A Monophonemic Analysis
of Prenasalized Consonants in Saramaccan

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This paper describes Saramaccan prenasalized consonants. We demonstrate that a phonetic analysis of consonant duration, and the duration of vowels preceding prenasalized consonants confirms phonological descriptions that characterize these units as monophonemic. We also provide evidence that, for some speakers, these have nasal allophones but, nevertheless, they are not “fortis nasals” (Voorhoeve 1959: 440). Our data show that Saramaccan has not only monophonemic onsets with complex melodies but also one biphonemic onset (/st/) of decreasing sonority. This study deals with the phonological interpretation of these consonants, and also provides a phonetic and phonological description of a Creole with a dominant CV syllable structure.

Key words: Saramaccan, prenasalized stops, monophonemic, clusters, onsets, sonority

1. Prenasalized consonants in Saramaccan

The issue of the monophonemic or biphonemic status of prenasalized consonants in Saramaccan is important to determine what constitutes a possible syllable in Creoles. This paper presents an experimental approach to this issue (Ohala & Jaeger 1986; Ohala 1999), and provides a phonological and phonetic analysis to determine whether these are clusters or monophonemic sounds.

Saramaccan is a language typically characterized as one with a dominant CV syllable structure (Aceto 1996; Plag and Schramm 2006), and with practically no syllable initial clusters (Plag & Albert 2001). Although

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1 I would like to thank the Puerto Rican Association of University Professors (APPU) for its continuous support of this research project. I would also like to thank the University of Puerto Rico for providing funding for travel and release time to complete this paper. I would like to thank Sandra Pascuas, my research assistant, for her help during different stages of this research. Finally, I would like to thank the Global Recordings Network for granting permission to use their recordings of the language. Any errors or misinterpretation are my sole responsibility.
some approaches question the complex melodic composition of prenasalized stops in other languages (Nasukawa 1999), the phonetic evidence reveals that these consonants have two melodic components in Saramaccan: a nasal and an oral feature. In fact, a more accurate name for this group of consonants would be prenasalized non-continuants, since the oral component includes stops and affricates.

Foregoing research provides evidence that prenasalized consonants constitute clusters (biphonemic) in some languages while they are monophonemic units in others (Herbert 1975; Piggott 1988; Duanmu 1990; Padgett 1994; Downing 2005; Chacha Mwita 2007). This key issue in the phonological literature on prenasalized stops has a reflex in descriptions of Saramaccan prenasalized stops. Good & McWhorter (2012: 7-10) claim that these consonants seem to be monophonemic in Saramaccan, and that prenasalized forms like /mb/ can be better represented as /m\b/, “[…] that is, as a nasal consonant with a secondary oral stop release […]”. Similarly, Voorhoeve (1959: 440) describes these as “fortis nasals”, suggesting that the oral element is secondary or subordinated to nasality. Smith (2007), on the other hand, describes prenasalized consonants as clusters restricted to a subset of melodic properties. For example, the non-continuant portion of a prenasalized consonant is never implosive in Saramaccan, even though the language has voiced labial implosive stops (bakulu, ‘supernatural apparition’; ambí, ‘lizard’) (2007: 105).

Prenasalized consonants and coarticulated stops are phonemic in this language. Indeed, previous phonological analyses of Saramaccan indicate that prenasalized stops are distinctive in word-medial and initial position. Since Saramaccan has practically no coda consonants, these distinctions are not attested in syllable final position.

The fact that these consonants participate in phonemic distinctions is crucial to determine whether these are monophonemic or biphonemic. Although prenasalized consonants have a nasal allophone in some varieties, Good & McWhorter (2012: 7-10) indicate that there are minimal pairs involving both types of sounds [(1) and (6)], as well as oppositions between prenasalized consonants (2), and prenasalized consonants and voiced non-continuants [(3)-(6)]:

(1) tendé, ‘to tear’ vs. tené, ‘to stretch’
(2) sëndé, ‘to shine’ vs. sëmbé, ‘person’
(3) hanga, ‘to hang’ vs. haga, ‘pellets’
Words with prenasalized consonants do not necessarily originate in languages with a similar set of consonants. For example, the following Saramaccan words originated in Portuguese and English [English examples from Good & McWhorter (2012: 5)]:

(7)  
   a.  *dendu*, ‘inside’ (< *dentro* - Port)  
   b.  *somba*, ‘shadow’ (< *sombra* - Port)  
   c.  *sindja*, ‘ash’ (< *cinza* - Port)  
   d.  *manu*, ‘husband’ (< *man* - Eng) vs.  
   e.  *mangu*, ‘thin (< *magro* - Port)  
   f.  *miti*, ‘to meet’ (< *meet* - Eng) vs.  
   g.  *mbeti*, ‘animal’ (< *meat* - Eng)  

Although most prenasalized consonants originate in N+C sequences (7a-c), there are exceptions that emerged from voiced stops and nasal consonants [see (7e) and (7g)]. Nevertheless, prenasalized consonants are widely attested in African languages. Although their distribution in the lexicon is not determined by the etymological sources, some of the phonological constraints that enable their presence in the language probably originated in the substrate.\(^2\)  

Unlike doubly articulated consonants, which are also phonemic in this language, the two components of prenasalized consonants share place of articulation and voicing features. We show that these are neither onset clusters, nor sequences of ambisyllabic nasals plus non-continuants (Downing 2005). As shown in the following sections, Downing (2005: 183-188) main arguments to support an ambisyllabic interpretation of these consonants do not apply in the case of Saramaccan, since prenasalized consonants in this language: (a) are not split by a morpheme or a syllable boundary (Bantu); (b)

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\(^2\) Gbe and Kikongo languages (4.7%) are the main sources of African etymons in Saramaccan (Smith 2012:91). There are numerous lexical items originating in Portuguese (34.9%), English (49.9%), and Dutch (10.5) (Smith 2012:90).
are not voiced counterparts of voiceless or voiced consonants (Fijian, Tohoku Japanese); (c) do not trigger lengthening of the preceding vowel or affect tone assignment (Johore Malay and Jita); (d) and are not phonetically longer than voiced stops. Furthermore, we argue that these constitute unitary onsets of decreasing sonority, and, therefore, do not violate the Sonority Sequencing Principle. Finally, we demonstrate that there is a cluster in the language (/st/) that exhibits decreasing sonority before nuclei. This challenges descriptions that claim that there are no onsets of decreasing sonority in this language (Alber and Plag 2001).

