The Phonology of Verbal Derivation in Bemba

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The Phonology of Verbal Derivation in Bemba

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Nancy Chongo Kula
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1 Introduction

There are various theories of the relation between phonology and morphology that have been proposed in the literature. Most notable of these is Lexical Phonology (Kiparsky 1982b,c, 1985, Mohanan 1982) (LP), which presents the first major departure from the Sound Pattern of English (Chomsky and Halle 1968) (SPE) position that treated the morphological and phonological components of the grammar as separate. Also notable is the early generative treatment of morphology in Halle (1973) and Aronoff (1976). In SPE, the interaction of phonology with morphology was limited to phonological rules making use of morphological information in the form of syntactic brackets and morphological boundaries; a morphological component fed into a readjustment rule component that then fed the phonological component. In contrast to this, the LP proposal developed the view that morphology and phonology interact and apply in tandem. A central claim that comes with this view is the cyclic application of phonological rules in morphologically complex forms. Cyclicity has been recognised as lying at the core of morphology-phonology interaction at least since Chomsky, Halle and Lukoff (1956), who postulated the transformational cycle. Theories on the morphology-phonology interface thus strive to retain this basic idea, and cyclicity remains central to recent approaches such as, for example, Prosodic Lexical Phonology as proposed by Inkelas (1993), or Borowsky's (1993) LP on the word level. In more recent times, Prosodic Morphology in Optimality Theory (McCarthy and Prince 1986) provided another departure from the LP position on the phonology-morphology interface. All these theories can be regarded as efforts to explain how much morphological structure is available to phonological processing. In this vein, the central question that this thesis addresses is also centred on a version of the same question: to what extent is morphology visible to phonology?

I develop answers to this question by investigating the verbal morphology of Bantu languages with particular reference to the verb in Bemba as spoken in the Northern province of Zambia.[1] I employ the framework of Government Phonology for this purpose. From this phonological perspective, morphology can be characterised comparatively simply as consisting of word formation processes, broadly characterised as inflectional or derivational, which are related in some way to the phonological component. The main proposal developed in this thesis is that phonology recognises only two domains in morphologically complex words and thus has no view of any other internal structure therein. The two domains can be considered to be in a head-dependent relation where the head position is assigned to

[1] Bemba is a central Bantu language of the Bantu language family that is a branch of the Benue-Congo family, which is a branch of the Niger-Congo family. Its principle dialects are Aushi, Bisa, Chishinga, Kunda, Lala, Lamba, Luunda, ŋumbo, Shila, Tabwa and Unga. There is an estimated 1.7-2m speakers of Bemba or one of its related dialects.
See [http://www.emory.edu/college/anthropology/faculty/antds/Bemba] for a short description.

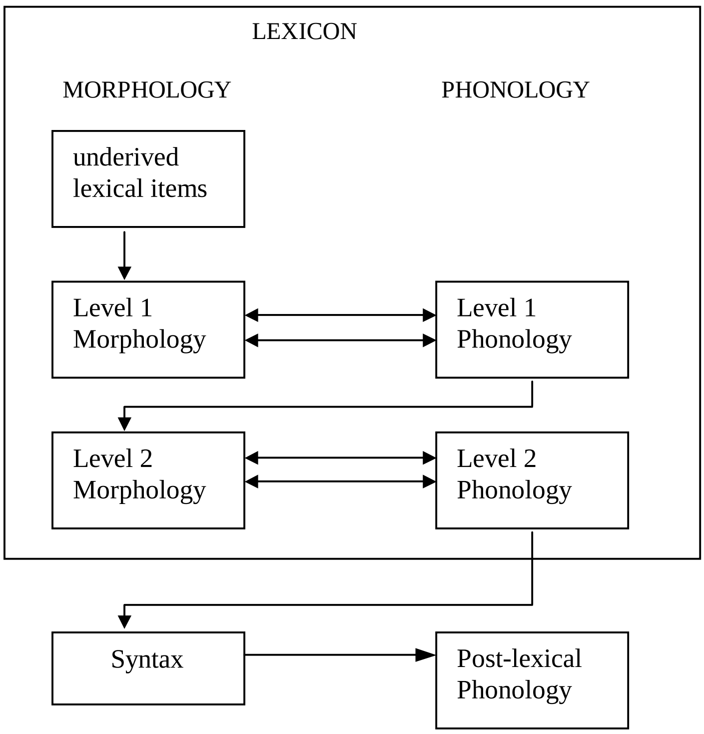
the verb root, which presents the core of the verbal structure, and the dependent position to the affixes. In the remainder of the thesis, I show how this head-dependent relation is reflected in the phonological processes applying in the verbal complex.

I begin this chapter by presenting the main proposals of Lexical Phonology (LP), and elaborate on the problems that such a model involves. I also discuss Prosodic Lexical Phonology (Inkelas 1993) as a breakaway of LP and Prosodic Morphology as a more recent view of the morphology-phonology interface in Optimality Theory (OT). I finally present the model of the structure of the grammar, with respect to phonology and morphology that results from the limited visibility of morphology in phonology that I pursue in this thesis.

1.1 Lexical Phonology

In Lexical Phonology (LP) three levels of phonological representation are assumed; an underlying level, a lexical level and a phonetic level. LP adopts from Siegel (1974) and Allen (1978) the assumption that the lexicon consists of ordered strata in which morphological rules may apply cyclically either stratum-internally or across strata. Word formation rules are paired with phonological rules on a particular level. Each output of morphology is cycled through phonology before it proceeds to the next level. Kiparsky (1982c) represents the model as in (1).

(1) The structure of the grammar in Lexical Phonology



Phonological processes that occur in the course of word formation, as illustrated in (1), take place in the lexicon. Two levels are seen in (1), but different versions of LP posit different numbers of levels. Halle and Mohanan (1985), for example, posit a four-levelled morphology. In the two-levelled version of LP, Level 1 is treated as consisting of mostly irregular morphology where morphemes are more intimately related to the stem and in many cases are merely historical relics (e.g. English *-th* in *length*, *width*, *depth*). Level 1 affixes are equivalent to the affixes that SPE associated with a ‘+’ boundary. Level 2 suffixes, on the other hand, are characterised as having little phonological effect on the base to which they attach, and thus mostly involve regular suffixation. An example is the non-stress shifting nature of level two suffixes as opposed to level one suffixes in English. Within this model the effect of morphological boundaries blocking phonological rules is achieved by stipulating the domain of a relevant rule to be on a stratum prior to the morphological concatenation across which the rule is inapplicable.

