009). On the other hand, vowel nasalization due to a nasal onset does not promote the deletion of the consonant that spreads the nasality feature. It surpasses the syllabic border and can therefore be heterosyllabic or tautosyllabic depending on the lexical stress. This section describes and proposes a phonological analysis for both nasalization processes. Thus, in subsection **Nasal from coda [+nasal]**, we focus on vowel nasalization induced by a nasal coda, sustaining a biphonemic interpretation of nasality, by which we assume the inexistence of intrinsic nasal vowels in LI. In subsection **Nasal vowel from [+nasal] onset**, we focus on the description of vowel nasality triggered by a nasal onset. These phenomena were analyzed according to a multi-level perspective of the language because non-linear factors, such as the syllable and the stress, are crucial for the phenomenon. Thus, based on autosegmental phonology (GOLDSMITH, 1976, 1995) and CV phonology (CLEMENTS; KEYSER, 1983) we will present a formal representation of these processes.

Methods and corpus

The *corpus* of this study consists of spontaneous speech recordings and controlled speech collected in Príncipe. By means of speech-controlled data, nasalization processes from codas and onsets were identified and analyzed using vehicle sentences. These sentences were *Ê faa X dôsu vêsê* ('I speak X twice') and *Ê faa X momoli* ('I speak X

softly’), where X was replaced by the target lexical item that contained the nasalized vowel. The sentences were repeated three times by each informant, and the first round of repetitions was discarded. In total, we worked with the recordings of four informants, all Príncipe natives and LI speakers.

For the description of vowel nasality in LI, we also considered data taken from the spontaneous speech *corpus* of Agostinho (2015). We observed the application of the process considering segmental order factors—such as the direction of nasal spreading and the segments co-articulated to the nasalized vowel—and suprasegmental factors, such as lexical stress, tone and the domain of the syllable to which the processes are applied. Based on the patterns identified by describing the phenomenon, we used vehicle sentences to verify which factors acted on the nasalization process, allowing its specification into (i) nasalization from a coda, and (ii) nasalization from an onset. Both processes have the same nature, but they present some singularities in their application.

Finally, in order to contribute to the discussion surrounding the definition of the status of vowel nasality in LI, and as a basis for comparison with Moraes (2003) study on BP, we applied a perceptual test. This test was performed based on speech data whose nasality, according to our interpretation, derived from a syllabic coda, as in (1):

- (1) a. /fiNta/ [‘fĩtɐ] ~ [‘fĩntɐ] ~ [‘fintɐ] ‘jink, evasion’
 b. /kaNta/ [kɛ̃ˈta] ~ [kɛ̃nˈta] ~ [kanˈta] ‘to sing’
 c. /kaNsa/ [kɛ̃ˈsa] ~ [kɛ̃nˈsa] ~ [kanˈsa] ‘to tire’
 d. /kaNsu/ [‘kɛ̃sʊ] ~ [‘kɛ̃nsʊ] ~ [‘kansʊ] ‘asthma’

The preparation of the material for the application of the perceptual tests was performed using Praat software (BOERSMA; WEENICK, 2015). At the first step, we recorded the repetition of the vehicle sentence *Ê faa X momoli* (‘I speak X softly’) by a LI speaker. Subsequently, we used the tool to cut and extract the consonant in the syllable onset following the target structure from the audio. Thereafter, we digitally deleted the phone [t] of the word /fiNta/ [fĩtɐ], for example. We then presented the already modified lexical items to LI speakers. They were asked to reproduce what they heard. Based on these reproductions, we observed whether the informants’ perceptions suggested the presence of a fully performed nasal consonant as in [‘fĩnɐ] or the presence of a phonological nasal feature of the vowel /ĩ/, corresponding to the perception [‘fĩɐ]. The first option corroborates the biphonemic interpretation of nasality, indicating the absence of phonological nasal vowels in LI, whereas the second option attests the existence of intrinsic nasal vowels.

Nasal from coda [+nasal]

Maurer (2009), due to the existence of vowel nasality in LI and the possibility of a distinction of meaning in relation to the segmental opposition between [ṽ] and [v], assumes the presence of nasal vowels in this language. Agostinho (2015), based

on the phonotactic behaviour of LI, refutes this assumption. According to Agostinho (2015), there are no minimum pairs of the type /ã/ and /aN/ in LI. In addition, in some contexts, the opposition between an oral and a nasalized vowel is not able to change the meaning between the nasalized and the non-nasalized lexical item (AGOSTINHO, 2015), which would characterize vowel nasality in this language as biphonemic /VN/, that is, promoted by a nasal coda. This view is corroborated by Agostinho (2015), who, by empirically analyzing the contrast between the durations of nasalized and oral segments, has found that the vowel nasalized by a coda is recurrently longer than its oral counterpart, suggesting that [ṽ] is composed by the duration of /VN/ (AGOSTINHO, 2015).

The investigation of this phenomenon, based on data collected through fieldwork conducted in Príncipe, reveals that the duration lengthening is not the only phonetic correlate of /VN/ in LI. There is also the possibility of producing a homorganic nasal consonant in coda, as well as the non-nasalization of the vowel which is adjacent to the [+nasal] consonant. Because the nasal consonant in the coda is always homorganic, its place of articulation is determined by the place of articulation of the coda. Therefore, the node equivalent to the Place of C is shared with the node of the Place of C of the following consonant, thus promoting the spreading of [labial], [coronal] or [dorsal] feature, which becomes associated with /N/. The process of nasalization, promoted by a syllabic coda, then occurs when the nasal tautosyllabic archiphoneme² /N/ nasalizes the vowel that precedes it, spreading [+nasal] to the left. This type of nasalization is applied independently of the tone, and it may indicate differences in meaning between oral and nasal vowels, as demonstrated in (2).

- (2) a. /fita/ ['fitɛ] 'band' - /fiNta/ ['fitɛ] 'jink, evasion'
 b. /kadja/ [ka'dja] 'prison' - /kaNdja/ [kê'dja] 'oil lamp'

The establishment of the minimum pairs in (2) occurs solely due to the opposition between the nasalized vowel and the oral vowel in either a stressed context—in which there is the opposition between [i] and [ĩ] (2a)—or in a pretonic context, which is marked by the opposition between [a] and [ẽ] (2b). However, this contrastive condition is not observed in every nasalized vowel due to a nasal coda. Therefore, items such as *glutan* [glu'tẽ] 'glutton', devoid of a minimum pair established by an oral vowel in contrast to a nasalized vowel, are also identified.

According to Günther (1973), nasalized vowels solely occur without the nasal consonant in word final context, or preceding fricatives or liquids: [la'vĩ] 'ship', [fĩ'ʒi] 'pretend', [õra], 'honour'.³ In other contexts, the nasalized vowel occurs with a homorganic nasal consonant, or the vowel becomes oral and occurs with a homorganic

² We use /N/ to represent the subspecification of nasal phonemes within a coda, since the nasal consonant does not have a defined place of articulation in this context.

³ Transcriptions of Günther (1973, p. 37): “[lavĩ]; [fĩʒi] and [õra].”

consonant: [ˈmẽndu]~ [ˈmendu] ‘fear’.⁴ Maurer (2009) argues that [+nasal] vowels can be performed as nasal in all contexts but that nasalization is not mandatory. For the author, the word ‘pão’ (‘bread’) can be performed as [ũˈpẽ], [ũmˈpẽ] or [umˈpẽ].⁵ On the other hand, in our analysis, we found that nasalization before /N/ is mandatory in vowels preceding such a consonant at the word’s edge, but it is optional if the vowel preceding /N/ is not at the word’s edge. The performance of the homorganic consonant is always optional, as shown in (3).