Additionally, we provide evidence that in some varieties the nasal element is the main feature in these sounds but these are not “fortis nasals”. Indeed, we found that only one speaker produced the nasal allophone for the /mb/ sound, and that the phonetic score clearly shows differences between these allophones.

The first sections (sections 2, 2.1 and 2.2) describe the criteria for a monophonemic analysis, and the phonological features that support such analysis. Section 3 explains the methodology for the phonetic analysis. Sections 3.1-3.2.3 describe the results. Sections 4 and 5 summarize our conclusions.

2. Phonic and phonological criteria: A monophonemic account

An important issue of segmental phonology, since Trubetzkoys’ [1969 (1936)] seminal work (Principles of phonology), is identifying monophonemic units among sequences of coarticulated sounds such as affricates, coarticulated stops, and prenasalized consonants. Trubetzkoys’ (1969: 56-60) criteria include phonetic as well as phonological standards. These criteria state that monophonemic sound combinations:

(8) show a homogenous articulatory movement or progressive dissolution of an articulatory complex;
(9) show durations that do not exceed that of other monophonemic sounds;
(10) keep the symmetry of the phonemic inventory;
(11) are not distributed over two syllabic domains;

\footnote{In fact, as indicated by Ohala (1999: 681), Trubetzkoys’ work in phonology is based on the observation of sound production.}
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(12) occur in positions that are different from those in which we find clusters;

(13) are not a combinatory variant of other phonemes.

There are two additional criteria we can add to this list:

(14) Prenasalized consonants comply with sonority constraints since these constitute monophonemic sounds (not clusters); and

(15) their nasal-oral components share core feature-values: [+voiced, αPA]

The first two, [(8) and (9)] describe phonetic behavior, which we analyze in sections 3.1-3.2.3. The remaining criteria consist of phonological features. Below (2.1-2.2), we evaluate the phonological criteria in in (10) through (15), and provide examples of other languages that have monophonemic prenasalized consonants.

2.1. Saramaccan phonological system

Good & McWhorter’s (2012) description of the Saramaccan consonant system shows that prenasalized consonants have a distribution that is analogous to that of other units in the system [Table based on Smith (2007) and Good & McWhorter (2012), and modified based on standard IPA Handbook (1999) descriptions]:

Table 1. Saramaccan’s Consonants

<table>
<thead>
<tr>
<th></th>
<th>labial</th>
<th>alveolar</th>
<th>palatal</th>
<th>velar</th>
<th>labialized velar</th>
<th>glottal</th>
<th>labialized velar</th>
</tr>
</thead>
<tbody>
<tr>
<td>[-Voiced] Obstruent</td>
<td>p</td>
<td>t</td>
<td>tf</td>
<td>k</td>
<td>kw</td>
<td>kp</td>
<td></td>
</tr>
<tr>
<td>[+Voiced] Obstruent</td>
<td>b (ɓ)</td>
<td>d (ɗ)</td>
<td>dʒ</td>
<td>g</td>
<td>gw</td>
<td>gb</td>
<td></td>
</tr>
<tr>
<td>Prenasalized Obstruent</td>
<td>mb</td>
<td>nd</td>
<td>pɗʒ</td>
<td>ŋg</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nasal</td>
<td>m</td>
<td>n</td>
<td>ɲ</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fricative</td>
<td>f</td>
<td>s</td>
<td></td>
<td>h</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>[+Voiced] fricative</td>
<td>v</td>
<td>z</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Approximant</td>
<td>l</td>
<td>j</td>
<td></td>
<td></td>
<td>w(hw)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
These “keep the symmetry of the phonemic inventory” [Criterion (10), above] since there are prenasalized consonants for all places of articulation, except for the labio-velar and glottal place (Good & McWhorter 2012). Indeed, some features, like nasal and glottal, are typically incompatible, and glottal consonants block the spreading of nasal features (Piggott 2003: 386).

Like other languages with prenasalized consonants, Saramaccan has prenasalized affricates, as shown by the following minimal pairs (Good & McWhorter’s 2012: 18):

(16) \(ndjú /ndʒú/\), ‘peanut type’ vs. \(dʒú /dʒú/\), ‘Jew’

Moreover, prenasalized affricates (17a) are phonologically distinctive if compared with sequences of prenasalized consonants and high vowels (17b), and voiced affricates (17c), as shown in the following minimal pairs (Good & McWhorter’s 2012: 17):

(17) a. \(gándji /gáŋdʒi/\), ‘sour’
   b. \(gandi /gáŋdi/\), ‘crocodile’
   c. \(gadii /gádʒi/\), ‘porch’

On the other hand, the nasal portion of prenasalized consonants is not a coda [Criterion (11), above]. Coda consonants are rare or practically absent in Modern Saramaccan (Rountree 1972a; Aceto 1996; Bakker, Smith & Veenstra 1994; Good & McWhorter 2012). If coda consonants were allowed in this language, in word-medial position, the nasal component could be part of a consonant group, with the oral component as the onset of the following syllable. Still, there is no syllable boundary between the nasal and the oral component in these consonants since there is no historical vowel epenthesis, as in the case of etymological clusters (Aceto 1996; Albert & Plag 2001). Languages like Rwanda, which are described by some as having prenasalized stops, show evidence of vowel epenthesis in their nasal-oral complexes (Demolin, Haude & Storto 2011). Additionally, Rountree (1972b: 22) describes syllable boundaries differently in sequences with prenasalized stops and nasal sounds plus voiceless stops (native speaker assessment): \(vi_{ndel}\) ‘throw’ versus \(vi_{ntu}\) ‘wind’. Moreover, the tense allophone [i] occurs only in non-nasal syllables, and it can precede prenasalized stops, indicating that the nasal portion is not a coda of the preceding syllable (Rountree 1972b: 22).

