On the Representation of NC Clusters in Bemba

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1. Introduction

In this paper I aim to provide an analysis of Nasal Consonant clusters. In attempting to derive the facts of nasal place assimilation two views of Nasal Consonant clusters (NC's henceforth) have evolved, namely; as a unit segment, complex segment or nasal contour, on the one hand, and as sequences of segments on the other. To account for NC's as attested in Bemba, I propose an analysis of NC clusters, in the framework of Government Phonology (GP) (Kaye, Lowenstamm and Vergnaud, 1985, 1990) as sequences of consonants employing onset to onset government and licensing constraints. The structure of this paper is as follows: Section 2 presents the phonological behaviour of NC's in Bemba, Section 3 gives some proposals that have been made for the representation of NC's, in Section 4 I give a brief background of Government Phonology, followed by my analysis and proposal's and Section 5 offers some concluding remarks.

2. Phonological behaviour of NC's in Bemba

The only consonant clusters found in Bemba,[1] as in many other Bantu languages, either involve 'semi-vowels', or a nasal and a homorganic consonant.[2] In order to motivate the structure I propose for NC's in Bemba, I present four relevant environments; assimilation, strengthening of consonants, NC simplification, and nasal consonant harmony (2.1–2.4).

2.1 *Homorganicity*

In Bemba the nasal in NC's is homorganic to the following consonant. This follows from the notion that nasals are typically placeless consonants that need to share a place of articulation with a following consonant as long as it is available. This can be seen with the 1st person singular prefix *n-* when followed by different stem-initial consonants:

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(1)	a.	-pata	'hate'	mpata	'I hate'
	b.	-futa	'pay'	mfuta	'I pay'
	c.	-masa	'daub'	mmasa	'I daub'
	d.	-tana	'refuse'	ntana	'I refuse'
	e.	-sala	'choose'	nsala	'I choose'
	f.	-naka	'get tired'	nnaka	'I get tired'
	g.	-ʃita	'buy'	nʃita	'I buy'
	h.	-ʃapa	'wash'	nʃapa	'I wash'
	i.	-kula	'grow'	ŋkula	'I grow'

(1) shows that the 1st person singular prefix surfaces as *m-* before stem initial consonants {p, m, f}, as *n-* before {t, s, n, ʃ, ʧ}, and as ŋ- before {k}.

2.2 *Strengthening of the following consonant*

1st person singular prefix also shows that some stem initial consonants change when preceded by a nasal. In particular, *β* becomes *b*, and *l* becomes *d*:

(2)	a.	-βila	'sew'	mbila	'I sew'
	b.	-leka	'stop'	ndeka	'I stop'

In (2a), *β* becomes *b* after the nasal *m-*, in (2b), *l* becomes *d* after *n-*. A similar process occurs with vowel initial stems:

(3)	a.	-alula	'redirect'	ŋgalula	'I redirect'
	b.	-olola	'straighten'	ŋgolola	'I straighten'
	c.	-ubula	'peel'	ŋgubula	'I peel'
	d.	-isula	'open'	nʤisula	'I open'
	e.	-elela	'forgive'	nʤelela	'I forgive'

In (3a–3c), that is, stems beginning with *a*, *o*, and *u*, the consonant *g* is inserted after the prefix while for stems beginning in *i* or *e*, *ʤ*, is inserted, (3d–3e).

Note that in Bemba, *b*, *d*, *g* and *ʤ* are only found in these contexts, that is in NC's, and also that the nasal prefix is regularly homorganic, in particular, it is *ŋ-* before *g*, but *n-* before *ʤ*.

2.3 *Meinhof's law*

Bemba has a process which illustrates what is known as 'Meinhof's Law': a process that simplifies an NC in a sequence of two. Bemba restricts the domain of application to adjacent NC's within a phonological domain with the law subject only to strengthened stops.