By its organisation, LP stipulates that all level 1 rules must precede level 2 rules, which in turn precede post-lexical rules. Thus the strict layer hypothesis (SLH) as proposed in Selkirk (1982) is enforced in LP – smaller phonological domains are strictly contained within larger ones. The SLH also implies that, for LP, the output of phonology at one level, which is the (morphological) input to the next level, is a well-formed word. Also implicit in this, is the Strict Cyclicity Condition (SCC); a phonological rule can only affect those strings of sounds that undergo a morphological rule that applies at the same level as the phonological rule. The general idea here is that phonological rules are restricted to specified strata. Let us consider an example. In English, the suffix *-ity* and the phonological rule ‘tri-syllabic laxing’ (TSL) are on level 1. This implies that any application of the *-ity* suffixation rule entails the concomitant application of the TSL rule. Consequently, suffixation of a level 2 suffix such as *-able*, will not trigger the TSL rule. A final point of importance in LP is the ‘Bracket Erasure Convention’. This refers to the removal of internal brackets resulting from the cyclic application of morphological rules, in order to ensure that they are not available to phonological rule application in later cycles.

Although the basic assumptions of LP are generally accepted in the literature, two main arguments have been levelled against LP. Firstly, the implicit rule ordering in the system makes the prediction that level 1 affixes will be closer to the root than level 2 affixes, to which counterexamples in the form of bracketing paradoxes have been pointed out (cf. Sproat 1988). Secondly, the lack of agreement on the number of levels that must be reasonably assumed is a source of concern. There seems to be no systematic way of regulating the number of levels and any additional divergence in phonological behaviour seems to suggest a new level. These, and other reasons (cf. Katamba 1993), have led to the development of new theories on the morphology-phonology interface. I will consider two here, but see also Borowsky (1993) who makes a proposal for a word cycle in LP.

1.2 Prosodic Lexical Phonology

Inkelas (1993) develops a model of the morphology-phonology interface called Prosodic Lexical Phonology (PLP) from which it follows that every process of word formation triggers cyclic phonological rules. In PLP, morphologically complex words consist of morphological constituents that are transformed into phonological constituents to which phonological rules apply. Phonological rules thus do not access morphological structure directly, but rather operate on phonological constituents called p-structures. Affixation processes result in new p-structures to which phonological rules apply automatically. Consider the illustration in (2). (MCF and PCF stand for morphological and phonological constituent formation, respectively).

(2) UR: stem

Level 1	MCF	→	‹stem›$_{m\alpha}$
	PCF	→	[stem]$_{p\alpha}$
	phonological rules	→	[stem]$_{p\alpha 1}$
Level 2	MCF	→	‹stem›$_{m\beta}$
	PCF	→	[stem]$_{p\beta}$
	phonological rules	→	[stem]$_{p\beta 1}$
Level 3	MCF	→	‹stem›$_{m\omega}$
	PCF	→	[stem]$_{p\omega}$
	phonological rules	→	[stem]$_{p\omega 1}$

As seen in (2), PCF creates p-constituents of the immediately higher category, the output of MCF. Phonological rules then apply to the p-structure, giving an output that is then subject to MCF. Thus at level 1, for example, a stem is parsed into an m-constituent (‹stem›$_{m\alpha}$) that is then turned into a p-constituent by PCF ([stem]$_{p\alpha}$). This p-constituent is what phonological rules access to produce a p-constituent ([stem]$_{p\alpha 1}$) that is the input to level 2 MCF, which then converts it into an m-constituent (‹stem›$_{m\beta}$) of Level 2. Under this PLP approach, it is still necessary to devise a form of bracket erasure in order to prevent phonological rules from accessing all of the internal p-structure that are generated in an extended derivation. Inkelas (1989), in line with Sproat (1993), treats bracket erasure as a locality constraint on what phonological rules may access, rather than as a structure deleting process, as in LP. Inkelas stipulates that phonological rules only access the highest node in p-structure, i.e. the outermost p-structure or bracket and in the illustration in (2), [stem] $_{p\omega 1}$ at level 3.

PLP employs mismatch or invisibility effects to allow any part of the morphological constituent to be parsed as a p-structure, i.e. p-structures do not have to be isomorphic with m-structures. Invisibility effects involve the adjustment of a p-constituent edge by allowing elements of a morphological constituent to be excluded from the corresponding p-constituent.[2] This accounts for processes such as circumscription (McCarthy and Prince 1995), where part of a morphological structure may be invisible to the application of a particular phonological process. One effect of not having isomorphic PCF and MCF is that the definition of a p-constituent is not static and thus can be used, for example, to account for varying internal structures of words of the same morphological complexity in different languages. Consider compound formation in Italian and Greek (Nespor and Vogel 1986), for example. Using stress placement facts, Nespor and Vogel show that Italian, as opposed to Greek, has two domains within compounds. This difference is accounted for in PLP by postulating different requirements for p-constituent formation between the two languages. In standard LP, this is not an option because compounding is represented on a specific level with the effect that compounds behave in a static way with respect to phonological rules (specified on the level where compounding takes place). Consider p-constituent formation in Italian and Greek in PLP.

(3) Compounding in PLP

	MCF		PCF	
Italian	‹tosta›$_m$	→	[tɔ́sta]$_p$	‘toast’
	‹pane›$_m$	→	[páne]$_p$	‘bread’
	‹tostapane›$_m$	→	[tɔ́sta]$_p$ [páne]$_p$	‘(bread) toaster’
Greek	‹kukla›$_m$	→	[kúkla]$_p$	‘doll’
	‹spiti›$_m$	→	[spíti]$_p$	‘house’
	‹kuklaspiti›$_m$	→	[kukláspiti]$_p$	‘doll house’

In (3), since stress assignment applies to p-constituents, the fact that only one stress occurs in Greek compounds is accounted for by the fact that the m-constituent of compounds maps onto a single p-constituent. In contrast, Italian illustrates the option in PLP to divide the m-constituent of the compound into two separate p-constituents which both get assigned stress.[3] If each output of morphology is regarded as consisting of a phonological domain, the Italian case in (3) could not be accounted for. PLP thus makes some positive changes to LP and in line with this

[2]Invisibility effects are on a par with *extrametricality* (Hayes 1981, Harris 1993), *extratonality* (Pulleyblank 1988) and *extraprosodicity* (Kiparsky 1985), which capture the exclusion of some part of the phonological string from the domain of phonological rule application.