Moreover, unlike other languages (Downing 2005: 184), Saramaccan prenasalized consonants in word initial position are neither split by a
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morpheme boundary nor constitute TBUs for tone assignment. The nasal portion of prenasalized consonants is neither syllabic nor moraic; although in limited cases, some plain nasal consonants may occupy the place of a deleted vowel (Good and McWhorter 2012: 7): “This is most frequently encountered with a reduced form of the first person singular tonic pronoun mí and is also found in a reduced form of mamá ‘mother’, m’má […]” This provides further evidence that the nasal portion is neither the coda of a preceding syllable nor an ambisyllabic consonant.

Furthermore, Good & McWhorter (2012: 47) indicate that: “[…] there is no evidence for consonant clusters in the language.” This would support our analysis of prenasalized stops but we have found evidence of a cluster in the same positions in which prenasalized stops are attested. Therefore, Saramaccan does not comply with Criterion (12).

There is no alternation between prenasalized consonants and voiced or voiceless oral obstruents, as in other languages (Piggott 2003; Malone 2010) [Criterion (13)]. In some languages, prenasalized consonants occur only in intervocalic position, which suggests that these are allophones of other obstruents (and the nasal portion is parsed as a coda of a preceding syllable). For example, Yamane-Tanaka’s (2005) study on prenasalized stops in the Tohoku dialects (historically conservative dialects) shows that prenasalized stops alternate with voiced stops in intervocalic position. In some languages, all voiced stops are prenasalized, as in Chimila (Malone 2010: 2).

Although prenasalized consonants have nasal consonant allophones in some Saramaccan lects, these are not variants of nasal consonants. In fact, this variation is attested only in the case of /mb/. Additionally, as shown below [(18) and (19)], there are distributional restrictions that apply to prenasalized stops but do not constrain the distribution of nasal consonants. Lax mid vowels can follow word initial nasals but these cannot follow prenasalized consonants. Other languages, like Kisi (Childs (1991: 31), also have this constraint. The Saramaccan examples follow (Good & McWhorter 2012: 51):

\begin{align}
(18) \quad & mbéti, ‘animal’ \quad \text{vs.} \quad mètì, ‘meter’ \\
(19) \quad & ndéti, ‘night’ \quad \text{vs.} \quad nètì, ‘fishing net’
\end{align}

Additionally, this constraint does not apply in the case of voiced obstruents. Prenasalized consonants do not pattern with nasals or obstruents regarding these contextual restrictions. Unlike other languages (Downing 2005), these are not allophones of other consonants.
Furthermore, if prenasalized consonants were clusters, these would violate the sonority scale (Downing 2005: 185), with the least sonorous segment (oral non-continuant) closer to the syllable nucleus. Monophonemic sounds, such as prenasalized consonants, are not necessarily subject to the sonority requirement, since each component is not evaluated independently [Criterion (14)]. Chacha Mwita (2007:62) indicates that this is a traditional argument for the monophonemic interpretation of prenasalized consonants.

Furthermore, these phonological units with two melodies share many features, like [+voiced, −PA] [compare to [+strident, -voiced] in the case of affricates (Jacobson, Fant & Halle 1952; Clements 1990)]. In other languages, like Kikuyu, voiceless fricatives trigger nasal deletion, removing conflicts in manner and voicing specifications in the sequence: in-fuwa → [ifuwa], ‘hippo’; in-satu → [isatu], ‘python’ (versus in+bale → [imbale], ‘plate’) (Morrison 2009: 227). In our Saramaccan data, sequences of nasal+voiceless sounds are not attested. Our phonetic evidence shows that in cases such as wanté ‘right away’, with a voiceless consonant, there is no preceding nasal. “Clusters” such as “nt”, exhibit a drop in intensity after the third formant disappears (nasality), at the onset of the voiceless consonant. This indicates that the nasal feature belongs to the preceding vowel (Rountree 1972b). Differences in voicing specifications are not licensed in prenasalized sequences [Criterion (15)].

2.2. Languages with prenasalized consonants

Saramaccan prenasalized consonants share numerous features with prenasalized monophonemic segments in other languages, like Fijian (Maddieson 1989: 60):

Fijian is a language in which prenasalized stops are persuasively analyzed as single segments from the phonological point of view (Geraghty 1983). […] no boundaries fall between nasal and stop and a post-nasal voicing assimilation rule cannot be motivated by alternations. If we set aside the prenasalized stops for the moment, all syllables are open, and no consonant clusters occur.

The description of Fijian shows important similarities with Saramaccan even if these languages are not genetically related. There is great variety of nasal+non-continuant combinations across language families (Maddieson 1984). These constitute monophonemic sounds in some languages and biphonemic sounds in others, for example, among languages from the Bantu family [see Morrison (2009) and Downing (2005)]. Additionally, previous studies describe prenasalized consonants as monophonemic in many African
languages, like Kikuyu (Rosenthall 1992: 253), Kibena (Morrison 2009), and Kisi (Childs 1991).

Summarizing, there is crosslinguistic evidence of the unitary status of prenasalized consonants (Cohn and Riehl 2011a: 564). The phonological analysis presented so far supports a description of prenasalized consonants as monophonemic sounds, except in the case of Criterion (12). The following sections describe the phonetic analysis, and provide evidence for (8) and (9). Section 3.1 briefly describes articulatory features of prenasalized consonants. Section 3.2 describes the phonetic evidence we gathered to support a monophonemic analysis of these sounds [Criterion (9)].

3. The phonetic analysis

The following section (3.1) constitutes a short description of the articulatory properties of prenasalized consonants [Criterion (8)]. The remaining sections (3.2, 3.2.1, 3.2.2, and 3.2.3) summarize the methodology and results of an acoustic analysis of Saramaccan we conducted for these sounds, vowels preceding prenasalized consonants, and one biphonemic cluster. In addition, we provide some data regarding the nasal allophones of these sounds.

