Homorganic NC sequences in Kibena: Pre-nasalized consonants, consonant clusters, or something else?

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Abstract

In Bantu linguistics, one topic of great debate concerns the segmental status of homorganic NC sequences. Traditionally, on the basis of durational properties, the phonological behavior of such segments, and native speaker syllabification, such sequences are considered to be pre-nasalized consonants. More recently Downing (2005) has taken the opposite position, arguing instead that NC sequences in Bantu languages should be treated as clusters. In this paper I present an analysis of NC sequences in Kibena, a Bantu language spoken in southern Tanzania. I consider acoustic duration, syllable structure, distribution, and native speaker intuitions about syllabification and conclude that these sequences are best treated as single segments in Kibena, rather than as a series of two distinct segments.

Keywords: Bantu, phonology, pre-nasalization

1 Introduction

In Bantu linguistics, one topic of debate concerns the segmental status of homorganic NC sequences. Traditionally such sequences are considered to be pre-nasalized consonants (with or without justification of such an analysis). Several linguists have argued that such sequences are best treated as NC sequences, where each consonant has full segmental status. Other linguists (notably Odden and Odden in their (1985) and (1999) treatments of Kihehe) have attempted to remain agnostic on the issue, simply referring to these consonants as "NC sequences." More recently Downing (2005) has argued that NC sequences in Bantu languages should be treated as clusters. In this paper I present an analysis of NC sequences in Kibena, a Bantu language spoken in southern Tanzania. I consider acoustic duration, syllable structure, distribution, and native speaker intuitions about syllabification and conclude that these sequences are best treated as single segments in Kibena, rather than as a series of two distinct segments.

The basic outline of this paper is as follows: in Section 2 I give an overview of various positions on the segmental status of NC sequences in Bantu linguistics. Section 3 provides some basic information

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about Kibena and the research on which this study is based, and Section 4 is a brief overview of Kibena phonology. The remainder of the paper deals with the status of pre-nasalized consonants in Kibena: Section 5 describes the durational properties of pre-nasalized consonants; Section 6 discusses the distributional properties of pre-nasalized consonants, and finally, Section 7 provides evidence for syllabification based on native speaker intuition.

2 The debate over NC sequences in Bantu linguistics

Four different so-called pre-nasalized consonants exist in Kibena. Three of these are pre-nasalized voiced stops (/mb/, /nd/, and /ŋg/) and one is a pre-nasalized voiceless fricative /ns/. Pre-nasalized stops are contrasted with regular nasals and both voiced and voiceless stops at each place of articulation; the pre-nasalized alveolar fricative has only a voiceless oral counterpart (/s/). Table 1 illustrates these contrasts using near-minimal sets:

Pre-nasalized C	*Voiced C*	*Voiceless C*	*Nasal*
hwambála 'to touch'	himabála 'aardvark'	nyalúpala 'lion species'	hukoŋomála 'to sit'
lugééndo 'trip'	ludóódo 'small.CL11'	lukééto 'small knife'	uhóóno 'place'
huuŋgíla 'to greet'	hulagíla 'to show'	múkila 'tail'	huŋíla 'to run'
mugeensi 'guest'	—	mugoosi 'husband'	lufweeni 'spinach'

Table 1: Near minimal sets contrasting some Kibena consonant types

It is possible to analyze sequences such as these as either nasal + consonant sequences or as pre-nasalized consonants. Traditionally segments such as these have been analyzed as pre-nasalized stops in Bantu languages such as Sukuma (Maddieson and Ladefoged 1993), Luganda (Clements 1986, Maddieson and Ladefoged 1993, Wiltshire 1999), Lusaamia (Marlo and Brown 2003), Rangi (Stegen 2002), and Kinyarwanda (Walli-Sagey 1986). (Burton *et al.* 1992) also treat similar segments as pre-nasalized consonants in Moru, a Nilo-Saharan language. A number of arguments are often used in the support of an analysis of these segments as pre-nasalized segments. These include durational properties that are more similar to single segments than clusters, distributional properties, their ability to trigger phonological processes such as compensatory lengthening, and the tendency of speakers to syllabify the nasal as an onset rather than a coda (i.e., V.NC rather than VN.C).

Hubbard (1995) and more recently Downing (2005) have both challenged an analysis of homorganic NC sequences as pre-nasalized consonants. Using data from Runyambo, Sukuma, and Luganda, Hubbard gives a number of reasons why homorganic NC sequences should not be treated as pre-nasalized consonants. First, she notes that durational properties of NC sequences vary widely (anywhere from one and a half to four times the length of individual nasals or consonants). She also uses phonological evidence (from tone assignment and from compensatory lengthening) to claim that the nasal in an NC sequence must be moraic; onsets cannot be moraic, and therefore the nasal cannot form part of an onset.

Downing (2005) offers similar evidence to support her argument that NC sequences should be treated as clusters. Like Hubbard, she notes that phonetic duration is not sufficient evidence by itself to support a claim that NC sequences are either pre-nasalized consonants or clusters. Phonologically, Downing notes that many claims in support of a pre-nasalization analysis argue that compensatory lengthening is necessarily dependent on the resyllabification of the nasal. She gives evidence from Johore Malay that shows that compensatory lengthening can occur when the NC sequence must be analyzed as a cluster. Downing also notes that arguments based on distribution of consonants in Bantu languages (i.e., syllables do not have codas, therefore the nasal must be an onset) do not take into consideration the sonority of the nasals in question: if a language were to have only one type of coda, it would likely be a highly sonorous consonant such as a nasal. Thus there is no reason to argue on the basis of syllable structure that nasal codas are impossible. She also counters the claim of the psychological reality for native speakers of NC sequences as pre-nasalized consonants: when asked to syllabify an NC sequence, speakers almost always syllabify it as .NC rather than N.C; however Downing notes that all words in Bantu languages end in a vowel, therefore pauses are likely to occur after vowels, as a result it is not unreasonable for a speaker, when asked to syllabify a word, to insert a pause between the vowel and the nasal. Below I examine the properties of Kibena homorganic NC sequences in more detail and I motivate my reasons for treating them as pre-nasalized consonants here.

3 The present study: background

Kibena is a Bantu language spoken by approximately 670,000 people living in southwestern Tanzania, northeast of Lake Nyasa (Gordon 2005). Guthrie's (1971) classification labels Kibena as G63.[1] Currently, very little research exists on Kibena. The only discussed of pre-nasalized consonants in Kibena occurs in Eaton (2007), a brief sketch of the phonology of Kibena. She gives NC sequences in Kibena only a brief mention (with examples). She treats such sequences as pre-nasalized consonants, mentioning that they occur most often in stem-medial position and at morpheme boundaries, but that some pre-nasalized consonants can occur stem-initially. The only place where Eaton's analysis differs from that given here is in the pre-nasalized alveolar fricative. Eaton treats this as voiced; evidence from my data set indicates that this phoneme is better treated as voiceless; however this is likely a dialectal difference.