[3] This latter compounding structure, where members of the compound act as separate phonological rule domains is well attested in Sanskrit (Selkirk 1980), Dutch and German (Booij 1985), Malayalam (Sproat 1986) and Indonesian (Cohn 1989).

approach, I will assume that phonological and morphological constituents do not necessarily have a one to one mapping.

1.3 Optimality Theory

Within Optimality Theory (OT) prosodic morphology deals with the interaction of phonology and morphology. OT is a framework in which the interaction of violable constraints determines the well formedness of output forms. The grammar of a language is defined by the constraint ranking that generates only the licit surface (phonological) patterns of a given language. Output forms are determined by a competition between an infinite number of candidates weighed against the language specific constraint rankings from which only one candidate emerges as optimal (see section 4.3.2 for a more elaborate introduction).

In the treatment of morphologically conditioned phonological alternations in OT two approaches can be identified (Anttila 1999). Either specialised morphological constraints that form part of the phonological constraint ranking of a language are used, or different constraint rankings for phonological phenomena triggered by morphology are used. The first option, which utilises morphological constraints uses *interface constraints* that consist of parameterised Faithfulness, Markedness and Alignment constraints, that are designed to apply to categories such as roots, affixes, and stems. The second option that utilises what are termed *co-phonologies* has the advantage over the first in that it keeps phonological constraints purely phonological.[4] However, co-phonologies that allow for different constraint rankings within one phonological grammar of a language re-introduce strata in phonological systems as seen in LP.

Consider the investigation of Axininca Campa presented in McCarthy and Prince (1993) where in line with standard LP grammar, a prefix-level constraint system, distinct from a suffix level constraint system is postulated. Each level consists of a distinct and separate co-phonology (i.e. allows for different constraint rankings) from the constraint ranking of the language for mono-morphemic words. Each level selects the candidate that best satisfies the parochial constraint hierarchy, which is then the input for the next level of derivation. Thus the following constituent structural analysis of morphology sensitive to phonology is made.

(4) morphological constituents in OT

prefix - root = stem$_{\alpha}$
stem$_{\alpha}$ - suffix = stem$_{\beta}$

The postulation of co-phonologies implies that different phonological rules (via the different constraint rankings) apply to the constituents in (4) and raises the same

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[4] See Inkelas, Orgun and Zoll (1996) for a discussion on co-phonologies.

concerns as in LP: how many co-phonologies can there be and is there any way of regulating them?

1.4 Government Phonology

Turning now to the Government Phonology (GP) view on the interaction of phonology and morphology, Kaye (1992b) proposes that since derivations are subject to the minimalist hypothesis in GP, phonological processes cannot be grouped in strata. Consider the minimalist hypothesis in (5):

(5) Minimalist Hypothesis

Phonological processes apply whenever their conditions are met.

According to (5), phonological rule application cannot be restricted to particular levels or strata but rather, rules apply at any time when the structural conditions of the rules are satisfied. The structural conditions for phonological rule application in morphology are defined as applying in two morphological environments; analytic morphology and non-analytic morphology. Analytic or synthetic morphology may consist of more than one domain (as in Italian compounding in (3)) while non-analytic morphology is consistent with one phonological domain (as in Greek compounding in (3)) (Kaye 1995). These are as illustrated below.

(6) Phonological structure in morphology in GP

Analytic morphology:	[[A] B]
	[[A][B]]
Non-analytic morphology:	[A B]

There are thus two types of analytic structure assumed: one where only one of the concatenating structures forms a phonological domain (mostly stem-affix relations) and one where both concatenating structures form phonological domains (mostly compounding). Non-analytic morphology presents no internal phonological domains and thus morphological outputs of this structure are treated on a par with simplex words. The definition of phonological domain generally accepted in GP is two-fold. On the one hand, a phonological domain defines an area that is subject to the application of phonological processes and, on the other hand, it defines units that are interpretable, i.e. consist of well formed words within the language under investigation. The latter view implies that analytic morphology will be reserved for languages in which morphological operations take place at the word level. In English, for example, with a few exceptions, inflectional ($(\text{walk})_{\omega}$ $\text{-s}_{3^{rd}\,sg.}$) and derivational ($(\text{walk})_{\omega}$ $\text{-er}_{agentive}$) morphology utilise the word as the base of the suffixation process. I will refine this latter interpretation to refer to units that are lexically accessible. Thus, in the remainder of this thesis, the term *phonological* *domain* has the dual role of defining domains of phonological activity and defining domains that are lexically accessible.

In essence, the phonological domain structure in (6) captures the cyclic and non-cyclic levels in LP. In English inflectional morphology, for example, irregular verbal inflection (e.g. *keep* + past → *kept*) is treated as non-cyclic, while regular verbal inflection (e.g. *peep* + past → *peeped*) is treated as cyclic. This same distribution is captured as non-analytic versus analytic morphology, respectively, in GP. The difference with LP, however, is that words that form non-analytic domains (words in the non-cyclic block of LP) are not derived from a base by phonological processes, but are rather considered to be lexically stored in an identical fashion to simplex forms. Thus, no rule of 'closed syllable shortening' is posited for the derivation of *kept* from *keep*.

Although not explicitly stated in Kaye (1995), the structures in (6) do not rule out the possibility of extrametricality or invisibility effects as seen in PLP, but merely define the phonological domains that hold between concatenated forms in morphology. I will thus take it that invisibility effects, where structure remains outside of the phonological domains defined in (6), are possible.[5]

The GP analytic domain structure in (6) assumes cyclic derivation, which I assume applies in a similar fashion to PLP and LP, in as far as some notion of the strict layer hypothesis is maintained. In other words, LP, PLP and GP all assume that there is a layering of suffixes that create new morphological domains with each newly added suffix and which may coincide with phonological domain structure. In PLP each of these morphological units result in a p-constituent and hence some notion of bracket erasure must be assumed. In similar fashion bracket erasure must also be assumed in LP. The GP structure presented in this section also requires some notion of bracket erasure. In this thesis I will propose a departure from this view and will not assume the strict layer hypothesis, at least not in the sense that morphological derivations involve incremental derivations. The advantage of this move is that no internal brackets have to be postulated in phonological processing. I will consequently refer to this approach as *No Bracketing Derivation*. I present my proposal in the next section.