- (3) a. /kaNsa/ [kẽˈsa] ~ [kẽnˈsa] ~ [kanˈsa] ‘to tire’
 b. /kɔsaN/ [kɔˈsẽ] ~ [kɔˈsẽŋ], *[kɔˈsaŋ] ‘heart’

(3a) is an example of a nasal in word-medial context /kaNsa/, which can be performed in three ways: a nasalized vowel [kẽˈsa], a nasalized vowel + a homorganic nasal consonant [kẽnˈsa] and an oral vowel + a homorganic nasal consonant [kanˈsa]. On the other hand, /kɔsaN/, in (3b), which has /N/ in word-final context, can be performed in two ways: as a nasalized vowel [kɔˈsẽ] or as a nasalized vowel + a nasal consonant [kɔˈsẽŋ]. The form oral vowel + homorganic nasal consonant *[kɔˈsaŋ] is not possible. In LI, unstressed syllables bearing nasalized vowels in word-final position were not identified.

The examples in (3) present the nasalized vowel in syllables with distinct lexical prominences, which could indicate that, in fact, the stress prevents the non-nasalization of [ẽ] in (3b). However, considering data such as /ubaNku/ [uˈbẽŋkɔ]~[uˈbaŋkɔ] ~ [uˈbẽkɔ] ‘bank’ (4)—in which the possibility of non-nasalization is observed even when the target vowel of the phenomenon is positioned in the prominent syllable of the word—we confirm that the nasalization block occurs due to the right border of the word and not due to lexical stress.

The context marked by the sequence: vowel, nasal coda and voiceless stop consonant favors the non-performance of the process, considering nasal spreading from the nasal coda. In these cases, [ṽ] or [vN] may occur phonetically, as pointed out in (4).⁶

- (4) a. /ubaNku/ [uˈbẽŋkɔ] ~ [uˈbaŋkɔ] ~ [uˈbẽkɔ] ‘bank’

Based on the distinct outputs of the vowels nasalized by syllabic codas, we can formalize the process considering (i) nasal spreading to the preceding vowel with the maintenance of the nasal consonant in coda provided there is assimilation of the place

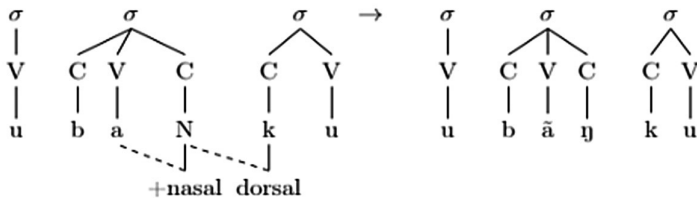
⁴ Transcription of Maurer (2009, p. 8): “[mẽndu] ~ [mẽndu] ‘fear’.”

⁵ Transcription of Maurer (2009, p. 8): “[ũpã], [ũmpã] and [ũmpã].”

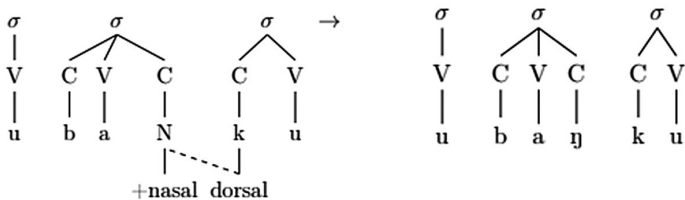
⁶ The word /uNa/ ‘one’, performed phonetically as [ˈũa]~[ˈwã]~[ˈũwa], is an exception because, in this single case, the nasal consonant in the coda of the first syllable is performed inside the word and nasalizes the rhyme obligatorily. It may also be a rare case of vowel nasality lexicalization, which is suggested to occur in BP by Wetzels (2000). The author argues in favor of the hypothesis that all nasal diphthongs of BP have a lexicalized high nasal vowel. In the sister language Santome, the word <ũa> (ARAUJO; HAGEMEIJER, 2013) also has a *sui generis* behavior in relation to general nasality, as in Lung’Ie.

of articulation of the next consonant, which will incur variability of the nasal consonant depending on the dorsal, coronal or labial consonant; (ii) the maintenance of the nasal consonant in coda, whose place of articulation is assimilated from the homorganic consonant, but without the regressive spreading of nasality to the vowel; and (iii) nasal spreading followed by deletion of the nasal consonant in coda without assimilation of the place of the next consonant. The possibilities are represented in (4). In the example (5a), we identified the possibility of vocalic nasality plus the maintenance of the nasal coda. In this case, in addition to the vowel assimilating the nasal feature of the coda, the coda itself assimilates the place of articulation of the next consonant, performing it as a homorganic nasal. In (5b), on the other hand, we observe optionality in nasalization in word-medial context. In this example, the vowel is not nasalized, but the coda manifests itself as a homorganic nasal. Finally, in (5c), the nasal spreading to the previous vowel and the deletion of the coda in the segmental layer are demonstrated. As a result of this deletion, the nasalized vowel becomes longer because it corresponds to two temporal units (AGOSTINHO, 2015).

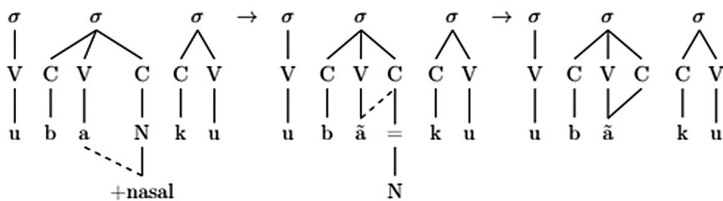
(5) a. /ubaNku/ [u'bẽŋkɔ] 'bank'



b. /ubaNku/ [u'baŋkɔ] 'bank'



c. /ubaNku/ [u'bẽkɔ] 'bank'



In the example (5c), we argue that the segmental deletion of /N/ does not imply time syllabic loss, and therefore the syllabic durations of CVN or C[̃v] are equivalent. The lengthening in duration (AGOSTINHO, 2015) and the segmental performance of the coda, identified in the data analysis, point to the existence of a temporal unit within the syllabic structure that corresponds to the coda position. Thus, considering the possibility of the phonetic manifestation of a nasal coda in data such as examples (5a) and (5b), we then assume that there is first a regressive spreading of the nasality to the right vowel and then a deletion of /N/. The homorganic performance of /N/ acquiring the place of articulation of the consonant in a subsequent onset indicates that this phoneme is sub specified. Therefore, the nasal segment /N/, albeit not having its place of articulation licensed by the coda, holds a temporal unity and is resyllabified in the rhyme, more specifically in the syllabic coda, and it shares the place of articulation of the following onset.⁷ Therefore, with respect to the domain of application, we conclude that nasalization triggered by a nasal coda occurs in the rhyme domain (i.e., in the nucleus and the coda). Thus, the segments that can be nasalized are vowels and offglides. In (6), we can observe nasalization in offglides.

- (6) a. /treN/ [ˈtrẽ] ~ [ˈtrẽ̃] ‘train’
 b. /oleN/ [oˈlẽ] ~ [oˈlẽ̃] ‘beyond’
 c. /obeN/ [oˈbẽ] ~ [oˈbẽ̃] ‘goods’

Based on the lexical items discussed in (6), we note that /N/ spreads its nasality to the nucleus vowels in [oˈlẽ] ‘beyond’, [oˈbẽ] ‘goods’ and [ˈtrẽ] ‘train’. However, it can also nasalize the offglide [j] of the words in question produced subsequently in the phonetic output.⁸ In contrast, onglides cannot be nasalized in the syllable coda

⁷ The subspecification of such a segment can be observed in the realization of the first person singular morpheme /N/, which occupies the nucleus of the syllable, performed as [ũŋ] and [ĩŋ] or as a syllabic nasal that assimilates the place of articulation of the next consonant and can nasalize the vowel that precedes it when it occurs after the verb, such as in [ˈdãŋ kwiˈse]. In this position, the first-person singular morpheme can also be realized as [ˈmi], as in [ˈdaˈmi kwiˈse]. The nasal consonant can be performed phonetically as syllabic, not triggering vocalic nasalization in these cases. On the other hand, when it is performed as a non-syllabic consonant, it behaves as a coda of the phonetic syllable; therefore, it nasalizes the vowel of the nucleus that precedes it, as in (1). Another possible analysis is to consider that the syllabic nasal begins as a pre-nasalization of the consonant.