The research on which this project is based was collected in Mbeya and Njombe, Tanzania during May and June 2007.[2] Recordings which are analyzed in this paper are all taken from a single speaker, Nelbert Mlunza,[3] a male native Kibena speaker who is currently living in Mbeya, Tanzania. Sessions with Mlunza totaled approximately 30 hours. While it would have been preferable to use a larger number of speakers to gain a more accurate picture of Kibena phonology, logistics during this research trip required me to spend the majority of my time with a single speaker. Basing acoustic phonetic analysis on data from a single speaker is not without precedence (Burton *et al.* 1992, Maddieson and Ladefoged 1993, Marlo and Brown 2003). All sessions were recorded digitally using an

[1]Guthrie (1971) developed a classification system for Bantu which is widely used to specify individual Bantu languages. It can be futher used to identify the geographic (and sometimes genetic) relationship between two Bantu languages. For further discussion and an update of Guthrie's system, see Maho (2003).

[2]This project was supported primarily by funding from the Dolores E. Mitchell Trust Fund.

[3]Intriguingly, the consultant's last name contains a nasal followed by a liquid, a sequence which is otherwise not found in the data set (nor does Eaton (2007) mention the existence of such a sequence). There are several possible explanations for the occurrence of a nasal-liquid sequence in the speaker's name. First, it is quite possible that the name "Mlunza" is not actually Kibena, but is derived from another Bantu language spoken in the area. Second, the sequence /ml/ may be the result of a deletion of an intervening /u/. The Class 1 (human, singular) prefix is /mu-/. In Kibena it is fairly common for /u/ to be deleted following a bilabial nasal. In any case, the nasal-liquid sequence in the speaker's name represents a fairly unusual case and the /ml/ sequence will not be treated any further here.

Edirol R-09 and a set of high-quality lapel microphones at a sampling rate of 44.1 kHz.

Elicitation was conducted in Kiswahili: the Kiswahili word was given and the consultant responded with the Kibena equivalent. There were several reasons for not using written word lists or sentences in this research. The primary reason for this is that the data analyzed for this paper represents basic elicitation: it was impossible to use word lists initially because previous to this research, I had not collected any Kibena data. It would have been possible to compile word lists based on initial elicitation sessions, but this approach was not used because the Kibena orthography is still in the process of development and quite a bit of individual variation exists between speakers. Much of this variation is related to the marking of long (and lengthened) vowels.[4] Because much of this research involves vowel length and I was unsure of the degree to which orthography would predispose a speaker to pronounce a word one way or another, I chose not to use written word or sentence lists. Unless otherwise noted, all examples and descriptions of Kibena are based upon data collected during this fieldtrip.

4 An overview of Kibena phonology

Kibena has five vowels: /a/, /e/, /i/, /o/, and /u/.[5] Vowel length is contrastive and has a number of different sources. Vowels may be underlyingly long or vowel length may be derived through vowel coalescence (when two vowels come together at a morpheme boundary) or compensatory lengthening. Except for grammatical length arising through vowel coalescence, long and lengthened vowels are restricted to the penultimate and antepenultimate moras of a word. Kibena has two tones: high and low (more accurately, syllables may be described as tonal or non-tonal). Preliminary research indicates that tone is fairly restricted in Kibena: only one high tone may occur per word; short syllables are either High or Low; High-Low contour tone can occur in long syllables. Odden (1988) has argued that Kibena tone is almost entirely predictable and that Kibena is an example of a language which is moving from a tone-based system to a stress-based system. Other processes which affect Kibena vowels include vowel height harmony and optional word-final devoicing.

The consonant inventory of Kibena is summarized in Table 2:

	bilabial	labio-dental	alveolar	palatal	velar	glottal
stops	p b		t d		k g	ʔ
nasals	m		n	ny	ŋ	
fricatives		f v	s			h
affricates			ts			
prenasalized	mb		ns nd		ŋg	
approximants	w		l	y		

Table 2: Kibena consonant phonemes

[4]Traditionally vowel length is not indicated in the orthography and currently according to Helen Eaton (a member of SIL who is working on Kibena) several differing opinions exist about the marking of vowel length: the first group of speakers (mainly older speakers) insist that marking vowel length is unnecessary; the second group advocates marking all long vowels (whether they are underlyingly long or lengthened); the third group prefers to mark only underlyingly long vowels, leaving those vowels whose length can be derived by rule unmarked.

[5]A broad phonemic transcription is used here with respect to vowels. Thus /i/ and /u/ represent the two high vowels (front and back, respectively). /e/ is used to represent a front mid vowel (which is phonetically closer to [ɛ]) and /o/ is its back counterpart. /a/ represents the sole low vowel.

As illustrated in Table 2, Kibena has three series of stops at the bilabial, alveolar, and velar places of articulation: voiced stops, voiceless stops, and pre-nasalized stops. As noted above, the pre-nasalized fricative /ns/ contrasts only with /s/ (Kibena has no voiced alveolar fricative). Thus in Kibena, pre-nasalized consonants do not exhibit a phonemic voicing contrast. However, phonetic differences in voicing of pre-nasalized consonants do occur. Pre-nasalized stops may be devoiced when they occur in the final syllable of a word. For example, the word /lúpeembe/ 'skinny horn' was pronounced by the consultant both as [lúpeembe] and [lúpeemb̥e]. In the current data set pre-nasalized stops are never devoiced anywhere except in the word-final syllable. When spoken slowly, pre-nasalized stops are always voiced.

Voicing of the fricative portion of a pre-nasalized fricative is also possible. The word for 'guest' in Kibena was pronounced both as [múgɛɛnsi] and as [mugɛɛnzi]. An additional intriguing property of pre-nasalized fricatives is that it seems to be possible to delete the nasal portion of /ns/. When this happens, the preceding vowel is nasalized and receives extra length; the fricative is then voiced. Thus /lífiinsa/ 'ash' was pronounced by the consultant as [lifĩĩĩza]. There is one further exception to the rule that pre-nasalized fricatives are voiceless. When a nasal prefix is attached to a stem beginning in /ts/, a voiced pre-nasalized fricative results. Thus /N+tsaayo/ is realized as [nzááyo] 'feet' and /iN + tsuguni/ is realized as [ínzuguni] 'mosquito.' Though the occurrence of tokens such as these in the data set is rare, voicing is quite clear and these words are never pronounced as [*nsáàyo] and [*ínsuguni].[6] Thus while it is possible for pre-nasalized stops to be devoiced and for pre-nasalized fricatives to be voiced, such cases are fairly rare and do not cause phonemic contrasts. Therefore the remainder of the paper will assume the existence of pre-nasalized voiced stops (/mb/, /nd/, /ŋg/) and a pre-nasalized voiceless fricative (/ns/).