1.5 No bracketing derivation

My proposal follows from the structure of the lexicon that results from the GP structures in (6). Since non-analytic morphology, which includes irregular morphology, historical relics and semantically opaque affixes, consists of words that are lexical entries in the lexicon, analytic morphology is the only morphology that entails phonologically relevant concatenations of structures that are themselves stored in the lexicon. I will claim that word formation processes involving multiply suffixed forms are not derived by cyclic affixation but rather that affixes within a

[5] In GP this has to be subsumed under some notion of licensing failure, resulting in exclusion from a phonological domain. In this case, the *word* that is to be interpreted is not exactly matched with the phonological domain(s) internal to the word, given the definition of phonological domain assumed.

morphologically complex word are accessed in parallel.[6] This is a possible option, given that analytic suffixation (the cyclic block in LP) involves regular suffixation with semantic regularity. The idea is that the derivation of, say, an *applicativised causative* in Bantu is not dependent on the presence of a causativised base. There are morphotactic restrictions on the order of suffixes in a base that I will take as ensuring that unattested suffix orders do not arise.[7] Thus in the Bemba complex verb in (7), the structure in (7IIIa) as opposed to (7IIIb) is the predicted phonological structure.[8]

(7) I lexical entries
(VERB) kak-a 'tie' (SUFFIX) -uluk-$_{\text{intransitive reversive}}$
(SUFFIX) -ilil-$_{\text{intensive}}$
(SUFFIX) -an-$_{\text{reciprocal}}$

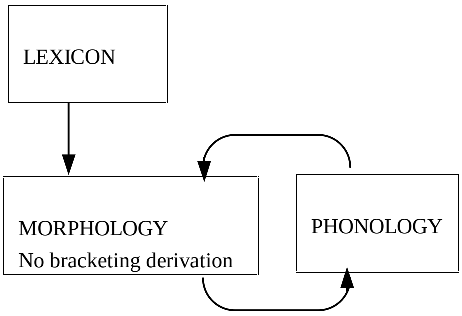
II morphological application adds suffixes in parallel:
kak-uluk-ilil-an-a 'become totally untied for/on each other'

III resulting phonological structure:
a. [[kak]$_1$-uluk-ilil-an-a]$_2$ *b. [[[[kak]$_1$-uluk-]$_2$ilil-]$_3$-an-a]$_4$

The lexical verb that acts as the base of affixation is accessed first because of its central role as the base. I will for this reason consider it to be the head of the phonological domain structure.[9] The affixes that give the desired meaning 'become totally [V] for/on each other' are then accessed in parallel. The affixes between themselves, because they are separate entries in the lexicon, *do* have morphological boundaries but their parallel affixation implies that the internal morphological domains do not form phonological domains (7b) - they never get a chance to. Put differently, the claim is that phonological rules are not sensitive to the internal morphological brackets of multiply affixed verbs. We thus do not need to evoke any notion of bracket erasure with respect to phonological bracketing between suffixes. Consider, then, the relation between phonology and morphology that is postulated under these assumptions.

[6] I use *access* here with reference to production from the point of view of a speaker who is aiming at producing an utterance.
[7] I do not at all go into the details of a theory of suffix order but there is ample evidence to show that strict order is required in Bantu suffixation. I take this to be lexically specified. See Hyman and Mchombo (1992), and Hyman (2002) for some constraints on suffix order in Bantu.
[8] The final vowel in the verb form in (7) II is a mandatory final vowel occurring in all verb forms. The status of this vowel will be discussed in chapter 2.
[9] I here put aside details with respect to whether words or stems are the input to derivation. I take up this topic in chapter 2. The head referred to here is a phonological head given left to right phonological parsing and is not the syntactic head of the output form. This therefore does not go against the generative view that derivational suffixes are the heads in morphology.

(8) Relation between phonology and morphology



In (8), the lexicon feeds a morphology module that derives words by no-bracketing derivation. Phonology applies as long as there is word formation and phonological processes apply within morphologically complex words if the conditions on which they are dependent are met. I will assume this model for the remainder of this dissertation.

One consequence of this model within the verbal system of Bantu is that morphologically complex verbs will consist of two phonological domains between the root and its dependent affixes, i.e. the domain of phonological activity will be the stem (root + verbal extensions). The stem as the relevant domain of phonological activity in Bantu has also been advocated in Mutaka (1994) in an LP model that treats the stem as belonging to a cyclic strata, as well as in Hyman (1998a) where the suffix domain following the root is treated as a prosodic trough that is subject to phonological processes as a unit. The difference between these approaches and no bracketing derivation is the absence of a cyclic rule block that phonologically processes each addition of a suffix.

1.6 Summary

The focus of this thesis will be to motivate 'no bracketing derivation'. Phonological processes within the verbal complex that show that there are no internal phonological domains in morphologically complex verbs will be considered. The idea is to establish what domains within morphology are relevant to phonology. In chapters 2 and 3 prefixation processes involving vowel fusion, gliding, consonant strengthening and consonant cluster simplification in Bemba will be considered. In chapters 4 and 5 I analyse suffixation processes that include spirantisation, nasal consonant harmony, palatalisation and imbrication. All these processes support the view of limited phonological visibility in morphologically complex verbs. Finally, in chapter 6, I present speculations for a phonological parser under the assumptions of a model such as that presented in (8) and consider its implications for phonological acquisition.

2 Government Phonology and Bemba Structure

In this chapter I introduce the basic principles of Government Phonology (GP), the framework assumed in this dissertation. There are various versions of GP that differ with respect to particular details, but the basic insights remain the same as presented in Kaye, Lowenstamm and Vergnaud (KLV) (1985, 1990). I also present the basic structure of Bemba and show how the assumptions of GP reflect on the structure of Bemba.[10] I settle for a version of GP that assumes no branching structure but a strict sequence of C's and V's, as proposed in Lowenstamm (1996).

2.1 Government Phonology

In GP, phonology is viewed as a purely cognitive function whose role is that of parsing; segmenting continuous input strings into phonological units that address lexical units. To achieve this purpose, the phonological word is divided into the constituents Onset, Nucleus and Rhyme, all of which are maximally binary branching. These constituents enter into government and licensing relations that define the scope of the phonological domain. There is no notion of *syllable* as understood in the traditional sense; rather, phonological units are regarded as consisting of sequences of Onset-Nuclear (ON) pairs.[11] The ON sequences are represented on a tier called P^0, which dominates a tier of timing units called the *skeleton*, to which the three constituents attach. The skeleton is seen as an anchoring device relating the (internal content of) segments to the constituents and the government and licensing relations that hold between them. The coda is not a licit constituent in GP and word-final consonants are syllabified as onsets followed by an empty nucleus, as per 'coda'-licensing defined in Kaye (1990: 311) and stated here in (1).