- (1) a. /da N kwise/ [ˈda ŋ kwiˈse] ~ [ˈdãŋ kwiˈse] ~ [ˈdã kwiˈse] ‘give me this’
 /da N dɔfi se/ [ˈda ŋ ˈdɔfi ˈse] ~ [ˈdãŋ ˈdɔfi ˈse] ~ [ˈdã ˈdɔfi ˈse] ‘give me this candy’

Maurer (2009) and Günther (1973) do not mention the velar nasal [ŋ] in their works. Maurer (2009) describes the first-person pronoun in this position as <n>, adding that Günther uses the form <m>. According to the author, his informants reject the form <m>, accepting solely [n], as in *da n kêtê* or *da mi kêtê*, but not *da m kêtê*, ‘give me the little one’. In our data, however, the velar nasal [ŋ] appears before velars [k] and [g] in these cases. Thus, [m] would solely appear before labial consonants [p, b, w]. We observe that the nasal consonant will assimilate the place of articulation of the subsequent consonant. It is therefore performed as [n] preceding coronal consonants, such as [m] before labial and as [ŋ] before velar consonants.

⁸ Concerning the nasalization of offglides, we can cite the example of /ukuru kajNkajN/ [uˈkuro kɛ̃j kɛ̃j] ‘very dark’, a multilexical unit of LI. We note that, in this case, the syllable is closed in phonological form by a glide (G) and a nasal coda (N). This goes against the syllabic pattern of LI, which does not admit two elements in coda (cf.

because they are positioned in the onset, and they are therefore outside the domain of application of the nasalization rule. This block is indicated in (7), in which we observe the impossibility of applying the process other than to the rhyme.

- (7) a. /bɛtu waN/ [ˈbɛtu ˈwẽ], *[ˈbɛtu ˈwẽ̃] ‘very open’
 b. /ljaN/ [ˈljẽ], *[ˈljẽ̃] ‘lion’

Günther (1973) also proves this by demonstrating sandhi with diphthongization within the phonological phrase in which the onglide is not nasalized because [swẽ're] is possible, but not *[swẽ̃'re], because nasalization is restricted to rhyme, as indicated in (8):

- (8) a. /suN are/ [swẽ're] ‘sir, the king’

The nasality promoted by the nasal coda in LI is regressive. Thus, at first, /N/ could nasalize the vowel /u/ of /suN/. However, the application of vowel sandhi promotes a syllabic restructuring, and therefore /u/ is phonetically an onglide [w] in the syllable onset and, consequently, being outside the domain of application of the nasalization process. Therefore, the sandhi process triggers the change of the vowel to the onset, the [nasal] remains in the rhyme, and with the subsequent docking of [a] to the nucleus, the context for the nasalization of the rhyme element, [ẽ], is created.

As for long vowels, because they are in the rhyme, the nasalization is normally spread, as indicated in (9):

- (9) a. /ubaaNku/ [uˈbẽ:ku] ~ [uˈba:ŋku] ‘white’

The fact that nasalization spreads in the two vowels suggests that they should be considered part of the nucleus of the same syllable, because the word /kaiN/ cannot be *[kẽ̃ĩ] but solely [kẽĩ], which demonstrates that the nasalization does not extend beyond the syllable border and that LI has long vowels. In addition to the phonetic reflexes of the nasalization process analyzed, it was determined that the nasalization of the vowel [ẽ] preceding /N/ can generate a diphthongization process. In these cases, if the vowel [e] preceding the nasal consonant is a nasalized, there is epenthesis of the glide [j], which is also nasalized by the consonant /N/ because it is in the rhyme.

AGOSTINHO, 2015). In our corpus and in the literature, no phonological syllables of the type (C)VGN or even (C)VGC were identified. The only exception is the ideophone /kajNkajN/. Bartens (2000) argues that ideophones may present phones that do not belong to the phonology of the language, as well as syllabic structures differing from those of their phonotactics, violating the phonological and phonotactic rules of the languages. However, Araujo (2009) states, in respect of ST, a language related to LI, that ideophones obey the general system of the language. Because /kajNkajN/ is an ideophone and the solely case of a complex coda found in our corpus, we will consider this case exceptional.

- (10) a. /treN/ [ˈtrẽ] ~ [ˈtrẽ̃] ‘train’
 b. /oleN/ [oˈlẽ] ~ [oˈlẽ̃] ‘beyond’
 c. /obeN/ [oˈbẽ] ~ [oˈbẽ̃] ‘goods’

Another recurring process involving the nasal coda corresponds to its final deletion before nasal spreading; thus, the vowel remains oral. This deletion is limited to the final stressed syllables, as we can see in (11):

- (11) a. /ozeN/ [oˈzẽ] ~ [oˈze] ‘knee’
 b. /iNpiN/ [ĩ ˈpĩ] ~ [ĩ pi] ‘thorn’

According to (11), final deletion is optional, and both forms are accepted by the informants without any change in meaning. However, coda deletion is not reserved for the word border. In a pretonic syllable, nasal coda deletion can also be verified in word-medial context, as discussed in (12):

- (12) a. [kẽˈta] ~ [kaˈta] ‘to sing’
 b. [lẽˈta] ~ [leˈta] ‘to enter’

According to Selkirk (1982), the syllabic coda is highly susceptible to changes, such as deletion, and to dialectal variation because it corresponds to a weaker position within the syllabic structure (SELKIRK, 1982 *apud* PEDROSA; HORA, 2010). According to Pedrosa and Hora (2010), the possibility of variation occurs in any position within the word, but it is more stressed in the final position. Thus, on the possibility of triggering the deletion of the coda in the word boundary, Hora, Pedrosa and Cardoso (2010) observe that “[...] the final position of the word is extremely weak, so it avoids consonant segments. Moreover, whichever segment occupies this position, there is a strong tendency to erase it or, still, to seek the CV standard” (HORA; PEDROSA; CARDOSO, 2010).⁹ Thus, the non-nasalization of final segments may result from the absence of nasal spreading to the tautosyllabic vowel, which is elided before the re-association of the [+nasal] feature to the vocalic node. In LI, the *locus* of this deletion, whether in the border or the middle of word, is related to lexical stress: the first type of deletion is restricted to stressed syllables, whereas the second is applied in pretonic syllables.

In summary, we observe that the phenomenon of vowel nasalization from a nasal coda can produce different outputs which, in general, reflect the bi-phonetic structure of the process. Thus, vowel nasalization through a nasal coda:

⁹ Original: “[...] a posição final de palavra é extremamente débil, por isso evita segmentos consonantais. Ademais, qualquer que seja o segmento que ocupe essa posição, há uma forte tendência a seu apagamento ou, ainda, à busca pelo padrão CV.” (HORA; PEDROSA; CARDOSO, 2010, p. 78).

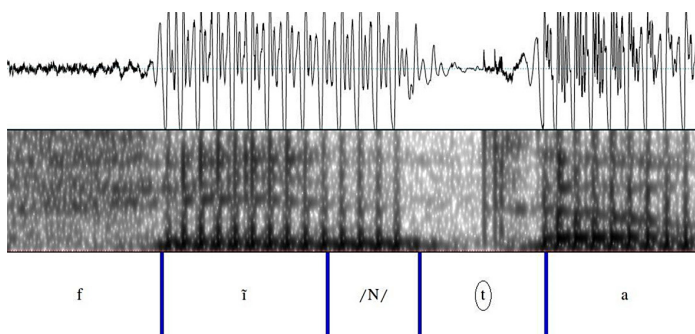
(13)

- (i) does not depend on lexical prominence for its application;
- (ii) may or may not produce a distinction of meaning via minimum pairs;
- (iii) is mandatory in word-final context;
- (iv) is optional in word-medial context, and its non-production is favored by the oral vowel segment + a homorganic consonant + a voiceless occlusive consonant;
- (v) can be manifested through the nasalization of the adjacent vowel by the presence of a homorganic nasal coda or, simultaneously, by phonetic reflexes;
- (vi) demonstrates a regressive nasal spreading;
- (vii) is limited to the rhyme domain;
- (viii) may not occur if /N/ is elided from the coda before the nasal spreading in word-final position;
- (ix) can produce diphthongization of the mid vowel [e] by insertion of [j] into the word border.