Syllable structure in Kibena exhibits a pattern similar to that of other Bantu languages. If the segmental status of NC sequences in Kibena is ignored, then it can safely be stated that Kibena allows only open syllables. If NC sequences are treated as consonant clusters, then Kibena allows only one type of coda consonant (nasals). If, on the other hand, NC sequences are treated as single segments, then Kibena disallows codas (for further discussion, see Section 6 below). Syllable onsets in Kibena may be either simple or complex. Complex onsets include the voiceless alveolar affricate /ts/ and consonant + glide sequences. If NC sequences are treated as pre-nasalized consonants, then these also fall within the complex onset category.

5 Durational properties of pre-nasalized consonants

As Downing (2005) notes, durational properties of pre-nasalized consonants vary widely, particularly with respect to how similar they are to simplex consonants. Thus, in some languages (such as Fijian) pre-nasalized consonants may have essentially the same duration as other singleton consonants in the language, while in others (many Bantu languages), pre-nasalized consonants may be much longer than other consonants. This study analyzes durational evidence for several reasons. First, many discussions of NC sequences use durational evidence either in favor of or against a treatment of such sequences as pre-nasalized consonants (see discussion below). Second, while durational properties may not provide definitive evidence in favor of a particular analysis, they contribute to a better understanding of consonant properties in a particular language and the differences between consonant types. Certain durational differences (for example, length distinctions between homor-

[6] The morphophonemic behavior of Class 9 and 10 nouns (/N-/ prefix) is quite fascinating and merits further investigation. The process described here is similar to that which occurs when nasals are prefixed to voiceless stops (/N-/ prefixed to a stem beginning in /k/, for example, results in /ŋ/).

ganic non-derived NC sequences and homorganic, morphologically derived NC sequences) could reflect underlying structural differences. While durational properties cannot be used exclusively to make any particular claims about consonant types, together with other properties (syllable structure, distributional properties, etc.) they can be used as evidence favoring one analysis over another. In an effort to establish the segmental status of homorganic NC sequences in Kibena, this study will consider the durational properties of these types of segments as compared with other consonant types (singleton nasals and consonants).

Several studies have reported findings that pre-nasalized consonants are approximately equivalent in duration with other singleton consonants. Herbert (1975) does not provide actual numerical figures for his data but claims that Luganda NC sequences are "durationally reduced" so that they have the same phonetic duration as other singleton consonants. Pre-nasalized stops in Fijian have been shown to exhibit the same durational properties as oral stops (Maddieson 1989, Maddieson and Ladefoged 1993). In contrast, Hubbard (1995) found that NC sequences were significantly longer than both nasals and oral stops in Luganda. Maddieson and Ladefoged (1993) describe the durational properties of partially nasalized consonants in a number languages. They find that in Sinhala pre-nasalized stops are similar in duration to NC clusters in other languages like English. They also found that pre-nasalized consonants in Luganda and Sukuma are longer than nasals or oral stops.

5.1 Durational properties: measurement and analysis

In Kibena, the duration of pre-nasalized consonants was measured and compared with singleton oral and nasal consonants. Durations were measured in milliseconds by analyzing both waveforms and spectrograms in Praat. Following Maddieson and Ladefoged (1993), the nasal portion of the pre-nasalized consonant was measured from the onset of the nasal murmur until the release of the consonant. The consonant portion was measured from its onset until the beginning of the following vowel. Both the nasal and oral singleton counterparts of each pre-nasalized consonant were also measured (this included /m/, /b/, /n/, /d/, /s/, /ŋ/, and /g/). Unless otherwise noted, durational means were compared using two-factor analyses of variance to test for significant differences; post-hoc contrasts were tested using Scheffe's test.

Before it was possible to compare the duration of pre-nasalized consonants with singleton consonants in Kibena, it was necessary to determine which factors affected the length of pre-nasalized consonants. First, the duration of initial pre-nasalized consonants was compared with the duration of medial pre-nasalized consonants. Overall, initial pre-nasalized consonants had a mean of 176 ms (SD=36, n=23) and medial pre-nasalized consonants had a mean duration of 152 ms (SD=33, n=119). Pre-nasalized consonants were further broken down by individual consonant; a summary of mean duration is presented in Table 3:

	Initial				*Medial*		
	Mean Duration	SD	*n*		Mean Duration	SD	*n*
Pre-nasalized stops							
bilabial	150	25	5		145	19	32
alveolar	184	40	4		130	15	31
velar	188	37	9		154	30	38
Pre-nasalized fricatives							
alveolar	170	38	5		200	36	18

Table 3: Mean duration (ms) of pre-nasalized consonants in Kibena

Pre-nasalized consonants in word-initial position were significantly longer than those in word-medial position: $F(1{,}134) = 6.705$, $p = .011$. Duration also varied significantly between the four phonemes /mb/, /nd/, /ŋg/, and /ns/: $F(3{,}134) = 6.686$, $p = <.001$. When consonant phonemes were compared it was found that the duration of /mb/ was not significantly different from /nd/ or /ŋg/, but all other mean differences were significant.

As evident in Table 3, word-medial pre-nasalized consonants are far more common than word-initial pre-nasalized consonants. This is a result of the data set which was used: this analysis draws from isolated nominal and verbal (infinitival) forms. Verbal infinitives always begin with hu-; nouns begin with a noun class prefix. There are 18 noun classes in Kibena; only Class 9 and Class 10 nouns may begin with a pre-nasalized consonant. Thus most of the examples of word-initial pre-nasalized consonants in the data set are nouns from either Class 9 or Class 10. Additionally, due to morphological properties of Kibena, the oral consonants /b/, /d/, /s/, and /g/ occurred fairly rarely in the data. Initial nasals are fairly common (many of the noun class prefixes begin in a nasal), but they are often subject to idiosyncratic processes that affect only noun class prefixes. The analysis has also shown that word-initial and word-medial pre-nasalized consonants have significantly different mean durations. For all of these reasons, in an effort to keep the data as balanced as possible, the remainder of the analysis deals only with word-medial consonants. This provides the additional benefit of restricting the analysis to those pre-nasalized consonants which occur underlyingly (rather than those which are derived through morphological processes).