3.1. Articulatory Complex Resolution

Prenasalized consonants entail a shift from a complete closure of the oral passage to a sound release into an oral burst (prenasalized stops) or frication (prenasalized affricates). Maddieson & Ladefoged (1993: 254) indicate that prenasalized consonants do not typically include a shift to approximants or laterals. In other words, these cannot comprise a sequence of sonorants, with no dissolution of the articulatory complex.

There are prenasalized affricates or fricatives, and some interpret combinations of a nasal with an affricate (/pdʒ/), and a nasal with a fricative (/pʒ/) as affricates since the nasal portion requires a closure of the oral track (Padgett 1994: 469). However, the sound release consists on a shift from [+nasal] to [+oral], not from [-continuant] to [+continuant]. In fact, in some languages, the oral portion of prenasalized consonants must be a [-continuant], like the preceding nasal. In Kikuyu, a consonant that shows up as a voiced fricative in other environments has a stop alternant after a nasal (Rosenthall 1992: 253): /βɔr-a/ → [mbureete] ‘lop off’; /ðɔr-a/ → [mgoreete], ‘buy’. In
fact, Padgett (1994: 467) indicates that nasal place assimilation to fricatives is “extremely disfavored” crosslinguistically.

Like affricates, prenasalized consonants share the features [±voiced, αPA] but diverge regarding manner of articulation features (prenasalized consonants are [+nasal]/[-nasal]; affricates are [-continuant]/[+continuant]). Prenasalized sounds include components that share values from major feature classes (classes such as Place and Laryngeal) (Padgett 2002), but differ regarding nasal features. This shift, from a nasal to an oral sound, constitutes a progressive dissolution of the articulatory complex [Criterion (8)].

3.2. An Acoustic Analysis: Features and Methodology

The acoustic analysis provides evidence for the last phonetic Criterion (9): “Prenasalized consonants show durations that do not exceed that of other monophonemic sounds.” We compared the duration of intervocalic prenasalized consonants to that of other voiced and voiceless stops, nasals, as well as to the duration of one consonant cluster (/st/). To this, we added the acoustic analysis of preceding vowel duration.

We ground our phonetic analysis in Maddieson & Ladefoged’s (1993) claim that the duration of intervocalic voiced consonants matches the duration of prenasalized consonants in the same position. Maddieson (1989: 62) found no differences in duration between stem internal prenasalized consonants and those resulting from prefixation in Fijian. Furthermore, he found that alveolar and bilabial prenasalized consonants are longer than prenasalized velar and postalveolar sounds. There is a significant difference of p < .01 between these groups. Maddieson (1989: 64-65) concludes that:

[...] these results indicate that the role of prenasalized non-continuants in the timing pattern of Fijian is generally similar to that of other single segments. They neither have longer duration themselves nor do they shorten a preceding vowel, as might be expected if they had a timing pattern like that of geminate consonants or consonant clusters.

Maddieson’s (1989: 63) study found that prenasalized consonants in initial position are shorter than medial ones. If these are clusters, there is no anchor for a coda position in word initial position, and the nasal portion cannot occupy a moraic slot (with resultant longer duration). Therefore, we restricted our analysis to the intervocalic context, so that their position is not a conditioning feature in our measurements.

Not everyone agrees with using duration to determine whether consonants are monophonemic or not. Downing (2005) has questioned the role
of duration in determining whether prenasalized consonants constitute clusters or monophonemic sounds in Bantu languages. However, other studies have found that the duration of prenasalized consonants is equivalent to that of single voiced segments (Herbert 1975; Maddieson 1989; Maddieson & Ladefoged 1993). Morrison (2009) answers Downing’s (2005) conclusions with data from Kibena (a Bantu language with a CV syllable structure, like Saramaccan). Her study shows that monomorphemic prenasalized consonants have a duration similar to that of other voiced stops. On the other hand, some studies support Downing’s (2005) conclusions (Browman & Goldstein 1986). More importantly, Cohn and Riehl’s (2011b) analysis of NC sequences in Austronesian languages provide evidence of three types of combinations: NC (nasal+voiceless cluster), NC (nasal+voiced cluster), and NC (prenasalized stops). They conclude that relative timing and the duration of each component are central to distinguishing these combinations. We concur with Cohn and Riehl’s (2011b) analysis that duration is a reliable phonetic cue of monophonemic status.

On the other hand, Maddieson (1989: 62) indicates that vowel duration is unaffected by whether the vowel precedes a voiced oral consonant or a prenasalized consonant. This result provides evidence that the nasal portion is not a coda of the preceding syllable. Some studies have claimed that preceding vowels should be shorter if there is a coda (Lahiri & Hankamer 1998: 331). Following a different interpretation, Downing (2005: 185) indicates that a longer preceding vowel in Bantu supports a biphonemic description of prenasalized stops. She suggests that the mora left by the double association of the nasal to a coda position and the onset of the following syllable produces vowel lengthening (the “God Bless the Child” principle, according to Downing (2005: 189)): vowels are longer if a voiced coda follows. However, studies show mixed results regarding the presence of a coda. Geminates, which are comparable to clusters of nasal-stop consonants according to Maddieson & Ladefoged (1993), might shorten a preceding vowel only in some languages. Lahiri & Hankamer (1988) have found that the duration of vowels preceding geminates shows significant differences only in Bengali, not in Turkish. These descriptions suggest that vowel duration in a closed syllable is language dependent.

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4 However, there are many language specific differences regarding the duration of each component, according to Cohn and Riehl (2011b). We thank one of the reviewers for suggesting this reference.
Concerning monophonemic prenasalized consonants, we propose the following hypotheses:

(20) The duration of monophonemic prenasalized consonants should not exhibit significant differences with that of other voiced obstruents.

(21) The duration of monophonemic prenasalized consonants should show significant differences with that of consonant clusters.

(22) The duration of vowels preceding monophonemic prenasalized consonants should not exhibit significant differences with that of vowels proceeding voiced obstruents and nasals.