Next, the discussion on the status of vowels nasalized by a nasal coda is expanded. In order to do so, we base our discussion on the perception of informants, native LI speakers, in relation to digitally modified lexical items.

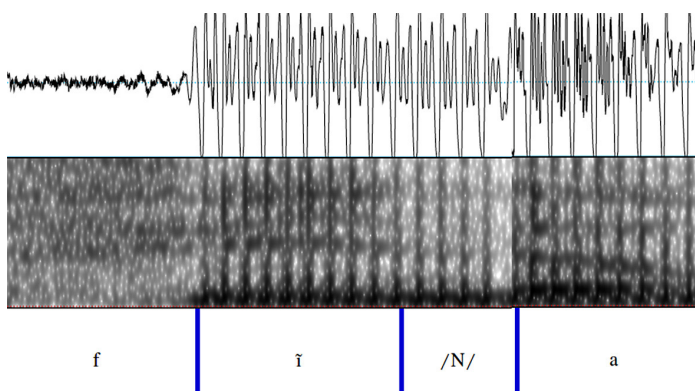
In agreement with the results identified by the description of data, we investigate the perceptual relevance of vowel nasality for the biphonemic interpretation of the tautosyllabic nasality in LI. Thus, we work with electronically modified lexical, stressed and pretonic items, and we submit them to the judgment of four speakers. The preparation of the material for the perceptual tests was performed using the element trimming tool of the Praat software (BOERSMA; WEENICK, 2015), which allowed us to extract the consonant in the syllable onset following the target structure. Therefore, we digitally deleted the phone [t] of the word /fiNta/ ['fitə], for example. This process can be visualized by the spectrogram in Figure 1, in which the segment [t] is delimited by the silence that precedes the explosion of the occlusive and by the explosion itself. In addition, we observe that the consonant [t] is preceded by an appendix or nasal murmur marked by /N/ in the spectrum.

Figure 1 – Spectrogram of **fin**ta /fiNta/ [ˈfĩtɐ], ‘jink, evasion’



Source: Authors' elaboration.

Figure 2 – Modified spectrogram of **fin**ta for [ˈfĩnɐ]

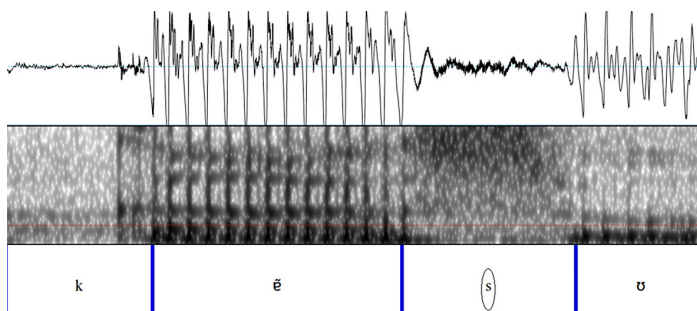


Source: Authors' elaboration.

The nasal appendix, in the spectrograms of Figures 1 and 2, corresponds to a lighter band than [ĩ]. It is characterized by an abrupt loss of energy, whereas an F2 equivalent to the vowel becomes virtually imperceptible. Its presence has been interpreted as the phonetic correlate of an underlying nasal consonant in the position of syllable locking (BARBOSA; MADUREIRA, 2015). By applying the test, we attempt to verify how this appendix is interpreted by the LI speaker, whether it is considered as a nasal consonant, resulting in the perception of [ˈfĩnɐ], or whether it is still perceived as a nasal feature of the vowel [ĩ], corresponding to the perception [ˈfĩtɐ]. According to Moraes (2003), the first alternative would indicate that /N/ is, in fact, perceived as heterosyllabic, indicated by the presence of a nasal consonant in the coda that is resyllabified into a full onset consonant. On the other hand, if the second alternative is confirmed, the appendix would correspond to an acoustic transition from a nasal vowel to an oral consonant [t], thus justifying the monophonic interpretation of nasality (MORAES, 2003).

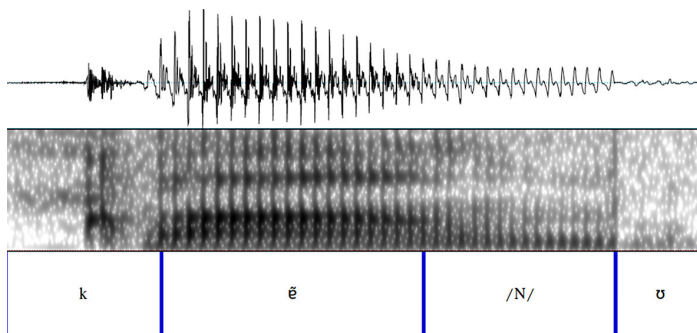
Thus, we note that, according to Moraes (2003), the nasal appendix plays a fundamental role in the characterization of vowel nasality from coda in Portuguese. Corroborating this point of view, some authors characterize the nasal vowel acoustically according to the coda by establishing two distinct phases: (i) an oral beginning, marked by an actual vowel production, and (ii) a nasal end, a *locus* in which the transition occurs for the nasal formants and the consequent production of the nasal murmur (DOMINGOS, 2011; BARBOSA, MADUREIRA, 2015). However, albeit the nasal murmur may be visible in the spectrogram, as in Figure 3, it is not always detected. In general, in Portuguese, the lexifier language of LI, in which the nasalized vowel is succeeded by fricative consonants, the appendix is not identified spectrally (CAGLIARI, 1977; SEARA, 2000; MEDEIROS, 2007; VALENTIM, 2009; ROTHE-NEVES; VALENTIM, 2012). In LI, the nasal murmur may or may not be produced before fricatives. With respect to the lexical items used in the test, they are always produced, as demonstrated by /kaNsu/ [ˈkẽsʊ] (Figure 3), where the F2 of [ẽ] extends to the last vowel pulse. However, prior to the production of the fricative [s], we observed a lighter part characterizing the murmur.

Figure 3 – Spectrogram of **kansu** /kaNsu/ [ˈkẽsʊ], ‘asthma’



Source: Authors' elaboration.

Figure 4 – Spectrogram modified from **kansu** to [ˈkẽnʊ]



Source: Authors' elaboration.

The presence of the nasal appendix in Figures 3 and 4 may reinforce the initial hypothesis, according to which the murmur is possibly perceived as a nasal consonant. Thus, we observe by the perception test that if this is the case, we also have data in which [ṽ] is followed by a fricative consonant. Then, the [s] of items such as /kaNsu/ ['kẽsɔ] was removed, and we verified whether, even without the murmur, there would be the possibility of /kaNsu/ being perceived as ['kẽnɔ], or whether LI speakers would perceive the nasality of the modified item as ['kẽu]. The lexical items used in the test contained nasalized vowels, but they did not have a phonetic nasal coda. In a substantial part of the data, the presence of the nasal appendix following [ṽ] was identified. The perceptions of the speakers are listed in Table 1.