(1) Coda-licensing principle

Post nuclear rhymal positions must be licensed by a following onset

This gives rise to the following structures involving word-internal and word-final codas.[12]

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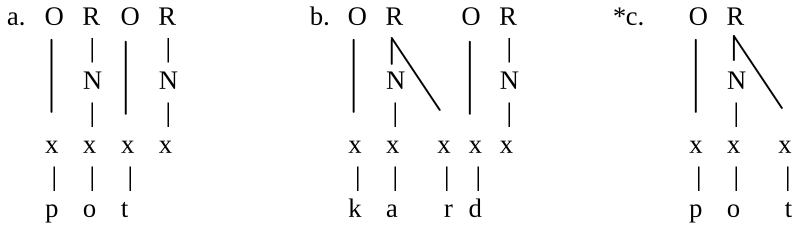
[10] In addition to my own elicited data on Bemba, I draw on Givón (1972), Hoch (1960), Kashoki (1968), Guthrie and Mann (1995), Mann (1999), van Sambeek (1955), Sharman (1963), White Fathers (1947).
[11] See Brockhaus (1999) for motivations of this position.
[12] The 'coda' is thus termed a 'post nuclear rhymal position' in GP, but the term *coda* is used for ease of reference.

(2)



Under coda licensing, only the structures in (2a) and (2b) are permissible, while (2c), which has a coda as a rhymal complement in final position, is barred. The empty nuclei in the structures in (2) are sanctioned via the Empty Category Principle, which will be discussed in section 2.2.

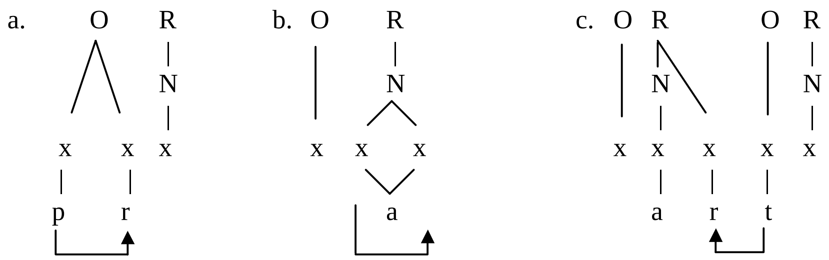
2.1.1 Constituent structure and government

The notion of *government* emanates from the hierarchical structure between and within constituents that is defined via a head-dependent relation. Between constituents, onsets are dependent on nuclei, which license them. Every position within a phonological domain must be licensed, i.e. must be sanctioned to exist. The source of licensing for the whole domain is the most dominant nucleus, which is regarded as the head of the domain and which itself remains unlicensed, because it is licensed from outside the domain by higher prosodic structure. The head nucleus licenses all nuclei in the domain, which, in turn, license the onsets in their ON pairs.[13] Furthermore, between constituents there is a government relation (inter-constituent government) that holds between a rhymal complement and a following onset. In the same vein, within constituents, which, as mentioned above, are maximally binary branching, a government relation holds between the first branch (governing head) and the second branch (governee) of a constituent. Government and licensing relations within a phonological domain can be regarded as the *glue* that holds the phonological word together, the means by which segments (which are dominated by these constituents) in a surface linear order are related.

Head-dependent relations between segments in a phonological domain are also found in Dependency Phonology (Ewen 1986, Anderson and Ewen 1987), which recognises the constituents of syllable, rhyme, nucleus, onset and coda. The nucleus and coda are subunits of the rhyme, which is itself dominated by the syllable node, as is the onset. I would like to draw attention to the differences in detail with respect to the head-dependent relations between the two approaches. Consider first the GP governing relations in (3).

[13] I give a more explicit characterisation of licensing within a domain in chapter 3.

(3) constituent government inter-constituent government



(3a) illustrates constituent government within a branching onset, where /p/ acts as the head that governs its dependent /r/. The same relation is seen in (3b), which gives the structure of a long vowel. (3c) illustrates inter-constituent government between an onset and a preceding coda consonant. Another inter-constituent government domain that is now also generally accepted in GP is that of the *inter-onset government* domain, which allows onsets to be in a government relation separated by an empty nucleus, which is allowed to remain unrealised by the government relation (cf. discussion of the ECP in section 2.2).[14] Government is subject to the conditions laid out in (4).

(4) Conditions on government

a. strict locality: only adjacent positions can constitute a government relation
b. strict directionality: constituent government goes from left to right and inter-constituent government goes from right to left.

In addition, Charette (1991: 101) proposes a notion of *Government licensing*, which requires all governing relations to be licensed by a following nucleus.

(5) Government licensing: for a governing relation to hold between a non-nuclear head α and its complement β, α must be government licensed by its nucleus.

The conditions on government in (4) imply that the only licit branching governing domains are structures that involve binary branching constituents, thus a branching nucleus within a branching rhyme is disallowed, because the nuclear head (in the left branch of the nucleus), will not be able to govern the rhymal complement without violating locality.[15] The assumption of government licensing as stated in (5) implies

[14] We will have ample discussion of inter-onset government in chapter 3.
[15] Notice that this violation does not have to hold if we assume, as in (3c), that the rhymal complement is governed by a following onset. This structure is allowed in Harris (1994) as a super-heavy rhyme. I do not pursue this matter as nothing in this thesis hinges on it.

that all governing relations are followed by a nucleus that sanctions the government relation. Government can take place at two levels within the phonological representation. At P^0, government takes place within constituents, as well as between two contiguous constituents, as in inter-onset government and coda-onset government, and at the level of the nuclear projection government takes place between nuclei.