In order to test these hypotheses, we conducted the following measurements:

(23) We measured the duration of prenasalized consonants, as well as the duration of other voiced and voiceless consonants. We also measured the duration of one cluster (/st/).

(24) We measured the duration of vowels preceding different consonants and the consonant cluster.

We analyzed recordings from five male speakers of Saramaccan. Recordings were taken from the SIL Saramaccan bible recordings (Global Recordings Network). These were produced in a formal reading style (narration). Some of the recordings included short conversations on the Bible but we did not use this information in our analysis.5

We completed 580 measurements. The data sample includes duration measurements for intervocalic consonants, with a total of 290 tokens. Some common words in the data are: (a) gaangadú ‘God’, sembi ‘people’, andí ‘what’ (prenasalized consonants); (b) bigi ‘big’, sabi ‘to know’, gadú ‘spirit’ (voiced stops); (c) buyu ‘good’, kunyútu ‘leave’ (nasals); (d) waká ‘to walk’, hati ‘heart’ (voiceless stops); (e) fustá ‘understand’ (clusters).

Measurements were performed for: (a) prenasalized phonemic units (112); (b) voiced obstruents (103); (c) voiceless stops (45); (d) nasals (21); and

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5 One reviewer suggested that a different kind of elicited data could render different results. However, as indicated by van Heuvel, Rietveld & Cranen (1994), the main factors affecting segment duration are: intrinsic duration, the effect of phonetic context, stress, and phrase final position. We have addressed these issues (except for stress) in this analysis. We have also addressed inter and intraspeaker variation by including five speakers and multiple repetitions of the same word [see Cohn and Riehl (2011b) on previous studies]. Nevertheless, further comparative research including implosive sounds (as suggested by a reviewer) and coarticulated stops can provide a better understanding of the system.
(e) /st/ consonant clusters (9). We also measured 290 corresponding preceding vowel tokens, including five of the Saramaccan seven short oral vowel phonemes: /a/, /e/, /ɛ/, /i/, /o/, /u/. Most examples include the vowel /a/ to avoid problems with intrinsic vowel duration but we still discuss cases in which intrinsic duration plays a role (Section 3.2.2). Some tokens had a smaller number of items than others, so we performed an analysis of variance (one-way ANOVA) to compare results, and measured mean consonant and vowel duration.

Since Saramaccan has a basic CV structure, it was difficult to find clusters in the data. However, during the phonetic analysis, we found evidence of a cluster /st/ in the word “fustá” (25). We considered the possibility of a lexical loan from Sranan, some switching, or Sranan influence (as suggested by Good & McWhorter 2012: 39), but the Sranan word is different from the form found in the data (no rhotic consonant) (26a). The word shares more features with the traditional Saramaccan word (26b):

(25)  
fustá ~ fusdá, ‘to understand’ (intrans.)

(26)  

a. Sranan: frustan/ferstan, ‘to understand’ (trans.)

b. Saramaccan: fusután (traditional), ‘understand’ (intrans.)

Moreover, this does not represent a case of vowel loss in weak positions, as shown by vowel preservation in our data in words with a similar structural configuration: pikinín, ‘child’. Additionally, Bruyn (2002:163) describes the use of the cluster /sk/ by the Saramaka in a “secret language” based on their native language. Although restricted to a domain, this constitutes evidence of the presence of sC clusters in the language. Additionally, the stop in the cluster has a voiced allophone (fusdá), a phenomenon attested in Saramaccan, not Sranan. See Figure 1 for evidence of the sibilant and the following stop:
Figure 1: fusdá, ‘to understand’, with an /st~/sd/ cluster

Other examples we found include similar clusters (Speaker 5): stááfu < sitááfu, ‘punishment’; sista < sisa, ‘sister. One important example is sitááfu since the cluster is attested in word initial position. Also sista does not result from vowel deletion, which shows that these clusters are licensed in the language. Clearly, the data do not support claims of a strict CV syllable structure. Also, this shows that there are, indeed, initial clusters of decreasing sonority in this language.\(^6\) As we describe below, the duration of this cluster is significantly different from the duration of prenasalized consonants. In fact, this cluster’s duration constitutes a baseline against which we can compare the duration of prenasalized consonants and all other consonants.

We measured tokens with prenasalized velars /ng/ (example: gangaa, ‘neck’), bilabials (example: ambé’, ‘who’), and alveolars (example: andí, ‘what’); with voiceless obstruent singletons (example: hatí, ‘heart’); with voiced obstruents (sábi, ‘to know’); with consonant sequences (fustá, ‘to understand’); and with nasals (búnu, ‘good’). All measurements were corroborated by visual inspection of wideband spectrograms, the waveform of the signal, formants, and the intensity profile to determine the onset and offset of consonants and vowels (van Heuvel, Rietveld & Cranen 1994). If the transition between consonants and vowels was not clear, we measured formant height to identify the onset or the offset of the vocalic segment. We used PRAAT to conduct these measurements. Tokens were compared by means of the SPSS software for statistical analysis.

\(^6\) Armstrong (2007) argues that sonority does not determine the order of consonants in onset position in Sranan.
We calculated the duration of prenasalized consonants from the onset of the vowel’s first and second formant dissolution to consonant closure in the oral portion. We measured vowels from the beginning to the end of the lower formants. The following sections summarize the results.

### 3.2.1. Results: Consonant Duration

There was a statistically significant difference between groups as determined by one-way ANOVA ($F(17,275) = 16.795, p = .000$). A Tukey Post-Hoc test indicates that differences in duration between prenasalized consonants and voiced stops are not significant ($p \geq .115$); except for cases involving differences in intrinsic duration (see Table 2). Voicing and place of articulation determine consonant duration; such that voiceless consonants are typically longer than voiced consonants, and bilabial longer than alveolar sounds. The Post-Hoc Test also shows significant differences between clusters (/st/) and all other consonants in the set ($p = .000$).\(^7\)

With regard to our hypothesis in (20) and (21), we found that:

(27) No significant differences are attested for sets of prenasalized consonants and groups of voiced consonants with the same place of articulation.