Table 1 – Interpretation of nasality triggered by the coda /N/ in stressed and pretonic syllables

Lexical Item	Gloss	Perception			
		I	II	III	IV
fin[t]a	‘jink, evasion’	fi[n]a	fi[n]a	fi[n]a	fi[n]a
kan[t]a	‘to sing’	ka[n]a	ka[n]a	ka[n]a	ka[ni]
kan[s]a	‘to tire’	ka[n]a	ka[r]a	ka[n]a	ka[n]a
kan[s]u	‘asthma’	k[ẽn]	k[ẽn]	k[ẽn]	k[ẽ]
	TOTAL	04	03	04	03
	%	100	75	100	75

Source: Authors’ elaboration.

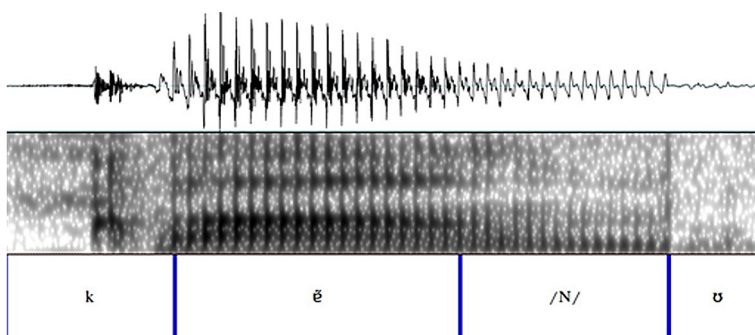
The data and their respective values shown in Table 1 demonstrate that, most of the time, LI speakers interpret nasality by coda as if it contains a nasal consonant, which, in the absence of [t] or [s], is resyllabified to the onset position, either in stressed or pretonic position. When considering all occurrences for each informant, we noticed that in 14 out of 16 cases or 87.5% of the time, the informants admitted the presence of a full nasal consonant onset in the lexical items. On the other hand, the data that escaped the standard of the resyllabification of [n] in the onset resulted from the perceptive judgment of informants II and IV.

Informant II interpreted the lexical item kan[s]a, originally [kẽn'sa], as [ka'ra]. Thus, even if we do not understand the presence of a [+nasal] segment, the speaker fills the onset position with the consonant [r], which shares the place of articulation with the onset [n], identified by the same speaker in other data. In this case, albeit the speaker does not interpret the nasal appendix as [n], he recognizes the existence of a consonantal item within the word; that is, the nasal appendix is conceived as a temporal unit within its internal structure. This fact by itself already constitutes evidence for the possibility of a biphonemic nasalization, because, by recognizing the presence of a segment, the speaker does not compute the nasal murmur as a non-phonological transition arising

from the phonemic nasality of the vowel, but as a segment positioned within a coda that is later resyllabified in an onset.

However, the informant IV maintained the vocalic nasality of kan[s]u ['kẽsɔ], interpreting the word as ['kẽ]; that is, the informant did not indicate the presence of a nasal coda, nor did he interpret the item as ['kẽw̃], as expected in the case of monophonic interpretation. For this same word, the only one ended in /u/ in the test, the other informants identified the nasal coda but did not resyllabify it as an onset, sustaining its position in syllabic locking. In all cases, we can observe the presence of a pattern: the systematic exclusion of /u/ in the perception of the speakers. Based on Figure 6, in which [s] was cut from the original kan[s]u, we note that this can be justified by devoicing [u].

Figure 5 – Spectrogram of kan[s]u digitally altered to ['kẽ (n) ɔ]



Source: Authors' elaboration.

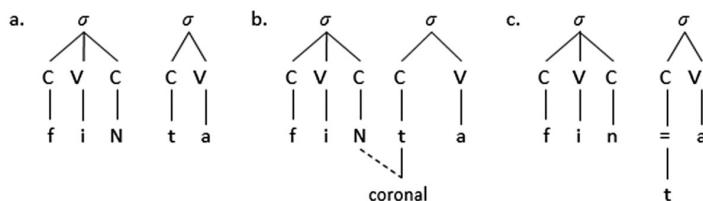
In Figure 5, we can observe, shortly after /N/, the voiceless [ɔ̥]. The voicelessness of this vowel may be due to a desynchronization triggered by the maintenance of the opening of vocal cords (CABRAL; RODRIGUES; CARVALHO, 2010), which is necessary for the articulation of the voiceless fricative [s]. The opening of vocal cords would then be maintained even during the production of the vowel that follows it, which would make it difficult for the speakers to understand it, resulting in the interpretation of ['kẽn] by most informants.

Otherwise, in respect of the informant IV, we can raise two explanatory hypotheses. The first hypothesis points to a monophonic interpretation, since ['kẽ] would thus be understood because [ẽ] corresponds to an intrinsic nasal vowel. In this case, the realization of the final vowel would be an essential evidence to the validity of such a premise, which does not occur. In a different way, the second hypothesis refers to the possibilities of *outputs* identified for the vocalic nasalization triggered by the syllabic coda in LI. In our data, all occurrences of /N/ in the final word coda nasalize the vowel to the left. This can be expressed with vowel nasalization + deletion of a nasal coda or by vowel nasalization + maintenance of a nasal coda, as in /kɔsɔN/ [kɔ' sɛ̃] ~ [kɔ' sɛ̃ŋ],

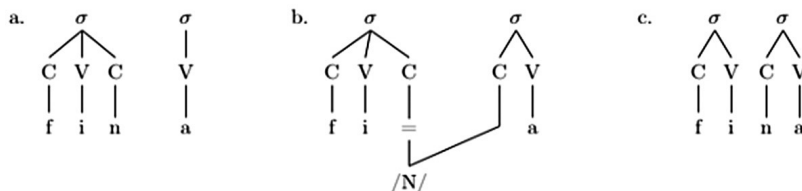
but not in *[kə'saŋ] ‘heart’. Since voiceless [u] is not understood by the speakers, there would be no possibility of resyllabification; therefore, informant IV would recognize the nasalization of the vowel provoked by the coda but would elide /N/ during its production, because this is a possibility of the language. This is corroborated by other interpretations attributed to the words modified by informant IV, which invariably entail the presence of a resyllabified nasal coda in an onset position. This last explanation, by combining other interpretations of the speaker himself and the phonotype possibilities of LI, is more plausible.

Considering the results obtained by the perception test, we then confirmed the biphonemic status of the vowel nasality from the syllable coda in LI. The resyllabification process is formalized in (14) and (15):

(14)



(15)



In (14a), the phonological representation of *finta*, ‘jink, evasion’, is presented. As can be noted, the first syllable is closed by a sub specified nasal coda /N/. This first form was manipulated by excluding the onset of the second syllable, as indicated in (14c). Thus, we expected the speakers to resyllabify it to CV.CV if they perceived a nasal coda, or to CV.V hiatus if the nasal was not perceived. However, the speakers resyllabify it as CV.CV, perceptually indicating a [coronal] nasal coda in the onset position (15b) and (15c). Thus, the fact that the speaker hears [‘fi.nɐ] demonstrates that, prior to resyllabification, [t] spreads the [coronal] feature to the coda before its actual deletion, which ceases to be sub specified, assimilates the same place of articulation of [t] and performs it as [n] (14b).

The phonotypic examination of the data in line with the perceptual test results indicate that one of the possibilities of vocalic nasality in LI is triggered by nasal coda. Next, we investigate the vocalic nasality produced from a nasal onset.

Nasal vowel from [+nasal] onset

The second type of nasalization is triggered in LI by a nasal onset, which can be occupied by one of the nasal consonants: [m], [n] or [ɲ]. In these cases, there is no difference in meaning between oral and nasal vowel performance in any case, such as in /mana/ ['mɛ̃nɛ] and ['manɛ] 'sister'. The nasal feature is not present in the phonological form of these vowels, and their nasalized performance comes from a nasal consonant onset of the same or the adjacent syllable, fully specified, and not from a nasal coda with no defined place of articulation. Thus, this second type of nasality can exceed the syllabic border, but it is still restricted to rhyme; that is, only segments of the same syllable or adjacent syllables that are within the rhyme may be nasalized. This type of nasality is always optional, and in contrast to the nasality produced from the coda, its spreading can be regressive or progressive.