(4)	a.	n-βomb-ele	mombele	'I have worked'
	b.	n-land-ile	nandile	'I have spoken'
	c.	n-ond-ele	ŋondele	'I have thined'
	d.	n-pang-ile	mpangile	'I have made'
	e.	n-βeleng-ele	mbelengele	'I have read'

The forms in (4a–4c) show that the expected voiced stop fails to appear. The interesting feature here is of course that the nasal 'assimilates' to the non-following stop. Example (4d) shows that non-strengthened NC clusters are not affected, and (4e) shows that an intervening consonant does not lead to stop deletion — Meinhof's rule is only triggered by an *immediately* following NC.

2.4 *Nasal consonant harmony*

By Nasal consonant harmony[3] I refer to a process that changes a lateral *l* or, in some languages, the stop *d* to a nasal.

In Bemba nasal consonant harmony occurs as a result of verbal suffixation processes involving the 'perfect' *-ile*, 'applicative' *-ila*, or the 'reversive' *–ulula* in which *l* becomes *n* when the preceding consonant is a nasal:[4]

(5)	a.	-fika	'arrive'	-fikila	'arrive for'
	b.	-tana	'refuse'	-tanina	'refuse for'
	c.	-tuma	'send'	-tumina	'send for'
	d.	-landa	'speak'	-landila	'speak for
	e.	-laŋga	'show'	-laŋgila	'show for sb'
	f.	-someka	'plug'	-somekela	'plug for'

In (5a), the applicative suffix is *-ila* following non-nasal consonants, but is *-ina* following stems ending in *n* or *m* (5b–5c). The data in (5d–5e) show that nasal harmony is not triggered by nasals in NC's. Finally, (5f) shows that the intervening *k* blocks harmony. Hence nasal harmony requires strict adjacency of the involved onsets.

3. Representations of nasal consonant clusters

3.1 *Herbert (1975, 1986)*

Herbert investigates prenasalised consonants (PNC's) by measuring segment durations in Luganda and concludes that in this language PNC's are actually clusters (NC's) because the two parts can be shown to be in different syllables. I am in agreement with Herbert as far as regarding NC's as not true PNC's is concerned, but differ in approach to representation.

The basis of Herbert's claim has to do with the compensatory lengthening phenomenon in Luganda where vowels are lengthened both before prenasalised stops and consonant-glide sequences. The logic is, if NC's were really prenasalised consonants we would expect a lengthened vowel to have approximately the same duration as an underlyingly long vowel, and thus for the nasal portion to be timed similarly to a nasal onset consonant. This is not what Herbert's durational data shows, contradicting the phonological claim that nasal consonant complexes are syllable onsets and therefore unitary elements.

The remainder of Herbert's argument rests on the notion that the syllable is an abstract unit of timing organisation that need not persist through surface realisation. He claims that nasals following other consonants belong to different syllables until a very late stage in the phonological rule. This implies prenasalised stops do not exist at the underlying phonological level but are rather derived in the course of a derivation Herbert terms *unification.*

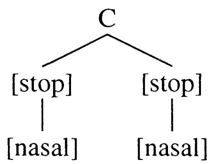
Herbert's motivations for the process of unification, illustrated above, is two-fold. Firstly, the fact that in a particular language only one consonant is allowed in onset position does not constitute a valid argument for the conclusion that NC's also occupy a single consonant position, hence the underlying form. Secondly, the phonetic unity of NC's, elicited from syllabification patterns of native speakers, consists evidence that NC's are *psychologically real* to the native speakers, hence the surface form.

Although Herbert provides an interesting account, the durational evidence does not successfully prove anything about syllable affiliation and does not provide a complete account of all the data given in Section 2. In addition Herbert's reasoning would fail to account for the lack of nasal vowels in Bemba, which nonetheless exhibits nasal spreading effects.