(28) There are significant differences in duration between prenasalized consonants and consonant clusters (/st/).

Regarding non-prenasalized voiced and voiceless phonemes and clusters, the data show:

(29) Significant differences attested between voiced consonants (including nasals) and voiceless consonants ($p \leq .002$). There are also significant differences between voiced consonants and clusters ($p = .000$).

Only the voiced velar /g/ does not exhibit significant differences in duration if compared with voiceless stops ($p \geq .119$). Some results not predicted by our initial hypothesis are the following:

(30) There are significant differences in duration between the voiced alveolar (/d/) and the prenasalized bilabial (/mb/). The voiced alveolar (/d/) also exhibits significant differences in duration with the prenasalized velar (/ŋg/) consonant.

---

\(^7\) The duration of the /st/ group is not conditioned by homorganicity in other languages (File-Muriel 2007: 49), but by manner and ease of transition during articulation.
There are significant differences in duration between the prenasalized palatal affricates (/pdʒ/) and some anterior voiced consonants (/b/, /d/, and /n/).

The results in (30) and (31) summarize the role that place of articulation plays in consonant duration. Alveolar voiced consonants are significantly shorter than prenasalized consonants with other than the alveolar place of articulation. Additionally, prenasalized affricates encompass two changes in manner of articulation: [+nasal] to [-nasal], and [-continuant] to [+continuant]. This might explain why these are longer than other prenasalized consonants, although further research is necessary.

We display below significant results for consonant duration:

**Table 2. Summary Significant Differences Consonant Duration (ANOVA)**

<table>
<thead>
<tr>
<th>Cluster vs Singleton</th>
<th>NC vs [+voiced]</th>
</tr>
</thead>
<tbody>
<tr>
<td>/st/ vs NC*</td>
<td>/st/ vs [+voiced]</td>
</tr>
<tr>
<td>/nd/</td>
<td>.000</td>
</tr>
<tr>
<td>/ŋg/</td>
<td>.000</td>
</tr>
<tr>
<td>/mb/</td>
<td>.000</td>
</tr>
<tr>
<td>/pdʒ/</td>
<td>.000</td>
</tr>
</tbody>
</table>

*We use NC as an abbreviation only.

As shown in Table 2, voiced stops exhibit no significant differences in duration with prenasalized consonants; except for the cases described above. Prenasalized affricates are significantly longer than other voiced consonants. Mean consonant duration is summarized in Table 3:

**Table 3. Mean Consonant Duration (ms.)**

<table>
<thead>
<tr>
<th>NC</th>
<th>[+voiced]</th>
<th>[-voiced]</th>
<th>[+nasal]</th>
<th>[+palatal]</th>
<th>cluster</th>
</tr>
</thead>
<tbody>
<tr>
<td>/mb/</td>
<td>95</td>
<td>74</td>
<td>101</td>
<td>100</td>
<td>/st/ 197</td>
</tr>
<tr>
<td>/nd/</td>
<td>82</td>
<td>60</td>
<td>109</td>
<td>65</td>
<td>/dʒ/ 91</td>
</tr>
<tr>
<td>/ŋg/</td>
<td>92</td>
<td>85</td>
<td>107</td>
<td></td>
<td>/ʒ/ 83</td>
</tr>
<tr>
<td>/pdʒ/</td>
<td>114</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
We can conclude that the data supports a monophonemic interpretation of prenasalized consonants. On the other hand, intrinsic consonant duration can explain differences in a handful of cases. Additionally, the /st/ sequence is significantly longer than prenasalized consonants, voiced stops, and voiceless stops.

In the next section, we show that there are no differences between vowels preceding prenasalized consonants and those preceding voiced consonants.

### 3.2.2. Results: Vowel Duration

We measured short vowels and the second portion of long vowels only. Thus, we eliminate possible phonemic length distinctions from our measurements. There was a statistically significant difference between groups as determined by one-way ANOVA ($F(28,269) = 6.213, p = .000$). A Tukey Post-Hoc test indicates that differences in duration for the same vowel before a prenasalized or a voiced consonant are not significant ($p > .128$). Only the vowel /a/ exhibits significant differences in duration when preceding the velar /ŋ/ versus /d/ ($p = .028$) and /m/ ($p = .011$).

Nevertheless, the results show that the key element in the case of vowels is intrinsic duration. The Post-Hoc test show that the low vowel /a/ is significantly longer than the high vowels /i/ and /u/, and the lax vowel /ε/. We summarize, in Table 4, the results of our ANOVA analysis for vowel duration.