Maddieson and Ladefoged (1988) and Maddieson and Ladefoged (1993) have shown that pre-nasalized stops in Fijian have the same durational properties as oral stops. For Kibena, word-medial singleton consonants (voiced stops and the voiceless alveolar fricative) were compared durationally with singleton nasals and the total duration of pre-nasalized consonants. This data is summarized below in Table 4:

	Singleton Nasal			*Singleton C*			*Pre-nasalized C*		
	Mean	SD	*n*	Mean	SD	*n*	Mean	SD	*n*
Stops									
bilabial	108	20	35	118	19	21	145	19	32
alveolar	99	20	29	98	26	45	130	15	31
velar	132	21	8	104	25	63	154	30	38
Fricatives									
alveolar	99	20	29	154	20	20	143	49	18

Table 4: Comparison of consonant type duration (ms) in Kibena

Table 4 shows that in Kibena, pre-nasalized consonants are longer than their singleton counterparts. For all four groups presented in Table 4 (bilabial, alveolar, and velar stops as well as the alveolar fricative), significant differences were found among the means of singleton nasals, singleton consonants, and pre-nasalized consonants (bilabial stops: $F(2{,}85) = 30.631$, $p<.001$; alveolar stops: $F(2{,}102) = 24.293$, $p<.001$; velar stops: $F(2{,}106) = 37.803$, $p<.001$; alveolar fricatives: $F(2{,}64) = 92.230$, $p<.001$). As expected, for the bilabial and alveolar stop groups, there was no significant difference in duration between singleton stops and nasals, but singleton consonants (stops and nasals) were shown to be significantly shorter than pre-nasalized consonants. For the alveolar fricative group, each consonant type (nasal, fricative, and pre-nasalized fricative) was significantly different from the others. What is surprising are the results of the post-hoc test within the velar stop group. Within this group, there was no significant difference in duration between the velar nasal and the velar pre-nasalized stop. Both the singleton velar nasal /ŋ/ and the pre-nasalized stop /ŋg/ were significantly longer than the singleton stop /g/. Compared with other singleton nasals, the velar nasal is particularly long; possible explanations of this extra length will be discussed in more detail below. Thus (with the exception of the velar nasal), this data has shown that, unlike Fijian, pre-nasalized consonants do not have similar acoustic durations to singleton segments.[7]

The next question deals with the duration of the two component portions of a pre-nasalized consonant and how well these compare to their singleton counterparts. Table 5 summarizes the duration of singleton consonants (voiced stops and voiceless alveolar fricatives) compared with the duration of component parts (stop/fricative and nasal) of a pre-nasalized consonant:

	Singleton Nasal				*in Pre-nasalized C*		
	Mean	SD	*n*		Mean	SD	*n*
Stop	104	26	130		32	8	31
Fricative	154	20	20		88	26	18
Nasal	109	27	73		108	20	119

Table 5: Mean duration (ms) of singleton consonants and component parts of pre-nasalized consonants

These data show that both stops and fricatives show a significant decrease in duration when they occur as part of a pre-nasalized consonant. Nasals, however, show no such decrease. Each of these findings is considered in greater detail below.

Comparisons were first made between the length of the nasal portion of a pre-nasalized consonant and a regular singleton nasal. Overall, word-medial singleton nasals were 107 ms long (SD=27, n = 72) and the mean duration of the nasal portion of pre-nasalized consonants was 108 ms (SD=19, n = 108). Findings were broken down according to place/manner of articulation and are summarized in Table 6:

	Singleton Nasal			*Nasal Portion of PNC*			*Mean Difference*
	Mean	SD	*n*	Mean	SD	*n*	
Stops							
bilabial	108	20	35	110	18	32	+2
alveolar	99	20	29	98	16	31	-1
velar	132	21	8	112	21	37	-20
Fricatives							
alveolar	99	20	29	112	15	18	+13

Table 6: Mean duration (ms) of singleton nasal consonants and the nasal portion of pre-nasalized consonants

No significant difference was found in mean duration of singleton nasals and the nasal portion of pre-nasalized consonants for bilabial and alveolar stops. The nasal portion of a pre-nasalized alveolar

[7]Preliminary research indicates that it may be possible to treat voiceless stops (composed of a significantly delayed release plus voiceless stop), pre-nasalized consonants, and the alveolar affricate /ts/ together as complex segments. Durationally, these segments pattern similarly. Voiceless stops have a mean duration of 148 ms, pre-nasalized stops have a mean of 152 ms, and the mean duration of the voiceless alveolar affricate is 154 ms. The treatment of complex segments in Kibena (and whether all of these consonant types, particularly voiceless stops, should be treated as complex segments) is a particularly intriguing direction for future research in Kibena.

fricative is slightly longer than that of a singleton nasal. The velar singleton nasal is significantly longer than other singleton nasals and the nasal portion of a pre-nasalized consonant. A discussion of possible explanations for this phenomenon is given below.

The final question which was addressed regarding acoustic duration of pre-nasalized consonants concerned the length of the "consonant" (oral stop or fricative) portion of the pre-nasalized consonant. The duration of simplex consonants (/b/, /d/, /g/, /s/) was compared against the duration of the stop or fricative portion of the pre-nasalized consonant. Findings were broken down according to place/manner of articulation and are summarized in Table 7 below. For these consonants, the stop or fricative portion of a pre-nasalized consonant is significantly shorter than a singleton oral consonant: $F(1,258) = 693.405$, $p<.001$.

	Singleton Nasal			*C Portion of PNC*			*Mean Difference*
	Mean	SD	*n*	Mean	SD	*n*	
Stops							
bilabial	120	19	19	35	9	32	-85
alveolar	99	26	43	32	8	31	-67
velar	104	25	65	39	12	38	-65
Fricatives							
alveolar	154	20	20	88	26	18	-66

Table 7: Mean duration (ms) of singleton consonants and the consonant portion of pre-nasalized consonants

5.2 Velar nasals: an exception to the analysis?

Several parts of the above analysis have indicated that velar consonants have different durational properties than other consonants in Kibena. In particular, singleton velar nasals have a mean duration of 143 ms while bilabial and alveolar nasals are much shorter (108 ms and 99 ms, respectively). This extra length on the velar nasal complicates the analysis: whereas alveolar and bilabial nasals have approximately the same duration when they occur in singleton consonants and in the nasal portion of a PNC, the velar nasal appears to have a significant decrease in duration from singleton consonant (132 ms) to pre-nasalized consonant (112 ms). One possible explanation for the unusually high duration for singleton velar nasals stems from their relative scarceness in the data set (the mean duration of 132 ms is based on only 8 tokens). An additional possible explanation for the extra length of velar nasals could be that velar consonants in general in Kibena are longer than alveolar consonants. However, voiced velar stops (mean 104 ms) are shorter than bilabial stops (120 ms); thus it does not seem on the basis of the current data set that such an explanation explains the Kibena data well (though the collection of more data may prove that this is indeed the case). There is a third possible explanation: most of the singleton velar nasals in the data set occur in stem-initial position. Stem-medial singleton velar nasals have a mean duration of 127 ms; stem-initial velar nasals have a mean duration of 152 ms.[8] Though the data set is obviously too small to draw any significant conclusions for this, it does point to a possible solution for the extra length of velar nasals.[9]

[8]A mean duration of 127 ms is still rather long. On the basis of the current data set it is impossible to determine whether this extra length is accurate or whether it is a relic of a small data set. The collection of additional tokens containing word-medial velar nasals in future research will help to answer this question.