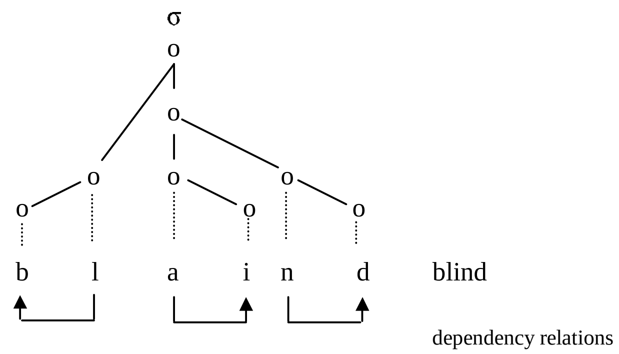
The main motivation for the nuclear projection is to retain locality in licensing relations. Recall that we have already stated that every position within the phonological domain must be locally licensed and that licensing proceeds from the head nucleus to other nuclei in the domain, which then license the onsets in their ON pairs. Such licensing between nuclei can only be adjacent under the assumption of a nuclear projection. The nuclear projection is also the level at which *proper government* takes place (see discussion in 2.2). Finally, all governing relations are subject to the projection principle.

(6) Projection Principle (Kaye 1990: 221)

Governing relations are defined at the level of lexical representation and remain constant throughout derivation.

The projection principle implies that all phonological operations are structure preserving, i.e. licensing relations at all levels of derivation, despite the possible change in internal configuration, remain stable. This implies that constituent categories may not be altered during the course of derivation; onsets remain onsets, nuclei remain nuclei and the licensing relation between nuclei and onsets remains stable. Let us now consider dependency relations in DP in the structure in (7), as presented in Durand (1990).

(7) Dependency relations in the phonological word /blaind/ in DP



The governing or dependency relations in GP and DP are basically the same, except for the segment that is treated as head in the government/dependency relation. In

GP, the less sonorous segment in a branching onset acts as head while in DP the more sonorous segment /l/ in /bl/ acts as the head. Notice that this requirement also holds for the coda-onset relations in DP (7). Thus, the difference in the direction of government/dependency that is seen between GP and DP follows from the choice of *head* in either approach.

In GP, the choice of head is based on complexity. The segment with the most complex representation is head. This means that an increase in sonority implies a decrease in complexity in GP. In the next section we will have a look at how the complexity of segments is determined.

2.1.2 Melodic structure

GP draws parallels with Dependency Phonology (DP) (Ewen 1986, Anderson and Ewen 1987) in viewing sound segments as exhaustively decomposable into what DP terms *components*, and GP calls *elements*. Both frameworks subscribe to the view that phonological features are unary as opposed to binary, and further that these unary features may combine to create complexes of features. In cases where a segment consists of a combination of features, the features can enter into head-dependent relations that allow for the expression of relative degrees of salience among the components or the elements that make up the segment. Thus, the smallest interpretable units that combine to form sound segments or phonological expressions are components (DP) or elements (GP). These phonological expressions (PE's) are the cognitive and melodic units that can be manipulated and which attach to the skeleton. This implies that melody and timing are separate in GP and therefore the smallest sound unit is not a phoneme that is specified for phonetic content and duration, but rather a mono-valent element which may combine with other elements to form sound segments, traditionally referred to as phonemes.

In GP, the combination of elements to create PE's is regulated by the notion of Licensing Constraints (LC's) (Charette and Göksel 1998). LC's define restrictions on the combinations of elements so that it is possible to derive a set of phonological representations that capture all and only those sound segments relevant to a particular language.[16] Up to ten elements (A I U R H L N h ʔ) can be employed for the purpose of representing the sound segments of a language, depending on the version of GP being used. The characteristics attributed to the elements in consonants are given in (8).[17]

[16] For a discussion of the general notion of Licensing Constraints, cf. Charette and Göksel (1998). Not all versions of GP subscribe to LC's.
[17] For a good introduction to elements in GP, cf. Harris (1994), Harris and Lindsey (1995).

(8) Elements

A	-	present in uvulars and pharyngeals
I	-	palatality
U	-	labiality
R	-	coronality
H	-	stiff vocal cords, aspiration, voicelessness
L	-	slack vocal cords, voicing
N	-	nasality
h	-	noise or aperiodic energy on release
ʔ	-	stop or edge

Within this set, (A I U) are used to characterise vowel systems. ((N) is also used in the representation of vowels for languages with nasal vowels). Within vowels, these elements take on the characteristics: A - lowness, I - high, front, and U - back, round. In Government Phonology, head status within a complex expression is assigned to only one element. There is thus no notion of mutual dependency or mutual government as proposed in DP, where two components may be allowed to both be head within the same expression. Consider, for example, the representations of the vowel system of standard Copenhagen Danish as presented in Durand (1990: 294) within DP.[18]

(9) Standard Copenhagen Danish vowel system in DP

i	{i}	y	{i, u}	u	{u}
e	{i; a}	ø	{{i, u}; a}	o	{u; a}
ɛ	{i:a}	œ	{{i, u}:a}	ɔ	{u:a}
æ	{a; i}			ɑ	{a}

In the representations in (9), a semi-colon represents a head-dependent relation where the head is to the left, a colon represents mutual dependency or equal preponderance between components, and a comma represents no dependency relation, so that components are of mutual strength. (Components are represented in curly brackets and in lower case letters). DP thus contrasts with GP on at least two points with respect to the combinatory possibilities of components/elements. Firstly, there is no notion of mutual dependency in GP as compared to the DP representations of Danish /ɛ/ as {i:a} and /ɔ/ as {u:a}: only one head per complex expression is allowed in GP. Secondly, elements in GP are considered to be decomposable at all levels and may not, as such, act in combination as head or in any other capacity with respect to other elements as seen in the DP representations

[18] A variety of authors have argued that Danish requires three levels of vowel height; cf. Martinet (1937), Basbøll (1968), for discussion.

of Danish /ø/ as {{i, u}; a} and /œ/ as {{i, u}:a}. The representation of the Danish vowels in GP would thus differ in these respects to that of DP.[19]

There are, however, similarities between the two approaches as well. GP and DP converge with respect to allowing complex expressions to be headless (cf. /y/ as {i, u} in (9)), and also, importantly, on not allowing the same component/element to appear more than once in the same expression. This means that expressions such as {a;a} (DP) or (A.A) (GP) are barred in both approaches. This is in contrast to Schane's (1984) Particle Phonology approach, where the addition of the same element produces contrastive effects. In Schane's approach, for example, *lowness* is denoted by incremental additions of the component (or particle, in his approach) /a/, so that /e/ is represented as (a, i) and /ɛ/ is represented as (a, a, i). This kind of approach has to devise ways of constraining this kind of incremental representations, in order to avoid over-generation.