<table>
<thead>
<tr>
<th>/a/ vs V</th>
<th>/ε/ vs V</th>
<th>/i/ vs V</th>
</tr>
</thead>
<tbody>
<tr>
<td>/amb/ /ɛmb/</td>
<td>.000</td>
<td>/ɛmb/ /ɛmb/</td>
</tr>
<tr>
<td>/ad/ /ɛmb/</td>
<td>.000</td>
<td>/ɛmb/ /ɛmb/</td>
</tr>
<tr>
<td>/ænɡ/ /ɛndʒ/</td>
<td>.002</td>
<td>/ɛmb/ /ɛmb/</td>
</tr>
<tr>
<td>/ænɡ/ /ɛndʒ/</td>
<td>.002</td>
<td>/ɛmb/ /ɛmb/</td>
</tr>
<tr>
<td>/ænɡ/ /ɛndʒ/</td>
<td>.002</td>
<td>/ɛmb/ /ɛmb/</td>
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<tr>
<td>/ænɡ/ /ɛndʒ/</td>
<td>.002</td>
<td>/ɛmb/ /ɛmb/</td>
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<tr>
<td>/ænɡ/ /ɛndʒ/</td>
<td>.002</td>
<td>/ɛmb/ /ɛmb/</td>
</tr>
<tr>
<td>/ænɡ/ /ɛndʒ/</td>
<td>.002</td>
<td>/ɛmb/ /ɛmb/</td>
</tr>
<tr>
<td>/ænɡ/ /ɛndʒ/</td>
<td>.002</td>
<td>/ɛmb/ /ɛmb/</td>
</tr>
<tr>
<td>/ænɡ/ /ɛndʒ/</td>
<td>.002</td>
<td>/ɛmb/ /ɛmb/</td>
</tr>
<tr>
<td>/ænɡ/ /ɛndʒ/</td>
<td>.002</td>
<td>/ɛmb/ /ɛmb/</td>
</tr>
<tr>
<td>/ænɡ/ /ɛndʒ/</td>
<td>.002</td>
<td>/ɛmb/ /ɛmb/</td>
</tr>
<tr>
<td>/ænɡ/ /ɛndʒ/</td>
<td>.002</td>
<td>/ɛmb/ /ɛmb/</td>
</tr>
<tr>
<td>/ænɡ/ /ɛndʒ/</td>
<td>.002</td>
<td>/ɛmb/ /ɛmb/</td>
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<tr>
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<td>.002</td>
<td>/ɛmb/ /ɛmb/</td>
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<tr>
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<td>.002</td>
<td>/ɛmb/ /ɛmb/</td>
</tr>
<tr>
<td>/ænɡ/ /ɛndʒ/</td>
<td>.002</td>
<td>/ɛmb/ /ɛmb/</td>
</tr>
<tr>
<td>/ænɡ/ /ɛndʒ/</td>
<td>.002</td>
<td>/ɛmb/ /ɛmb/</td>
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<tr>
<td>/ænɡ/ /ɛndʒ/</td>
<td>.002</td>
<td>/ɛmb/ /ɛmb/</td>
</tr>
<tr>
<td>/ænɡ/ /ɛndʒ/</td>
<td>.002</td>
<td>/ɛmb/ /ɛmb/</td>
</tr>
<tr>
<td>/ænɡ/ /ɛndʒ/</td>
<td>.002</td>
<td>/ɛmb/ /ɛmb/</td>
</tr>
<tr>
<td>/ænɡ/ /ɛndʒ/</td>
<td>.002</td>
<td>/ɛmb/ /ɛmb/</td>
</tr>
<tr>
<td>/ænɡ/ /ɛndʒ/</td>
<td>.002</td>
<td>/ɛmb/ /ɛmb/</td>
</tr>
<tr>
<td>/ænɡ/ /ɛndʒ/</td>
<td>.002</td>
<td>/ɛmb/ /ɛmb/</td>
</tr>
<tr>
<td>/ænɡ/ /ɛndʒ/</td>
<td>.002</td>
<td>/ɛmb/ /ɛmb/</td>
</tr>
<tr>
<td>/ænɡ/ /ɛndʒ/</td>
<td>.002</td>
<td>/ɛmb/ /ɛmb/</td>
</tr>
<tr>
<td>/ænɡ/ /ɛndʒ/</td>
<td>.002</td>
<td>/ɛmb/ /ɛmb/</td>
</tr>
<tr>
<td>/ænɡ/ /ɛndʒ/</td>
<td>.002</td>
<td>/ɛmb/ /ɛmb/</td>
</tr>
<tr>
<td>/ænɡ/ /ɛndʒ/</td>
<td>.002</td>
<td>/ɛmb/ /ɛmb/</td>
</tr>
<tr>
<td>/ænɡ/ /ɛndʒ/</td>
<td>.002</td>
<td>/ɛmb/ /ɛmb/</td>
</tr>
<tr>
<td>/ænɡ/ /ɛndʒ/</td>
<td>.002</td>
<td>/ɛmb/ /ɛmb/</td>
</tr>
<tr>
<td>/ænɡ/ /ɛndʒ/</td>
<td>.002</td>
<td>/ɛmb/ /ɛmb/</td>
</tr>
<tr>
<td>/ænɡ/ /ɛndʒ/</td>
<td>.002</td>
<td>/ɛmb/ /ɛmb/</td>
</tr>
</tbody>
</table>
Mean vowel duration is shown below (Table 5):

**Table 5. Mean Vowel Duration Preceding Prenasalized and Voiced Consonants (ms.)*

<table>
<thead>
<tr>
<th></th>
<th>/a/</th>
<th>/e/</th>
<th>/i/</th>
<th>/u/</th>
<th>/o/</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>/mb/</td>
<td>92</td>
<td>90</td>
<td>59</td>
<td>54</td>
<td>86</td>
</tr>
<tr>
<td>/nd/</td>
<td>82</td>
<td>92</td>
<td>56</td>
<td>57</td>
<td></td>
</tr>
<tr>
<td>/ng/</td>
<td>72</td>
<td>85</td>
<td>89</td>
<td>59</td>
<td></td>
</tr>
<tr>
<td>/ndʒ/</td>
<td>106</td>
<td>140</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>/m/</th>
<th>/n/</th>
</tr>
</thead>
<tbody>
<tr>
<td>/mb/</td>
<td>48</td>
<td>81</td>
</tr>
<tr>
<td>/nd/</td>
<td>146</td>
<td>90</td>
</tr>
<tr>
<td>/ng/</td>
<td>106</td>
<td></td>
</tr>
<tr>
<td>/ndʒ/</td>
<td></td>
<td>100</td>
</tr>
</tbody>
</table>

*Table includes following consonant

There are no significant differences between vowels that precede voiced consonants and those preceding clusters (/st/). Vowels before the cluster /st/ only exhibit significant differences with those preceding the prenasalized affricate (p = .021).⁸

In conclusion, differences in vowel duration show that:

(32) There are no significant differences between vowels preceding prenasalized consonants and those preceding voiced stops.

(33) There are no significant differences in duration between vowels preceding clusters (/st/) and vowels preceding prenasalized consonants.

(34) The only significant differences attested are determined by intrinsic vowel duration.

Since short vowels exhibit little variation, the results do not confirm nor deny the hypothesis in (22) (repeated below):

(22) The duration of vowels preceding monophonemic prenasalized consonants should not exhibit significant differences with that of vowels proceeding voiced obstruents and nasals.