[9]Preliminary research indicates that when a nasal (Class 9 or 10 prefix) is prefixed to a word beginning in a voiceless stop, the nasal and the stop coalesce. Thus /N-peembe/ 'horn' is realized as /meembe/. When a nasal is prefixed to a

5.3 Non-homorganic NC sequences

If an analysis of homorganic NC sequences as pre-nasalized consonants (rather than as NC clusters) is correct, it would be expected that pre-nasalized consonants would exhibit different durational properties from non-homorganic NC clusters, which would be impossible to treat as single segments. Unfortunately, examples of non-homorganic NC clusters are fairly limited in Kibena. Some examples are given in Table 8 below:

mudala ∼ mdala	'wife'		mutaali ∼ mtaali	'tall.CL1'
mulomo ∼ mlomo	'mouth'		kimuswiiliya∼ kimswiiliya	'otter'
mutaanda ∼ mtaanda	'six'		mutamwa ∼ mtamwa	'sick person'

Table 8: Non-homorganic NC sequences in Kibena

It should be noted that without exception, non-homorganic NC sequences are derived through deletion of /u/ following /m/. Odden and Odden (1999) observed a similar process in Kihehe. The deletion of the /u/ was made more obvious in several cases when the consultant was asked to repeat the word. For example, 'pastor' was pronounced /mtehetsi/ at first, but when asked to repeat the word, the consultant slowed down and said /mutehetsi/. Further, every case of a non-homorganic NC cluster involves a bilabial nasal followed by some consonant; non-homorganic NC clusters always occur in stem-initial position, and the deleted /u/ is always part of a noun class prefix (either Class 1 or Class 3). Thus sequences such as these are impossible to analyze as pre-nasalized consonants. Durational evidence, though somewhat anecdotal as there are very few examples of this process in the data set, seems to support this, as shown in Table 9:

	Nasal	*Voiced Stop*	*Voiceless Stop*	*Fricative*	*Alveolar Lateral*
Mean	125	95	129	173	108
SD	28	3	14		
n	12	3	6	1	1

Table 9: Duration of consonants in non-homorganic NC clusters.

As Table 9 illustrates, nasal length in non-homorganic NC clusters is similar to that of inter-vocalic nasals and to the nasal portion of a pre-nasalized consonant (see Table 6). Crucially, however, voiced stops occurring in non-homorganic clusters have a mean duration of 95 ms. Though there are only three examples in the data, the evidence seems to indicate a significant difference from the stop portion of a pre-nasalized consonant. The voiced stop portion of a pre-nasalized consonant ranges from 22 ms to 51 ms (mean of 32 ms); thus though there are only three examples of voiced stops in non-homorganic clusters in the data set, all three (92 ms, 97 ms, 97 ms) are almost twice as long as the longest stop portion of a pre-nasalized consonant. Further evidence contrasting pre-nasalized consonants with non-homorganic NC clusters lies in the ability of the nasal to bear tone. The nasal portion of a pre-nasalized consonant does not bear tone (except those pre-nasalized consonants which are

word beginning in a voiced stop, a pre-nasalized consonant results: /N-badaansi/ 'okapi' is realized as /mbadaansi/. I have observed that the nasal seems to be slightly longer when it results from a nasal prefixed to a voiceless consonant. Insufficient evidence (particularly with regard to the form of the stem) prevents me from pursuing this issue any further at this time.

morphologically derived from Class 9/10 prefixes, see Section 6.2 below); nasals in non-homorganic NC clusters are tone bearing units. For example, the Kibena word for 'six' is /ḿtaanda/. Here the nasal bears high tone; the rest of the word has low tone. Thus in a non-homorganic NC cluster the nasal is syllabic: it can bear independent tone and the following consonant is similar in duration to other singleton consonants in Kibena. In particular, the significant difference in duration between the consonant portion of homorganic NC sequences and that of non-homorganic NC sequences is an indication that such segments have different structural properties and should be treated differently.

5.4 Durational properties: discussion

The analysis presented above produced intriguing results. Durationally, in a pre-nasalized consonant, the nasal portion is not actually any shorter than a normal nasal; in fact, it is the stop or fricative portion which is significantly shortened. This is illustrated by Figures 1–3.

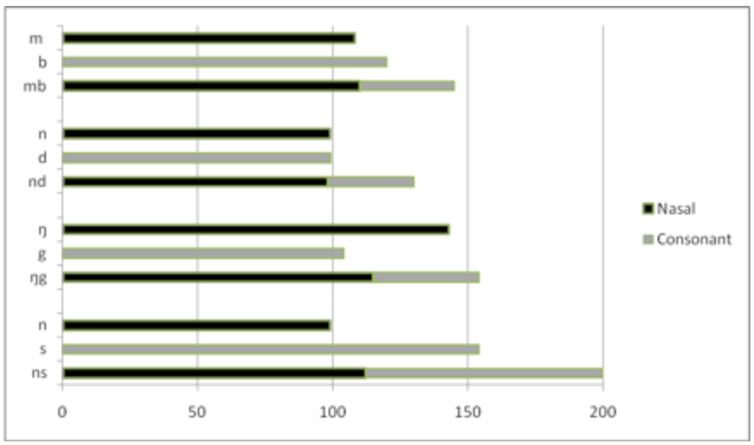

Figure 1: Mean duration of nasals, oral stops, oral fricatives, and pre-nasalized consonants in Kibena.