3.2 *Van de Weijer (1996)*

Van de Weijer characterises the combination of a nasal followed by a stop specified for place as prenasalised stops with the representation in (6):

(6)



Both the nasal and the stop are attached to the same root node and since the stop features are considered to be ordered on their tier, the two parts are also ordered. Prenasalised stops[5] therefore have a single root node and are considered to be unit segments. Although Van de Weijer considers the ordering of the stops as ruling out the possibility of nasalising vowels following the NC, it is not clear to me why this should be so. In addition, in postulating an analysis for post-nasalised consonants a switch is made on the stop tier, which is considered ordered (with the stop specified for nasality now appearing to the right of the stop specified for place).

Van de Weijer, citing phonetic data from Herbert (1986), Poser (1979), Sagey (1986a, b), and Maddieson (1989), makes the phonetic observation that prenasalised stops have approximately the same duration as single segments, suggesting the null hypothesis that prenasalised stops are single segments.

I would like to present data from Hubbard (1995) that contradicts such phonetic evidence. Hubbard considers consonant durations in Runyambo, Sukuma, and Luganda and comes up with the results tabulated in (7).

Table 7. *Mean scores of consonant durations (Hubbard 1995:252)*

	Runyambo	Sukuma	Luganda
Nasal in VNV	84	73	62
Nasal in VNC	96	119	85
Stop in VCV	65	37	
Stop in VNC	24		
NC combined	120	144	109

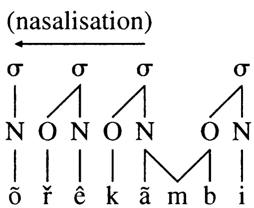
Hubbard concludes that NC elements are not timed like single nasals or single stops in any of the cases examined here. In fact the duration of NC is anywhere from one and a half to almost four times that of a singleton N or C.

We cannot therefore consistently use the phonetic evidence as a criterion for deciding that NC's are units. In fact Van de Weijer only agrees with Herbert in regarding these segments as 'what they are phonetically' on the condition that there is no phonological evidence to the contrary. In Section 2, I have provided this contrary evidence calling for a reanalysis of NC's that shall be duely proposed in Section 4.

3.3 *Piggott and Humbert (1997)*

Piggott and Humbert in analysing nasal harmony in Guaraní propose an ambisyllabic structure to account for the fact that Guaraní is a rigidly codaless language and as such all nasal consonants are confined to non-coda positions. The *Nasal Domain*, i.e the span of nasal spreading is said to be right headed with the head of the domain a nasal consonant. Piggott and Humbert's motivations for an ambisyllabic structure are firstly that a nasal in this representation would be phonetically overt because it would have to share place of articulation with the following obstruent. And secondly, evidence comes from a pattern of vowel nasalisation that nasalises vowels before nasal-obstruent sequences but not before simple nasals. This can be summed up as: the nasal component of the cluster is syllabified in the preceding syllable to account for vowel nasalisation but also in the following syllable to ensure that the nasal gets a place node, as only nasals specified for place can be the head of a nasal domain. An illustration of their representation is given in (8).

(8)



Piggott and Humbert point out an important phenomenon in nasal harmony patterns as regards obstruents, that is worth noting. We can identify three language types; those with transparent obstruents, those with opaque obstruents and those with nasalised obstruents. Guaraní as in the above example is said to exhibit properties of transparent obstruents so that the nasalisation process is uninterupted by an intervening obstruent, like /k/ in (8). I shall claim that Bemba is of the opaque type with obstruents blocking nasal spreading effects. The structure in (8), however, cannot do for languages like Bemba and Cokwe which do not nasalise vowels but nonetheless have nasal spreading effects. It shall become clear from my proposal of the structure of NC's that an analysis along these lines is more satisfactory and incorporates an account for the nasalisation processes in Guaraní while maintaing a structure that does not have the nasal consonant partly in the coda, for a codaless language.