---

⁸ This consonant might be biphonemic; however, we need to conduct additional phonetic analyses (including VOT) to determine the source of these differences. I want to thank one of the reviewers for suggesting that prenasalized affricates are biphonemic.
Given these facts, it is possible that prenasalized stops as well as the cluster st, which does not shorten the duration of a preceding vowel either, are onsets. That would explain why there is no vowel shortening. This is compatible with a language structure consisting of open syllables, with affricates, prenasalized stops, and sC clusters in onset position. However, further research is necessary regarding this issue.

According to Lisker (1974: 225): (a) duration of the acoustic segment associated with a vowel depends to a significant extent on the degree of opening of the vowel; (b) duration depends also on the nature of the following consonant. Only the first effect is attested in Saramaccan. Vowels have intrinsic duration depending on vowel quality. For example, /a/ is typically longer than /i/, or /ɛ/ in Saramaccan. It is also interesting that the high back vowel /u/ has longer duration than all remaining vowels in the same context (see Table 5), with a mean duration of 113.4 ms.; while /a/ has a mean duration of 94.8ms., and /i/ has a mean duration of 56.6 milliseconds. The relation between vowel quality and duration has been an important issue in the literature on prosodic features (Fox 2000).

One problem with variation of vowel duration is the fact that vowel length is distinctive in this language, so the functional load of shortening a vowel in different contexts is greater than in other languages. Consequently, the hypothesis in (22) cannot be confirmed. However, other data supports a unitary interpretation of prenasalized stops. The next section provides some evidence that although there is a nasal allophone for prenasalized consonants, these are not “fortis nasals”.

### 3.2.3. Additional Phonetic Evaluation

One important issue in the description of prenasalized consonants is whether these are allophones of other nasal or oral consonants. The phonemic analysis indicates that these are neither voiced obstruents nor nasals. However, most studies describe the nasal element as primary (sections 2.1 and 2.2). Our data show that only one of the speakers, Speaker 3, produces nasal consonants instead of prenasalized consonants.

Spectrograms provide evidence that an oral non-continuant followed a nasal in some tokens (sɛmbɛ’, ‘people’) (Figure 2), while there was no oral component in others (sɛmɛ’) (Figure 3):
Formants are clear (including the third and fourth formants) in Figure 3; while in Figure 2 there is a drop in intensity in the transition between the nasal portion and the oral non-continuant. A shift to the oral stop (/b/) occurs after the durational mid point in the consonant. There is also a clear transition into the following vowel. In conclusion, the oral component of prenasalized consonants constitutes more than a stop release. It exhibits a clear drop in
intensity and a transition between the nasal and oral portions (Cohn & Riehl 2011b).

The variation between NC and N, attested only in one speaker and for only one form (/mb/), requires further study. Differences in duration between these variants are not significant ($p \geq 1.000$). An additional phonetic study, measuring the offset of nasalization in vowels following prenasalized stops, can show the presence/absence of an oral portion in these consonants, particularly in cases of dialectal variation (Downing 2005; Cohn & Riehl 2011b). Further study of these allophones and their distribution in the population is necessary but these issues are beyond the scope of this paper.

4. Conclusions for the Phonetic Analysis

The phonetic evidence supports the following conclusions:

(35) Prenasalized non-continuants are monophonemic in Saramaccan: The duration of prenasalized consonants shows no significant differences with that of other voiced obstruents, except in cases of intrinsic consonant duration.

(36) The nasal portion of prenasalized non-continuants is not in coda position: The duration of vowels preceding prenasalized consonants is not shorter than that of vowels preceding other voiced obstruents. Only differences in intrinsic vowel duration are attested.

Our hypotheses in (20) and (21), regarding the duration of prenasalized consonants, are confirmed by the data. The hypothesis in (22), regarding preceding vowels, is not relevant due to constraints that override variation in vowel duration.

It is necessary to study other issues related to the presence of prenasalized forms, such as the onset of nasalization in preceding vowels, as well as the offset of nasalization for following vowels. It is also important to analyze durational differences in VOT for prenasalized consonants and voiced consonants. Additionally, the genesis of these forms (given the fact that these lexemes originate in different languages) is an important issue for further research in order to understand their status as monophonemic sounds (Hajek 1997; Beddor 2009).
5. General Conclusions

Prenasalized consonants in Saramaccan are not clusters, as in other languages, but show significant differences in duration with respect to clusters attested in our data. Moreover, they constitute units with complex melodies and, unlike the case of Tohoku Japanese (Nasukawa 1999), their duration corresponds to that of voiced stops. Therefore, we place Saramaccan within the set of languages with phonemic prenasalized consonants [in line with Tak’s (2011) classification (based on Ruhlen 1987)].

The description of prenasalized consonants as monophonemic provides the tools for a unified account of consonant distribution in this language. As stated before, our study suggests that Saramaccan syllable structure consists of open syllables, with affricates, prenasalized stops, and sC clusters in onset position. Saramaccan, besides its CV and V syllable structure (Klein 2006), allows a diversity of sequences (CV, CCV) as onsets. It also provides arguments against interpreting prenasalized consonants as onset clusters of decreasing sonority.

Given the fact that only 12% (Maddieson 1991) of the word languages have prenasalized consonants, among which most are African languages, the presence of prenasalized consonants (and coarticulated stops) in this language shows considerable influence from the substrate. However, not everyone agrees that prenasalized consonants are unitary in African languages (Downing 2005). Although Saramaccan has a syllable structure that matches that of its substrates in many aspects (Michaelis 2008: 141), prenasalized consonants also show many similarities with genetically unrelated languages, such as Fijian. Moreover, prenasalized consonants are attested in words originating in the European-based lexicon, which suggests an autonomous development. Finally, this study provides a basis for a comparative analysis with prenasalized non-continuants in other Creoles like Palenquero, Sango, Shaba, Swahili, Angolar, and Kriyol (Klein 2006: 47).
A monophonemic analysis of prenasalized consonants in Saramaccan

References:


Armstrong, Clifford. 2007. *Stress, sonority, and the syllable in creoles and other languages.*