Further, the stop/fricative portion of a pre-nasalized consonant is significantly shorter than stops and fricatives occurring in non-homorganic NC clusters which cannot possibly be analyzed as pre-nasalized consonants. This indicates that there is some validity to a claim that component parts of pre-nasalized consonants are durationally reduced. What is intriguing, however, is that the stop/fricative portion is reduced—the nasal portion is not. Perhaps the name 'pre-nasalized consonant' is a bit of a misnomer. Referring to such segments as 'pre-nasalized consonants' implies that it is the consonant itself which is most prominent; it simply receives a bit of nasalization at the beginning of the consonant. However, this data has shown that the nasal is actually longer than the consonant.[10]

These results led to the question of whether segments such as these should more appropriately be considered orally stopped nasals rather than pre-nasalized consonants. Maddieson and Ladefoged (1993) observe that "post-stopped nasals" have only been documented in a number of dialects of Chinese and several Austronesian languages. They distinguish between pre-nasalized consonants and post-stopped nasals by claiming that the latter do not actually contain an oral stop component because "air flow is shunted almost instantaneously from a nasal escape to an oral one, without the

[10]Though the nasal portion is longer, durational evidence is not sufficient to prove which portion of the pre-nasalized consonant is in fact more prominent (or which portion is more salient to speakers); it is possible that perceptual tests could shed some light on this issue.

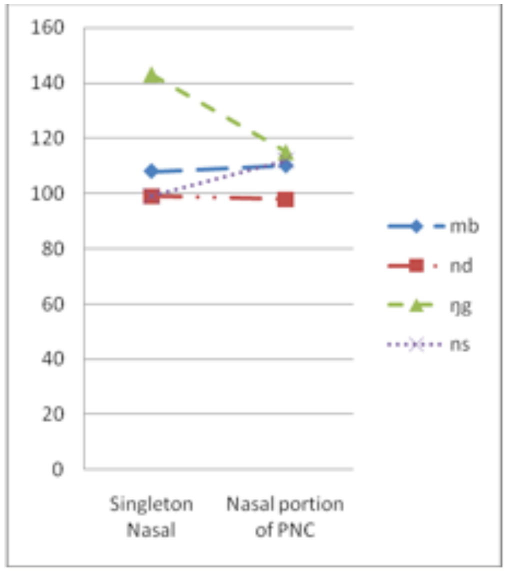

Figure 2: Mean duration of nasals and nasal portion of PNC.

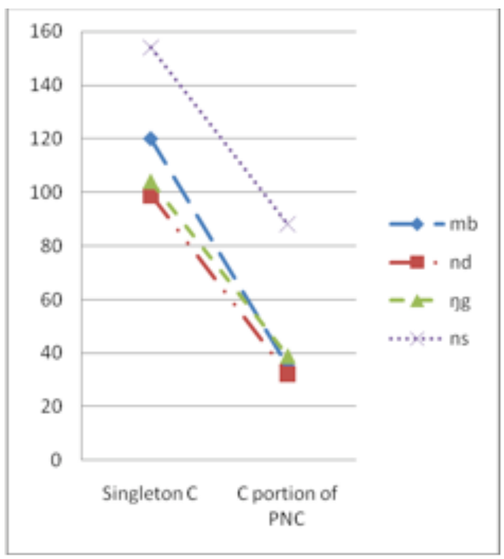

Figure 3: Mean duration of oral consonants and stop/fricative portion of PNC.

overlapping of nasal and oral closures that occurs in a pre-nasalized stop" (Maddieson and Ladefoged 1993:281). Hu (2007) corroborates this observation in a study of the aerodynamic and acoustic properties of post-stopped nasals in a number of Chinese dialects.

Though aerodynamic measurements of intraoral pressure and nasal flow seem to be the best method of testing this distinction between orally stopped nasals and pre-nasalized consonants, Kibena does not seem to exhibit any of the properties described above. An analysis of waveforms and spectrograms indicates a clear oral stop component which is distinct from the nasal component. Figure 4 is a spectrogram of /mbadaansi/ 'okapi.' The spectrogram shows a distinction between the nasal and consonant portions of pre-nasalized consonants (/mb/ and /ns/). Also evident on this spectrogram is the distinct difference in duration between the stop component of a pre-nasalized stop /mb/ and a singleton voiced stop /d/.

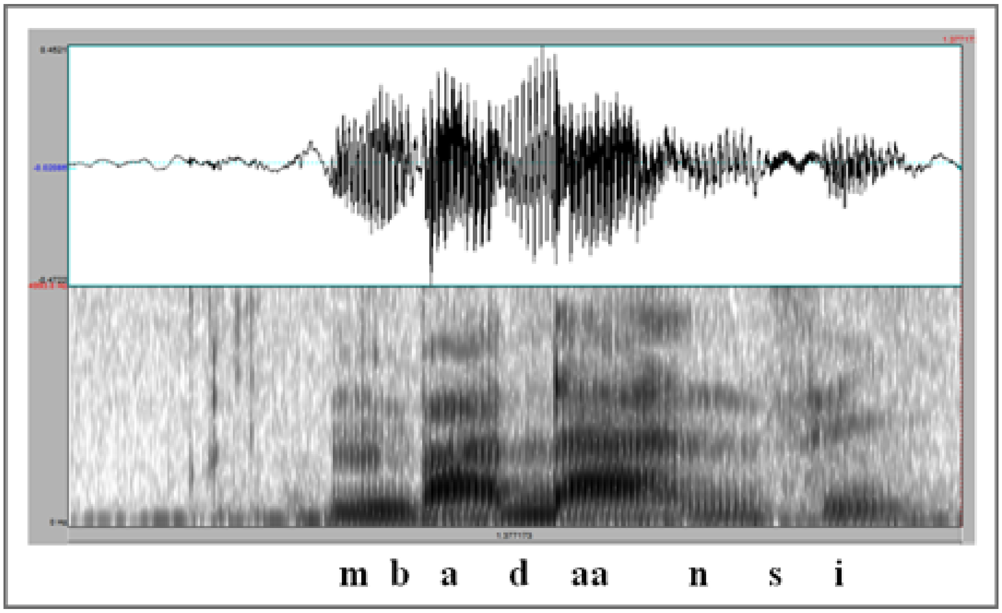

Figure 4: Spectrogram of /mbadaansi/ 'okapi.'

Two other observations are worth making about the distinction between pre-nasalized stops and orally stopped nasals. Hu (2007) notes that "post-oralized nasal consonants" rarely contrast with plain nasals. In Kibena (and in most Bantu languages) there is a definite phonemic contrast between pre-nasalized consonants and plain nasals. Additionally, to my knowledge, no one has proposed that segments such as these should be analyzed as an orally stopped nasal in a Bantu language. Thus in spite of the significant shortening of the oral portion of a pre-nasalized consonant, it seems reasonable to conclude such segments should be analyzed as pre-nasalized consonants, rather than as orally stopped nasals.