4. Government phonology and NC's in bemba

Phonology in GP is viewed as a bi-directional mapping from lexical forms to phonological forms. The central cognitive role phonology plays is that of parsing, the segmentation of a continuous input stream of noise into phonological units which address lexical storage points with a number of associated pieces of information. Phonological information is represented on a skeletal tier consisting of timing slots, which are structured by government and licensing relations into the constituents onset, nucleus and rhyme, where rhymal constituents dominate nuclei. Each constituent may branch, thereby entering into a strictly local and strictly directional government relation, from which it follows that branching is maximally binary.

The branching or non-branching of constituents is parameterized, so that cross-linguistic variation results partly from permitted branching. In Bemba the only branching constituents are nuclei.

The points of the timing structure are associated to Phonological Expressions (PE's) which consist of phonological elements. Elements are 'monovalent', unary, atomic units of phonological description. They are associated with distinct morpho-phonological behaviour. They are fully specified in that they are immediately pronounceable, in isolation as well as in combination, subject to language particular variation. The combination of elements into more complex PE's is regulated by 'association conventions'. Universally, a PE may have one designated position, the 'head',[6] and any number of 'operators'. The universal set of elements out of which all possible sounds in natural language are composed is:

(9) {A, I, U, L, H, ?}[7]

To account for cross linguistic variation, languages are able to restrict possible combinations of elements by employing Licensing Constraints (LC's). LC's impose constraints on the role elements can or must play in a PE. The following LC's have been motivated[8] for Bemba to derive all and only those phonologically relevant sounds in Bemba.

(10) Bemba Consonantal Licensing Constraints

a. Only L and H are heads
b. L must be head
c. L must license exactly one operator
d. A and U do not combine
e. I can only occur in expressions containing both A and H

Crucially these LC's hold at the lexical level and hence do not derive voiced stops which result from phonological processes. These LC's therefore reduce the set of 112 possible expressions to 13 expressions unique to Bemba. These are illustrated in (11) below:

(11) Elemental make-up of Bemba Consonants

[m]	(U.$\underline{\text{L}}$)	[n]	(A.$\underline{\text{L}}$)	[ŋ]	(H.$\underline{\text{L}}$)		
[p]	(U.$\underline{\text{H}}$)	[t]	(A.$\underline{\text{H}}$)	[ʧ]	(I.A.$\underline{\text{H}}$)	[k]	($\underline{\text{H}}$)
[f]	(H.U)	[s]	(H.A)	[ʃ]	(I.H.A)		
[β]	(U)	[l]	(A)	[ø]	(H)		

All oral stops in Bemba are voiceless. β is a voiced bilabial fricative.

I now consider the phonological processes outlined in Section 2, with the goal of illustrating why I opt for a representation of NC's as attached to two onsets comprising an inter-onset governing domain.

Let us take for illustration (12a). The intervening nuclear position is empty and is licensed to remain silent by virtue of the inter-onset government relation obtaining between the two adjacent onsets.[9] The government relation is manifest in the relation between the PE's associated to the participating points. In particular, the PE associated to the governing (second) onset has to be either headed or to be as complex as the governee, and has to share the element (U), (A), or (H) with the PE in the first onset. I assume that the 1st person singular prefix has an onset-nucleus structure, with an empty nucleus and the expression (A.$\underline{\text{L}}$) associated to the onset. In this structure, the nucleus is not licensed to be empty, until an ONO sandwich is created when the morpheme is prefixed to a verb.

(i) Homorganicity is attained by the requirement that the positions in a governing relation share at least one element.

(12) pata → mpata

```
←-------
|       |
O   N   O   N   O   N
|   |   |   |   |   |
X   X   X   X   X   X
|       |   |   |   |
n       p   a   t   a
L       H
U ←---- U
```

In (12a) a governing relation is licensed by virtue of the fact that both onsets in the ONO share or have an element in common, namely (U). I assume this structure as underlying all NC's. The need for a shared element is illustrated by spreading (U) into the governee. The element (A), as the non-head, has to be delinked in order to respect the complexity condition — governees cannot be more complex than governors.[10] The same process applies with *ŋ*- prefixes (H.L), where (H) instead of (U) spreads.