Regressive spreading occurs towards the left. This process occurs in stressed vowels that precede a nasal consonant in the following syllable onset, as observed in (16):

- (16) a. /kama/ ['kamɛ] ~ ['kɛ̃mɛ] 'bed'
b. /afikanu/ [afi'kɛnɔ] ~ [afi'kɛ̃nɔ] 'African'
c. /kɔnɔ/ ['kɔnɔ] ~ ['kɔ̃nɔ] 'vagina'

In progressive spreading, the lexical stress conditions the application of nasalization from the nasal onset because, considering data such as /bana/ 'banana', nasalization does not occur in unstressed syllables such as [ba]. Thus, /bana/ 'banana' presents two possibilities of performance: without any kind of nasalization, as in [ba'na], or with the nasalization of the stressed syllable [ba'nɛ̃]. In general, in cases such as the latter, when the nasal spreading is progressive, we observe the spreading of the nasal feature of the consonant in onset nasalizing the stressed vowel to the right within the same syllable, as the examples in (17) demonstrate:

(17) a. /umwε/	[u'mwε] ~ [u'mwẽ]	'sea'
b. /unwa/	[u'nwa] ~ [u'nwẽ]	'moon'
c. /kanwa/	[ka'nwa] ~ [ka'nwẽ]	'canoe'
d. /nɔ/	['nɔ] ~ ['nɔ̃]	'3 rd person plural'
e. /bana/	[ba'na] ~ [ba'nẽ]	'banana'
f. /kumi/	[ku'mi] ~ [ku'mĩ]	'place, way'
g. /kajma/	[kaj'ma] ~ [kaj'mẽ]	'manioc gum'
h. /lema/	[lɛ'ma] ~ [lɛ'mẽ]	'to experiment'
i. /ɲa/	['ɲa] ~ ['ɲẽ]	'yes'
j. /ɲɛ/	['ɲɛ] ~ ['ɲẽ]	'to squeeze'
k. /kɔɲa/	[kɔ'ɲa] ~ [kɔ'ɲẽ]	'penis'
l. /gɪɲa/	[gi'ɲa] ~ [gi'ɲẽ]	'chicken'

In (17), it is possible to observe that, once again, differing from the nasality process triggered by a nasal coda, regardless of the type of place of articulation that characterized nasality in onset, nasality produced by nasal onset was not produced in unstressed syllables in our corpus. This demonstrates that the lexical stress should be taken into account in this language because, in the case of the analyzed process, this is a crucial factor in predicting the application of voiced nasality triggered by a nasal onset, as well as in distinguishing the origin of the nasalization processes, because the phenomenon promoted by the nasal coda will present a slightly different behaviour. This interpretation is reinforced in (18), in which we identified some data that illustrates the importance of the stress, pointing to the agrammaticality of vowel nasality in unstressed pre-final syllables.

(18) a. /kana/	[ka'na], *[kẽ'na]	'sugarcane'
b. /bana/	[ba'na] ~ [ba'nẽ], *[bẽ'na]	'banana'
c. /kama/	['kamɐ] ~ ['kẽmɐ], *['kamẽ], *['kẽmẽ]	'bed'
d. /ama/	['amɐ] ~ ['ẽmɐ], *['amẽ], *['ẽmẽ]	'nurse'

According to Maurer (2009), disyllabic names may contain four underlying tones: LL, HL, LH or HH.¹⁰ The words /kànà/ and /bànà/ have two low LL tones, and the word /kámá/ has two high HH tones according to Maurer (2009).¹¹ Because LL disyllabic words have a final stress - that is, the first syllable is unstressed - nasalization cannot be spread to the left in these words. However, the nasalization of an LL word can be spread to the right, as in the example /bana/, in which [bà'nẽ] is possible but not *[bẽ'nà]. In other words, it is not possible to explain the fact that [bà'nẽ] is possible and *[bẽ'nà] is not if we consider solely the tone and not the stress. The same is true for the word

¹⁰ H = high tone; L = low tone. No indication of tonicity, as in the original.

¹¹ All tonal notations were taken from Maurer (2009). It is worth noting that there is a disparity between the tonal patterns presented by other authors, such as Günther (1973) and Traill and Ferraz (1981).

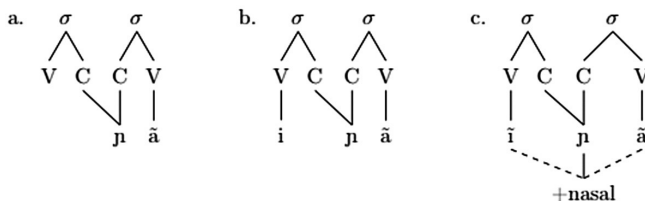
/kama/, in which [kəm̃] is possible but *[kàm̃] is not. Because nasalization of this type can be spread to the left and to the right, and because we can have nasalization to the left on an H syllable, why could not we have nasalization to the right of a syllable that is also H? Thus, the notion of stress is essential to understanding nasal spreading. In addition, the nasalization demonstrates that there is no pre-nasal consonant and that, in a nasal consonant + consonant sequence, each segment is in one syllable because it nasalizes unstressed syllables, necessarily forming part of the coda and not of the onset, because nasalization caused by this latter position is conditioned by the greater lexical prominence. For a discussion on tone and stress in LI, see Maurer (2009) and Agostinho (2015).

The solely identified case in which the unstressed vowel incorporates the nasalization of a nasal consonant occurs with pre-vocalization. In LI, the epenthetic vowel [i] optionally assimilates the nasality of the consonant in some words initiated exclusively by /ɲ/, as shown in (19):

- (19) a. /ɲɔ/ [ˈɲɔ] ~ [ˈɲɔ̃] ~ [iˈɲɔ] ~ [ĩˈɲɔ̃] ‘none’
 b. /ɲa/ [ˈɲæ] ~ [ˈɲɛ̃] ~ [iˈɲæ] ~ [ĩˈɲɛ̃] ‘yes’
 c. /ɲaNSi/ [ˈɲɛ̃fi] ~ [ĩˈɲɛ̃fi] ‘yes’

The vowel [ĩ] is nasalized because of the ambisyllabicity of [ɲ], because the onset would not nasalize the left vowel in an unstressed syllable.¹² In these cases, [ɲ] would be associated with both the onset position and the position of the coda, as shown in (20), resulting in a syllable formed solely by a coda, as indicated in (20a). Because of this syllabic formation, it would be possible to add an epenthetic element to the syllable to fill the nucleus position. This epenthetic element would be [i], as shown in (20b). The insertion of the epenthetic vowel, in the case of pre-vocalization, promotes a progressive and regressive vocalic nasalization because [ɲ] is ambisyllabic. Thus, [ɲ], as a coda, nasalizes the nucleic vowel [i], and, as an onset, nasalizes [a]. The result of this complex articulation is represented by the spreading of [+nasal] to the left and to the right in (20c).

(20)



¹² Wetzels (1997) proposed a similar analysis for Portuguese palatal consonants.

The regressive and progressive nasalization of the vowels surrounding [ɲ], as well as the insertion of [i] as an epenthetic vowel in the nucleus position, support the ambisyllabic nature of the palatal nasal consonant. The very nature of the nasalized [i] lies in the fission of the palatal consonant that projects a vowel node to the left (WETZELS, 1993). Moreover, in these cases of nasalization, there is also optionality. The ambisyllabic consonant may or may not spread the nasal feature to the prosthetic vowel [i] or to the vowel that occupies the nucleus of the next syllable. The nasality promoted by a coda, as long as /N/ is not present in word-final context, is optional in LI, and therefore [i] may or may not be nasalized. This optionality is still observed in the nasalization triggered by an onset.