Having looked at the conditions at play in the representation of the internal structure of PE's, let us now look at the conditions necessary for these PE's to enter into government and licensing relations. With respect to licensing, every nucleus must license the onset in its ON pair, regardless of its complexity. Complexity here refers to the number of elements that are contained within a PE. Thus *Onset licensing* is a property of the nuclear constituent rather than of the elements contained in the nucleus. In governing relations, on the other hand, complexity plays a role, as defined in the complexity condition. We adopt here the version of Harris (1994: 170).

(10) Complexity condition

> Let α and β be melodic expressions occupying the positions A and B, respectively. Then, if A governs B, β is no more complex than α.

The complexity condition in (10) requires a governing head to be at least as complex as the governee it governs, i.e. the governing head should contain at least as many elements as the governee.[20]

Notice here that we have assumed three senses of *head* in GP. The head within an expression, which is the most salient feature in characterising the nature of the PE, the head in a government relation that may hold within a constituent or between

[19] Adapting the DP representations to GP would give a representation of the Danish vowels as follows, where heads are indicated by underlining.

i	($\underline{\text{I}}$)	y	(I.U)	u	($\underline{\text{U}}$)
e	($\underline{\text{I}}$.A)	ø	($\underline{\text{U}}$.I.A)	o	($\underline{\text{U}}$.A)
ɛ	(I.A)	œ	($\underline{\text{I}}$.U.A)	ɔ	(U.A)
æ	($\underline{\text{A}}$.I)			ɑ	($\underline{\text{A}}$)

Naturally the vocalic processes of standard Copenhagen Danish would have to be investigated before selecting a set of Licensing Constraints that best captures the contrasts expressed by determining which elements are head within the phonological expressions.

[20] See Rennison (1998) for a computation of complexity in GP in terms of strength units, where different elements, depending on whether they are head or operator, are graded in terms of numerically defined strength units.

different constituents and which is defined by complexity, and finally the head within a phonological domain, the most dominant nucleus, from which all licensing emanates. A final point I would like to touch on with respect to GP is a geometry of elements.

2.1.3 Element geometry

It has long been observed that sounds within phonologies of languages pattern into natural classes with respect to processes that they may undergo. Feature geometries have in this respect been proposed in order to not only classify natural classes, but also to exclude unnatural ones (cf. Clements 1985, Sagey 1986, Clements and Hume 1995). The GP view that elements are directly linked to the skeleton implies that they are individually accessible to phonological processing. True as this is, it has also been observed that particular phonological processes do indeed access more than one element at the same time and thus make it necessary for us to perceive of some geometric organisation of elements. Element geometries for GP have been proposed in Harris (1994), and along the same lines in Brockhaus (1995). I develop a geometry following closely on proposals made in van der Hulst's (1994, 1995) Radical CV Phonology, which is an offshoot of Dependency Phonology.

2.1.3.1 Radical CV Phonology

In Radical CV Phonology (RCVP), phonological primes are defined by the two features *C* and *V*, which in combination, regulated by head-dependent relations, define sound segments.[21] Having only two phonological features responds to the need to regulate over-generation in phonological systems by the reduction of phonological features, hence the term *radical*, because RCVP uses the minimum number of features. Given that there is an easily attainable exhaustive list of combinations that can be made with two features, additional contrasts are generated by different positions within the geometric structure of segments in RCVP. It is this idea, that the same combination of features may acquire different interpretations based on the location assumed in the geometric structure, that I draw on for GP, so as to not only capture sets of natural classes but to also reduce the number of elements used by the system.

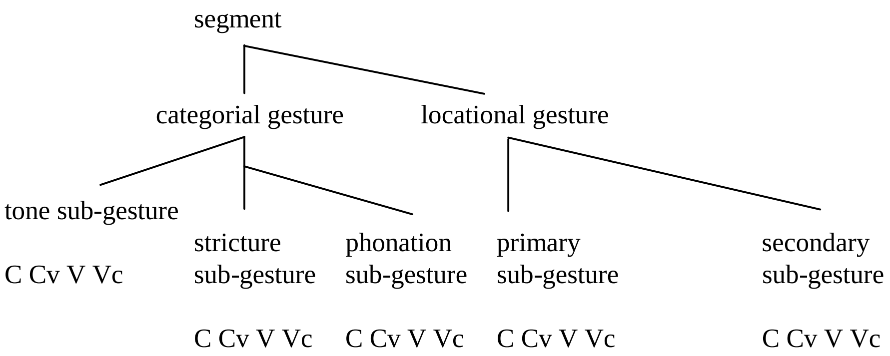
In RCVP the two elements *C* and *V* have the following basic phonetic interpretations. *C* denotes articulatory events of closure, stricture and contraction and their acoustic effects and *V* denotes the opposite of this, i.e. relatively high sonority. A combination of the two elements gives the four basic components {C, Cv, V, Vc}, which cannot be further decomposed.[22] Cv represents a C head with V as dependent and Vc a V head with C as dependent. These four elements are

[21] RCVP is a theory that is still being developed and some of the ideas expressed here may have changed in more recent versions. See van der Hulst (2001) for updates.
[22] It is not clear to me why this is so since Cv and Vc are formed by a combination of C and V, but suffice it to say that the four basic components in RCVP are {C, Cv, V, Vc}.

considered to be simplex and are the primes that enter into head-dependent relations to derive other segmental contrasts.[23]

The segment is divided into two gestures; the categorical gesture and the locational gesture. The categorial gesture is further divided into three sub-gestures; the tone sub-gesture, the stricture sub-gesture and the phonation sub-gesture. On a par, the locational gesture is also divided into sub-gestures; primary location and secondary location sub-gestures. An interesting addition in RCVP is that these gestures and sub-gestures stand in a fixed head-dependent relation to each other: the categorial gesture is head of the locational gesture. Within the categorial gesture, stricture is head of the other two sub-gestures and in the locational sub-gesture, primary location is head of secondary location. Consider the geometric representation in (11) that captures this distribution. (Straight lines identify heads).