(ii) Strengthening is attained by spreading of element (L)

β and *l* with the elemental make-up of simplex, unheaded expressions, (U) and (A), respectively, are strengthened by the element (L) from the prefix.

(13a) shows (L) spreading and element sharing, resulting in the surface form *ndeka*, 'I stop'. Notice that the process involves 'switching'; the element (L), spreading from head position ends up being operator, while the original operator is promoted to headship in the resulting expression. I assume this to be an OCP effect, requiring a contrast between adjacent expressions.

(13) leka → ndeka 'I stop'

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←-------
|       |
O   N   O   N   O   N
|   |   |   |   |   |
X   X   X   X   X   X
|       |   |   |   |
n       l   e   k   a
L ----→ L
A       A
```

Next note the strengthening of vowel-initial verb-stems. As pointed out above, vowel initial stems 'insert' a *g* or *ʤ* when preceded by a nasal. It is this context where I employ the expression (H). I propose that the initial onset of otherwise 'vowel initial' stems is lexically filled with this element. The effect of (H) can only be seen in phonological processes — otherwise, it is silent.[11] Under this assumption, the strengthening can be characterized as the parallel cases with *l* and *β*, namely as rightward spreading of (L) and leftward spreading of (H), with switching:

(14) a. ußula → ŋgußula 'I peel'

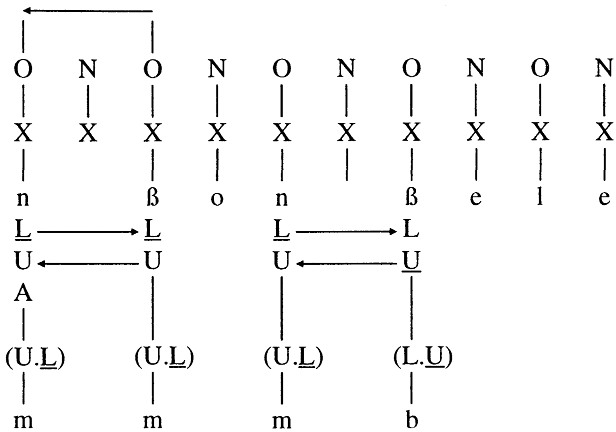
```
←——————
|      |
O   N   O   N   O   N   O   N
|   |   |   |   |   |   |   |
X   X   X   X   X   X   X   X
|       |   |   |   |   |   |
n       ø   u   ß   u   l   a
L̲ ————→ L
H       H̲
```

Note that here, as above, (A) has to be deleted. The process exemplified in (14a) is sensitive to the following vowel. Before the front vowels *e* and *i*, the strengthened consonant is *?*, not *g*. This means that an element (I) spreads leftwards from the following nucleus to give the PE (L̲.H.I), that expresses *ʤ*.

(iii) Meinhof's rule as a restriction on switching

Meinhof's rule in Bemba amounts to restricting switching to one NC in a sequence of two. This means that clusters affected by Meinhof's rule are geminated.

(15) n + ßombele → mmombele ‘I have worked’



In (15) spreading of both (L) and (U) takes place, but in the first ONO domain, (U) remains operator and (L) spreads as head, resulting in a nasal-nasal sequence. In Bemba, Meinhof’s law cannot be analysed as a constraint against two voiced stops in one domain (as in Dahl’s law) since an intervening consonant prevents Meinhof’s rule:

(16) mbelengele — ‘I have read’ (*mmelengele)

Here two voiced consonants are allowed because the two NC’s are not adjacent; there is an *l* intervening.

(iv) Nasal Harmony as (L) spreading

From the aforesaid, nasal harmony appears as another instance of the spreading of element (L), locally, from left to right, into simplex headless expressions. The (L) element spreads rightwards from the stem final consonant into suffixes containing a simplex headless (A) resulting in nasalisation:

(17) tum-ina 'send for'

O	N	O	N	O	N
X	X	X	X	X	X
t	u	m	i	n	a
		U		A	
		L	⟶	L	

The process is strictly local on the onset projection, explaining why we have no harmony in (5f). Since we have analysed NC's as ONO sandwiches, the failure of NC's to trigger nasal harmony is clear — in forms like *fimbila*, 'cover for', the nasal and the suffix consonant are not strictly local on the onset projection.