6 Distributional properties

6.1 Syllable structure

Distributional properties of NC sequences in Kibena provide further evidence in favor of their treatment as single segments. If NC sequences are temporarily ignored, Kibena (like most Bantu languages) allows only open syllables. With respect to the behavior of NC sequences, two different positions can be taken. First, it can be argued that only open syllables are possible in Kibena; therefore NC sequences must be treated as a single segment. The second possible position is that closed syllables are possible and that therefore NC sequences should be analyzed as consonant clusters. Logically, these two positions can be expressed in the opposite order: if NC sequences are analyzed as pre-nasalized consonants, then Kibena allows only open syllables. Similarly, if NC sequences are analyzed as clusters, then Kibena allows coda consonants. Thus the open/closed syllable question cannot provide any conclusive evidence for either position, but it is still worth examining to gain a better understanding of the behavior of these sequences.

Downing (2005) addresses "open syllable" arguments in her discussion of NC sequences in Bantu. She claims that because nasals are very high in sonority, if a language were to only allow one type of coda consonants, it would likely be a nasal. A similar argument is possible for Kibena, though it should be noted that Kibena does not allow other higher sonority consonants such as glides or laterals in coda position.[11] Further, word-final syllables are always open—it is impossible to end a word in a nasal in Kibena. Thus an analysis of NC sequences as clusters would necessitate the treatment of word-final syllables differently from other types of syllables (though this is possible, it is not ideal). Additionally, while Kibena does not allow other types of consonant codas, it does allow other complex onsets. These include the alveolar affricate /ts/ and consonant + glide sequences. Analyzing NC sequences as pre-nasalized consonants is a simpler analysis: there is no need to propose that nasals have the unique ability to occur in (non-word final) coda position, and proposing that NC sequences be treated as complex onsets does not further complicate the analysis, because other complex onset types are allowable in Kibena.

6.2 Word-level distribution of NC sequences

A further piece of evidence which must be taken into account in an analysis of the segmental status of NC sequences involves their distributional properties within words. NC sequences in word-medial position are fairly common in Kibena. Consider the examples in Table 10:

dáànda	'blood'		hudindulílwa	'to be closed'
hítsiimba	'bushbuck'		mabadáánsi	'okapi (pl.)'
mugúúnda	'field'		hutááŋga	'to help'
hwifúúŋgo	'down'		huvéémba	'to cry'

Table 10: Word-medial NC sequences in Kibena

Though they occur frequently in Kibena, word-medial NC sequences provide no additional evidence regarding the question of whether such sequences should best be analyzed as single segments or as consonant clusters. Either argument can explain such sequences equally well.

NC sequences occurring in word-initial position are more difficult to explain if one takes the position that such sequences are consonant clusters. Downing (2005) claims that the existence of word-initial NC sequences should not necessarily lead to analysis of such sequences as single segments. She gives three primary reasons for this claim: first, she argues, there is almost always a morpheme break between the nasal and consonant in a word-initial NC sequence. Secondly, the nasal portion of a word-initial NC sequence often has the ability to bear stress and/or tone. Third, because word-medial NC sequences are best analyzed as consonant clusters (under her theory), there is no reason to suppose that word-initial NC sequences should be treated any differently. Below I take each one of these arguments and show why it is still preferable to treat NC sequences in Kibena and pre-nasalized consonant.

Much of Downing's argument that NC sequences should be treated as consonant clusters hinges upon her claim that "word-initial NC sequences in Bantu languages are almost always separated by a morpheme boundary, so the sequences are clearly input clusters" (2005:208). In Kibena, many (but not all) of the word-initial NC sequences are morphologically derived, particularly when such

[11]The fact that Kibena does not allow other high sonority consonants in coda position does not necessarily mean that nasals cannot occur in coda position. Jim Stanford (p.c.) has pointed out that other languages, such as Mandarin Chinese and Vietnamese, do not allow laterals in coda position but do allow nasals to occur in coda position.

sequences arise after the prefixing of a Class 9/10 prefix (/N-/) to a word beginning in a voiced stop;[12] see Table 11.

singular			*plural*			*gloss*
N-badaansi	→	m-badáánsi	ma-badáánsi			'okapi'
N-gubi	→	ŋ-gúbi	ma-gúbi			'pig'
N-béva	→	m-béva	ma-béva			'hyrax'
		li-gíli	N-gili	→	ŋ-gíli	'warthog'
		lu-báwo	N-báwo	→	m-báwo	'wood'

Table 11: Morphologically derived NC sequences in Class 9 & 10 nouns

When a nasal prefix attaches to a stem beginning in /l/, a pre-nasalized alveolar stop is produced. Thus when /lu-leeŋga/ 'water' is pluralized, the resulting form is /n-deeŋga/. When a nasal prefix attaches to a stem beginning in /ts/, a *voiced* pre-nasalized alveolar fricative results, as shown in Table 12.

singular	*plural*			*gloss*
lu-tsááyo	N-tsaayo	→	n-zááyo	'leg'
lú-tsitsi	N-tsitsi	→	n-zítsi	'rope'

Table 12: Nasal prefixation with /ts/-initial nouns

It should be noted, however, that such morphologically derived word-initial NC sequences occur only in the absence of an augment.[13] Augmented forms of Class 9/10 nouns have an additional /i-/ on the beginning of the word, resulting in such words as *imbadáánsi* 'okapi', *iŋgíli* 'warthog,' and *inzááyo* 'leg.'

Thus as Downing predicts, many of the NC sequences in Kibena are morphologically derived. However, this does not necessarily mean that these must be treated as clusters. Downing provides no reasons why a proscription against underlying pre-nasalized consonants in word-initial position would mean that such segments could not be treated as unit segments on the surface. In Kibena, the addition of the Class 9/10 nasal prefix to words beginning with a voiceless stop provides direct evidence to counter the implicit assumption in Downing's argument that underlying clusters must be analyzed as surface clusters. When a Class 9/10 nasal is prefixed to a stem beginning in a voiceless stop, the stop and the nasal coalesce as shown in Table 13.

Thus one type of input (nasal + voiceless consonant) results in a single segment. There is no reason to assume that a slightly different type of input (nasal + voiced consonant) would not result in a single segment.

[12]Somewhat unusual singular-plural pairings are given here, because in Kibena, the plural class which typically corresponds to Class 9 nouns is Class 10. In Kibena, both Class 9 and 10 nouns are marked by a nasal prefix. Thus from prototypical pairings it is impossible to determine the stem of the word.