By reanalyzing the data in (21), it is possible to identify that nasality in onset is triggered by different nasal consonants: /n/, /m/ or /ɲ/.

- (21) a. /kanwa/ [ka'nwa] ~ [ka'nwẽ] 'canoe'
 b. /bana/ [ba'na] ~ [ba'nẽ] 'banana'
 c. /kumi/ [ku'mi] ~ [ku'mĩ] 'place, way'
 d. /kajma/ [kaj'ma] ~ [kaj'mẽ] 'manioc gum'
 e. /ɲa/ ['ɲɐ] ~ ['ɲẽ] ~ [i'ɲɐ] ~ [ĩ'ɲẽ] 'yes'
 f. /kɔɲa/ [kɔ'ɲa] ~ [kɔ'ɲẽ] 'penis'

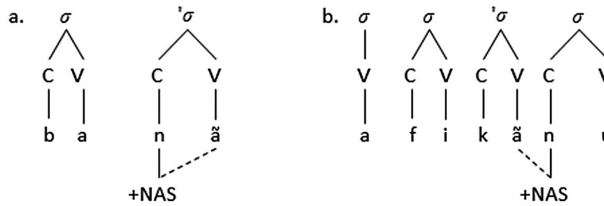
Because nasalization is promoted by a syllabic coda, the onglide is not nasalized, as in [ka'nwẽ], also restricting the vocalic nasalization triggered by an onset to the domain of the rhyme; that is, the onglide seems to be part of the onset, and therefore it is not a target (AGOSTINHO, 2015). Thus, the analysis presented here provides a generalization about the rhyme as a relevant domain to the nasality process in LI.

The analysis of the data that contained nasalized vowels from a syllabic onset leads us to conclude that such a process:

- (22)
- (i) occurs solely in stressed syllables and, therefore, the lexical stress is crucial for its establishment;
 - (ii) produces no distinction of meaning;
 - (iii) is optionally independent of the nasal consonant involved ([m], [n] or [ɲ]);
 - (iv) presents nasal spreading can be regressive or progressive, and the directionality of the process is determined by the lexical stress of the word;
 - (v) is limited to the rhyme domain.

Therefore, this process can be represented in (23), in which we first see the progressive nasalization of /a/ of the stressed syllable due to the spreading of the [ɲ] tautosyllabic segment in (23a), followed by the regressive nasalization of stressed /a/ due to the spreading of the heterosyllabic onset [ɲ] in (23b).

(23)



In any possibility of nasalization from the nasal onset, the nasal segment is maintained in the output. There is no segmental deletion, as predicted for the nasalization promoted by the coda /N/. The stress, in this case, will determine whether nasalization occurs, indicating that, as argued by Agostinho (2015), the suprasegmental system of LI is mixed and cannot be considered solely tonal, in contrast to the view of Günther (1973) and Maurer (2009).

Final remarks

The phonotactic analysis of the data and the results of the perceptual test corroborate the presence of two processes of vocalic nasality in LI due to the spreading of the nasal consonant feature: (i) vocalic nasality is triggered by a nasal coda, which is already described in the literature, and (ii) nasal onset-promoted vowel nasality, originally described here. Therefore, LI presents not phonological nasal vowels but nasalized vowels (AGOSTINHO, 2015; BALDUINO *et al.*, 2015; BANDEIRA, 2017).

According to the first type of nasalization, besides the possibility of different meanings in oral and nasal vowel performance—as in the words [fi'ka] 'to stay' and [fi'ka] 'to thrust in'—the spreading of [+nasal] feature is regressive, and the requirement of the phenomenon is restricted to the word border. Thus, we found that nasalization before /N/ is mandatory in vowels preceding such a consonant at the word's edge, but it is optional if the vowel preceding /N/ is not in word-final context. Nasal coda may or may not be produced in the coda nasalization process. However, if it is performed, its place of articulation will be defined by the following onset, characterizing the phoneme as sub specified for the place of articulation. Otherwise, if the coda is not performed, the contiguous left vowel will always be nasalized and will be longer than its oral counterpart (AGOSTINHO, 2015). In these cases, /N/ is elided from the segmental layer after spreading its nasal feature to the previous vowel, which then occupies two temporal units within the syllable. When there is coda /N/ deletion before the transfer of the nasality feature, the nasalization process is not performed; therefore, the vowel is not nasalized. In the perceptual test, the speakers interpreted nasal appendix 87.5% of the time. It is perceptible in the spectrogram as a resyllabified nasal consonant in the onset position. This result confirms the biphonemic interpretation of nasality, but

it must be relativized by the low number of informants, highlighting the need of a perceptive experiment with a larger sample.

With respect to the second type of nasalization, nasal spreading of the nasal consonant in onset may be to the left (heterosyllabic) or to the right (tautosyllabic). The assimilation of nasality by the vowel is always optional. Similar to nasality by coda, the nasal feature is not present in the phonological form of these words, and nasality arises from a nasal consonant in the onset of the same or adjacent syllable. Thus, nasality may extend beyond the syllabic border, but it is restricted to rhyme, including in cases of nasality triggered by a coda (AGOSTINHO, 2015). In these nasalization processes, there is no difference in meaning between the oral and nasalized vowel performance, as in the word [ˈmɐ̃nɐ] and [ˈmanɐ] ‘sister’. In addition, the spreading process – albeit it may be triggered by a nasal consonant in the onset of a stressed or unstressed syllable – targets stressed vowels and is not predicted in unstressed syllables. The importance of the stress indicates that this should be considered within the suprasegmental system of LI, which is not solely tonal, in contrast to the view of Günther (1973) and Maurer (2009).

Due to the limitations of perceptual test data, this study left some unanswered questions. In future studies, it is advised to widen the scope of data and to analyse the perception of the coda spread nasality considering the surrounding segmental contexts, as well as distinct lexical prominence. It is necessary to observe the manifestation of the nasal appendix preceding different consonant contexts, primarily considering the sequence /VN.S/, where /S/ corresponds to any fricative consonant in the syllable onset, because the behavior of the nasal appendix, as pointed out in the literature, is not always uniform in this context (SOUSA, 1994; MEDEIROS, 2007; VALENTIM, 2009). Finally, it is interesting to investigate the perception of vowels nasalized by an onset and compare the results with the perception of vowels nasalized by a coda in order to analyse the possible perceptual effects that the different sources of triggering – whether by a coda or an onset – may cause according to the judgment of native speakers of LI.

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- *RESUMO: Este artigo descreve e analisa a nasalidade vocálica produzida por coda e onset nasal em lung'le, língua crioula falada em São Tomé e Príncipe. Assim, observamos o comportamento fonotático da língua, investigando a aplicação dos processos de nasalização conforme o acento lexical e a possibilidade de ressilabificação dos segmentos. Ademais, através de um teste perceptivo, visamos identificar o modo que a nasalidade engatilhada por coda é concebida em lung'le. Nesse caso, os resultados indicam que, com a exclusão da consoante em onset da sílaba seguinte à sílaba que continha nasalização, os falantes compreendiam o apêndice nasal como uma consoante plena [n] ressilabificada na posição de onset nasal, reforçando, portanto, a interpretação bifonêmica da nasalidade no lung'le (AGOSTINHO, 2015; BALDUINO et al., 2015; BANDEIRA, 2017). A análise fonotática, por sua vez, indica que o acento é primordial para o engatilhamento da nasalização a partir de onset silábico, ao passo que a nasalização em coda pode ocorrer independentemente da maior proeminência lexical envolvida. O acento como fator importante na concretização deste processo sugere a existência de um sistema suprasegmental misto em lung'le, constituído por tom e acento, sendo o acento a categoria suprasegmental mais importante (AGOSTINHO, 2015), e não somente um sistema tonal (MAURER, 2009).*
- *PALAVRAS-CHAVE: Nasalização. Lung'le. Suprasegmentos. Acento.*

REFERENCES

AGOSTINHO, A. L. **Fonologia e método pedagógico do lung'le**. 2015. 417f. Thesis (Doctorate in Philology and Portuguese Language) - Faculdade de Filosofia, Letras e Ciências Humanas, Universidade de São Paulo, São Paulo, 2015.