From the discussion of the behaviour of nasals and NC's in Bemba I am drawn to conclude that only an analysis of NC's as onset sequences[12] can give a unified account of the processes outlined in this section's (i–iv). Although an account viewing NC's as a unit may be able to account for assimilation and homorganicity through a shared place of articulation, only an ONO account adequately explains why only particular segments (in Bemba *l* and β) are strengthened in cases where all NC's are homorganic — the two involve different processes. In addition, in an ONO view, processes of simplification like Meinhof's law, as well as the lack of nasalised vowels despite nasal spreading effects can be explained without postulating resyllabification or different structures.

5. Conclusion

I have proposed that Nasal Consonant clusters can only be successfully analysed as sequences of onsets in an inter-onset government relation, if the facts of assimilation and homorganicity, strengthening of consonants, nasal consonant harmony, and simplification of NC's, are to be accounted for adequately. The licensing constraints for Bemba have provided the basis for analysing the behaviour of NC's in Bemba. The restrictions on the processes of element spreading and switching of heads provide an analysis that points, at least for Bemba, to NC's as sequences and *not* units.

Acknowledgements

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Notes

1. My principle written sources are Hoch (1955), Sambeek (1954) and Sharman (1963).
2. This distribution is of course more widespread than Bantu, see e.g. Evans (1995) for Australian languages. Within Bantu, geminates, as in Luganda, are frequent in addition to N+C clusters. A more curious case is Tumbuka, which seems to allow *-sk-* clusters (see e.g. Young 1931 for data).
3. This process is also found in a number of other Bantu languages such as; Cokwe, Heroro, Lamba, Luba, Tonga and Yaka (cf. Bastin 1980, Greenberg 1951).
4. There is also vowel harmony with these suffixes, which I take to be independent from nasal harmony, and which is not discussed here (see, however, discussions in Kula (1997), Marten (1997)).
5. Van de Weijer considers all NC sequences under *prenasalised stops*.
6. By convention headed expression shall be represented by underlining the relevant element.
7. I do not employ the glottal element as part of the consonantal inventory (for argumentation for this position, see discussions in Jensen 1994, Ritter 1997, and Kula and Marten 1998).
8. See Kula and Marten 1998 for a detailed discussion of the proposal and motivations of the LC's in Bemba.
9. I assume an onset projection at which level the onsets are adjacent. This structure assumes rhymes project higher than the onsets and so remain heads of constituents.
10. Of course it's not nice to have an element just disappearing. A pretty alternative would be to have the prefix lexically as simply ($\underline{\text{L}}$) (by changing the LC (1c) from "exactly" to "maximally") as assumed by Frost (1995), but that runs into problems in cases where the prefix appears as [n] (i.e. (A.$\underline{\text{L}}$)) without local source for the element (A). This happens before 'strengthened' *j* as in *njisula* 'I open', discussed below. Assigning a different structure to affricates might solve this problem, but as things are, I am committed to saying that (A) is in the prefix lexically, and so it has to be deleted when unwanted.
11. Other evidence for the presence of the element (H) might come from the failure of vowel-coalescence in these contexts, although the case is not clear (cf. Sharman 1963: 32). Note also that vowel-initial stems are 'exceptions' to preferred CVC stems.
12. The point of emphasis here, lies with a representation of NC's as sequences be it in any other framework, such as for example, feature geometry or Optimality Theory.

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