[13]In many Bantu languages, each noun class prefix has two alternate forms. For example, the word for 'girl' in Kibena may be *u-mu-hiinsa* or *mu-hiinsa* (where *mu-* is the Class 1 prefix). This extra vowel on the beginning of a noun is referred to in the Bantu literature as an "augment", a "pre-prefix", or an "initial vowel". In different languages the augment seems to play different roles, licensing definiteness and/or other semantic and pragmatic features. The function of the augment in Kibena at the current time is unclear.

singular			*plural*			*gloss*
N-kahala	⟶	ŋ-áhala	ma-kahála			‘trash’
N-kolegáta	⟶	ŋ-olegáta	ma-kolegáta			‘antelope sp.’
		lú-piiŋga	N-piiŋga	⟶	m-iiŋga	‘herd’
		lu-tóóndwe	N-toondwe	⟶	n-óóndwe	‘star’
		lu-káánsi	N-káánsi	⟶	ŋ-áánsi	‘wall’

Table 13: Class 9/10 stop-nasal coalescence

Further, even if we were to accept Downing’s claim that morphologically derived pre-nasalized consonants should be treated as clusters, there exist in Kibena a number of examples of word-initial NC sequences which are not morphologically derived. Sequences such as these are not addressed in Downing’s analysis. Consider the following examples in Table 14.

mbáha	‘until’		ndi-	‘1SG.SUBJ’
ndauli	‘how’		ns-	‘CL10’
nde	‘if’			

Table 14: Non-morphologically derived word-initial NC sequences

The first singular subject marker /ndi-/ and the Class 10 agreement prefix /ns-/ (which occurs before adjectives beginning in a vowel) are illustrated by examples (1) and (2).

(1) *ndi-hamem-íts-e í-nd-owo u-lu-lééŋga.*
1SG-fill-CAUS-FV AUG-9-bucket AUG-11-water
‘I filled the bucket with water.’

(2) *ŋ-úhu ts-ááŋgu ns-éélu.*
10-chicken 10-1SG.POSS 10-white
‘my white chickens’

Examples such as these illustrate that contrary to Downing’s (2005) claim, word-initial pre-nasalized consonants are not necessarily morphologically derived. In such cases these consonants are better treated as single segments, rather than as consonant clusters.

Downing’s second piece of evidence that word-initial NC sequences are better treated as clusters lies in their ability to bear tone and/or stress. It is possible in morphologically derived word-initial sequences for the nasal to bear tone. This occurs only in the absence of the augment, as in Table 15.

augmented	*non-augmented*	*gloss*
índowo	ńdowo	‘bucket’
íŋgola	ŋ́gola	‘skin’
ímbega	ḿbega	‘monkey’

Table 15: Nasals bearing tone in morphologically derived word-initial NC sequences

Thus when the augment is deleted, the nasal bears its tone. Word-initial sequences which are not morphologically derived can never bear tone. While the lack of the ability of non-morphologically derived NC sequences to bear tone does not prove that such segments should be treated as prenasalized consonants, the ability of the nasal portion of morphologically derived NC sequences does not provide concrete evidence that such segments should be treated as clusters either, since their tone results from the deletion of the augment (the tone-bearing unit). Thus not all nasals in initial NC sequences have the ability to bear tone (though some do). An argument on the basis of tone does not substantially support either position with respect to the segmental status of NC sequences.

Downing's third and final argument that word-initial sequences should be treated as NC clusters is simply that if word-medial NC sequences are treated as clusters, there is no reason to suppose that word-initial NC sequences are any different. Thus far, an analysis of Kibena shows that word-medial NC sequences should not be treated as clusters. Further evidence (presented in Section 7) from native speaker intuition supports this conclusion. Therefore because word-medial NC sequences are not treated as clusters here, Downing's last argument for the treatment of word-initial NC sequences as clusters does not hold up. Thus I have shown that Downing's three arguments in favor of a treatment of word-initial NC sequences as clusters do not hold true for Kibena: not all word-initial NC sequences in Kibena are morphologically derived (and there is no reason to believe that those that are underlyingly clusters are necessarily not single segments on the surface), non-morphologically derived NC sequences cannot bear tone, and it cannot be argued that initial NC sequences are clusters because medial NC sequences are clusters (since it is not necessary to treat medial NC sequences as clusters).

7 Native speaker intuition: syllabification

An additional piece of evidence lies in the psychological reality of syllable boundaries. When asked to repeat a word, the consultant usually spoke deliberately; at a very slow rate of speech NC sequences were always syllabified as .NC and never as N.C. Downing (2005) argues that this is actually a test for prosodic-wordhood (rather than syllable structure): when asked to break words into syllables speakers pronounce syllables as if they occur at the end of words (and thus syllabify nasals as onsets because words in Bantu languages do not end in consonants). She uses the word "happy" in English as an example: speakers generally syllabify this word into "hap" and "py" (evidence such as this has been used to argue that the /p/ is ambisyllabic). Downing argues that speakers pronounce "hap" rather than "ha" because "hap" is a possible phonological word in English; "ha" is not. While this argument seems to work in this situation, it does not explain the Kibena data very well. First, the speaker was not actually asked to break the words into syllables, he was simply speaking slowly. Second, open syllables occur both word-medially and word-finally in Kibena (thus it cannot be argued that syllables pronounced as open at slower rates of speech are necessarily word-final). In Kibena, however, there is a possible difference in pronunciation between word-medial and word-final syllables. Kibena speakers often devoice word-final vowels (this is why word-final vowels were not measured in this study). Though this phenomenon is optional, it is limited to word-final position. The consultant never devoiced word medial syllables (supposedly "word final" vowels under Downing's argument) when he was speaking slowly, though he would often devoice final syllables. That raises the question of why speakers would use one property of word-final syllables (constraints against words ending in consonants) while not invoking another property (where word-final syllables are devoiced). If the speaker really was treating word-medial syllables as word-final syllables at slow rates of speech, some additional mechanism would be necessary to explain why devoicing never happened in this position.

8 Conclusion

The above argument has presented a number of pieces of evidence in favor of the treatment of NC sequences in Kibena as pre-nasalized consonants: stops and fricatives are significantly shortened when they compose part of a pre-nasalized consonant (though pre-nasalized consonants are still significantly longer than their singleton counterparts); pre-nasalized consonants can occur at the beginning of a word and at the beginning of a morpheme; distributionally Kibena syllables seem to disallow consonant codas, and there does seem to be some psychological reality for speakers of the pre-nasalized consonant as a syllable onset. While none of these pieces of evidence is individually enough to claim an analysis of NC sequences as pre-nasalized consonants, together these arguments seem to indicate that treating such segments as pre-nasalized consonants is the best approach.

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