AGOSTINHO, A. L.; BANDEIRA, M.; ARAUJO, G. A. O Lung'le na educação escolar de São Tomé e Príncipe. **Trabalhos em Linguística Aplicada**, Campinas, v.55, n. 33, p. 591-618, 2016.

ARAUJO, G. A. Ideofones no são-tomense. **Papia**, Brasília, v. 19, p. 23-37, 2009.

BALDUINO, A. M. **A nasalidade vocálica no português falado em São Tomé e Príncipe**. 296f. Dissertation (Master in Philology and Portuguese Language) - Faculdade de Filosofia, Letras e Ciências Humanas, Universidade de São Paulo, São Paulo, 2018.

BALDUINO, A. M.; AGOSTINHO, A. L.; ARAUJO, G. A.; CHRISTOFOLETTI, A. A nasalidade vocálica em santome e lung'ie. **PAPIA**, São Paulo, v. 25, n. 1, p. 7-25, 2015.

BANDEIRA, M. **Reconstrução fonológica e lexical do protocrioulo do Golfo da Guiné**. 2017. 440 f. Thesis (Doctorate in Philology and Portuguese Language) -

Faculdade de Filosofia, Letras e Ciências Humanas, Universidade de São Paulo, São Paulo, 2017.

BARBOSA, P.; MADUREIRA, S. **Manual de fonética acústica e experimental**. São Paulo: Cortez, 2015.

BARTENS, A. **Ideophones and sound symbolism in Atlantic Creoles**. Helsinki: Academia Scientiarum Fennica, 2000.

BOERSMA, P.; WEENICK, D. **Praat: doing phonetics by computer**. [Computer program]. Version 5.4.08. Restored on: 24 mar. 2015. Available in: <http://www.praat.org/>. Access on: 05 jun. 2020.

CABRAL, A.; RODRIGUES, A.; CARVALHO, F. Ensurdimento vocálico em Zo'ê. **Estudos Linguísticos**. Belo Horizonte, v. 18, n. 1, p. 51-60, 2010.

CAGLIARI, L. **An experimental study of nasality with particular reference to Brazilian Portuguese**. 1977. Thesis (Doctorate in Linguistic) - University of Edinburgh, Edimburgo, 1977.

CÂMARA-JR, J. **Estrutura da Língua Portuguesa**. Rio de Janeiro: Vozes, 1970.

CHRISTOFOLETTI, A. **Ditongos no português de São Tomé e Príncipe**. 2013. 109 f. Dissertation (Master in Philology and Portuguese Language) - Faculdade de Filosofia, Letras e Ciências Humanas, Universidade de São Paulo, São Paulo, 2013.

CLEMENTS, N.; KEYSER, S. **CV Phonology: a generative theory of the syllable**. Cambridge, MA: MIT Press, 1983.

DOMINGOS, M. **Nasalidade vocálica em Português: pistas para identificação forense de falantes**. 2011. 189 f. Dissertation (Master in Linguistic) – Faculdade de Letras, Universidade de Lisboa, Lisboa, 2011.

GOLDSMITH, J. **Autossegmental phonology**. 1976. Thesis (Doctorate in Linguistic) - Massachusetts Institute of Technology, Cambridge, 1976.

GOLDSMITH, J. **Autossegmental and metrical phonology**. Oxford: Blackwell, 1995.

GÜNTHER, W. **Das Portugiesische Kreolisch der Ilha do Príncipe**. Marburg and der Lahn: Im Selbstverlag, 1973.

HORA, D.; PEDROSA, J.; CARDOSO, W. Status da consoante pós-vocálica no português brasileiro: coda ou onset com núcleo não preenchido foneticamente? **Letras de Hoje**, Porto Alegre, v. 45, n. 1, p. 71-79, 2010.

HYMAN, L. M. Do all languages have word accent? *In*: HULST, H. V. D. (Ed.). **Word stress: theoretical and typological issues**. Cambridge: Cambridge University Press, 2014. p. 56-82.

HYMAN, L. M. Word-prosodic typology. **Phonology**, Cambridge, v. 23, n. 2, p. 225–257, 2006.

INE. **São Tomé e Príncipe em números**. São Tomé: Instituto Nacional de Estatística, 2012. Available in: <http://www.ine.st/2012.html>. Access on: 05 jun. 2020.

MAURER, P. **Principense Grammar texts, and Vocabulary of the Afro-Portuguese Creole of the Island of Príncipe, Gulf of Guinea**. London: Battlebridge Publications, 2009.

MEDEIROS, B. Vogais nasais do português brasileiro: reflexões preliminares de uma revista. **Revista Letras**, Curitiba, n. 72, p. 165-188, 2007.

MICHAEL, L. The interaction of tone and stress in the prosodic system of Iquito (Zaparoan). **Amerindia**, Paris, v. 35, p. 53–74, 2011.

MIGUEL, M. A. Vogais nasais e nasalizadas: uma falsa questão? *In*: ENCONTRO DE ESTUDOS DE DIALECTOLÓGICOS, 1., 2003, Ponta Delgada. **Actas [...]**. Ponta Delgada: Instituto Cultural de Ponta Delgada, 2006. p. 183-206.

MORAES, J. Produção e percepção das vogais nasais. *In*: ABAURRE, M. (Org.). **Gramática do português culto falado no Brasil: a construção fonológica da palavra**. São Paulo: Contexto, 2003. v. 2, p. 95-112.

MORAES, J.; WETZELS, L. Sobre a duração dos segmentos vocálicos nasais e nasalizados em português: um exercício de fonologia experimental. **Cadernos de Estudos Linguísticos**, Campinas, n. 23, p. 153-166, 1992.

ROTHER-NEVES, R.; VALENTIM, H. On the duration of nasal vowels in Brazilian Portuguese. **Revista Diadorim**, Rio de Janeiro, v. 12, p. 108-128, 2012.

ROTHER-NEVES, R.; VALENTIM, H. On the Duration of Nasal Vowels in Brazilian Portuguese. **Revista Diadorim**, v. 12, p. 108-128, 2012.

SEARA, C. **Estudo acústico-perceptual da nasalidade das vogais do português brasileiro**. 2000. 270 f. Thesis (Doctorate in Linguistic) - Universidade Federal de Santa Catarina, Florianópolis, 2000.

SELKIRK, E. The syllable. *In*: HULST, H.; SMITH, N. (Ed.). **The structure of phonological representations**. Dordrecht: Foris, 1982. p. 337-383.

SOUSA, E. **Para a caracterização fonético-acústica da nasalidade no português do Brasil**. 1994. 189 f. Dissertation (Master in Linguistic) – Instituto de Estudos da Linguagem, Universidade Estadual de Campinas, Campinas, 1994.

TRAILL, A.; FERRAZ, L. The interpretation of tone in Principense Creole. **Studies in African Linguistics**, Portland, v. 12, n. 2, p. 205-215, 1981.

VALENTIM, H. **Duração dos segmentos vocálicos orais, nasais e nasalizados do português brasileiro**. 2009. 112 f. Dissertation (Master in Theoretical and Descriptive Linguistics) – Faculdade de Letras, Universidade Federal de Minas Gerais, Belo Horizonte, 2009.

WETZELS, L. Comentários sobre a estrutura fonológica dos ditongos nasais no português do Brasil. **Revista de Letras**, Curitiba, v. 22, p. 25-30, 2000.

WETZELS, L. The lexical representation of nasality in Brazilian Portuguese. **Probus**, The Netherlands, n. 9, p. 203-232, 1997.

WETZELS, L. Prevowels in Maxacali: Where they come from. **Abralin**, Campinas, v. 14, p. 39-63, 1993.

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