(11) RCVP element geometry



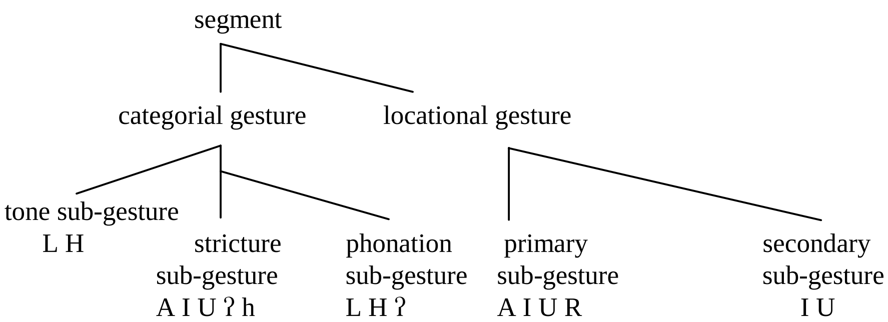
One implication of this organisation of features is that, with respect to phonological processing, in for example spreading processes, dependents will be able to spread independently while heads must spread with their dependents. This, for example, explains the symmetry seen between the frequently spreading place features as opposed to the relatively stable stricture features.

In (11), the categorial gesture is chosen as the head of the whole segment because stricture distinctions generally determine the distribution of segments in syllabic organisation. Within the categorial gesture, the representation of the tone sub-gesture as forming the outer shell of the categorial gesture characterises its supra-segmental nature. The stricture sub-gesture contains features/elements that express different levels of stricture, such as absolute stricture (C), non-absolute stricture (Cv), unimpeded outflow of air (V) and some interruption in unimpeded outflow of air (Vc). These relate to features of consonantality, continuancy and sonorance, which are represented in the phonatory sub-gesture in DP. The phonation sub-gesture expresses glottal stricture and voicing, viz. glottal stricture (C), glottal

[23] For details on the interpretations of the different element combinations cf. van der Hulst (1994, 1995, 2001). My focus here is limited to the geometric representation of elements.

opening (Cv), oral voice (V), and nasal voice (Vc). The locational sub-gesture defines both consonantal and vocalic place articulations. The same place features are found in the primary and in the secondary sub-gestures with the difference that secondary place only occurs with some primary place specification. I adopt the RCVP geometry with respect to the organisation of the phonological segment into gestures, and superimpose the elements of GP as presented in (8) on this skeleton. Consider the illustration of this in (12).

(12) GP element geometry à la RCVP



Given the representation in (12), any elemental composition with a stricture element has that element as head and this defines the class of the segment as stop (ʔ) or fricative (h) or vowel (A I U). If a stricture element is specified and the phonation element (L) is added, (L) is interpreted as voice. In contrast, if no stricture feature is specified and (L) is specified in phonation, it acts as head and has the interpretation of nasality. In this way we collapse (L) into concurrently interpreting voice and nasality, depending on whether it is head or dependent. This helps us get rid of a specific element for nasality, i.e. (N). Other positive effects of this geometry will be elaborated on as we discuss the consonantal system of Bemba in section 2.3.

In this section we have seen how GP defines elements as the smallest interpretable units that make up sound segments, and how these sound segments can enter into governing and licensing relations via the strictly binary branching constituent structure. We have also defined a geometry that regulates the manner in which elements may combine. Let us now move on to the structure of Bemba and see how these assumptions relate to it.

2.2 Bemba structure

In this section, I look at the structure of Bantu languages in general and of Bemba in particular, and discuss the basic assumptions I make on the phonology of Bemba for the remainder of this dissertation. The area of investigation will be the verbal complex. I will have nothing to say about the complex nominal system.

2.2.1. The Bemba verb

Within the verb, Bemba, like many other Bantu languages, has a robust morphology traditionally referred to as 'agglutinative', which allows affixation of a variety of morphemes both to the left (prefixes) and the right (suffixes) of the verbal root. The illustration in (13) gives all the positions available in the Bemba verb. This template is subject to co-occurrence restrictions: not all the slots can be filled in at the same time.[24]

(13) TAM1 - NEG1 - SM - NEG2 - TAM1 - OM - Verb root - D-suffixes - I-suffixes - Final Vowel (FV)

ta-	tu-	aku-	laa-	ba-	bomb-	el-	a
NEG	SM1PL	FUT	PROG	OM2	*work*	appl.	FV

'we will not be working for them'

In (13) the label TAM is a category for tense, aspect and/or mood. SM and OM refer to subject and object markers, respectively, that are based on a nominal classification system. TAM2 is the main slot for tense-aspect-mood while TAM1 is reserved for a specific tense that is related to focus. The two slots cannot be filled simultaneously. Similarly, the two slots for the negative cannot be expressed at the same time. NEG2 is reserved for negatives of class-1 subject markers while NEG1 caters for the other classes. Derivational suffixes and Inflectional suffixes are structurally optional. Finally the FV slot must always be filled. In the default case the vowel /a/ is used but the FV slot may be filled by a tense related vowel.

Within the verbal complex, emphasis in this dissertation will be placed on the investigation of phonological processes resulting from morphological operations in word formation. The main focus will be on suffixation processes and their interaction with the verb root, including both derivational and inflectional suffixes. As opposed to derivational affixes, which are all expressed as suffixes, inflection is generally marked by prefixes to the left of the verb root; only one inflectional suffix will be discussed. As seen in (13), the Bemba word must include at least a prefix, verb root and FV. Thus, in order to have a full analysis at the word level, the interaction of prefixes with the verb root will also be discussed. The area of investigation is therefore the word in the verbal system. The terminology for the

[24] See also a very similar verb template for Swahili in Schadeberg (1984:14ff) where 7 verb slots are distinguished preceding the root.

1 negative *ha-*
2 subject agreement prefixes, infinitive *-ku-*, habitual affix *-hu-*
3 negative *-si-*
4 tense and mood prefixes, negative infinitive affix *-to-*
5 relative agreement prefixes (tensed and negative forms)
6 metrically motivated empty affix *-ku-* (infinitival)
7 object agreement prefixes
STEM
8 affix-*ni* encoding a plural addressee, relative agreement suffixes, tenseless affirmative forms

relevant morphological units that I assume following Bantu linguistics (Meeussen 1967) is given in (14).

(14)

	morphological units	term
a.	root + Dsuffixes^n	verbal base
b.	root + Dsuffixes^n + FV	verb stem
c.	root + (Dsuffixes^n) + Isuffixes	verb stem
d.	prefixes + root + (Dsuffixes^n + Isuffixes) + FV	verb stem/word

(14a) shows that the addition of any number of derivational suffixes to the verb root produces what I will refer to as the *base*.[25] Addition of the FV to a base produces a pronounceable unit called the *stem* (14b). Because inflectional suffixes always come with a specified FV, their addition to a base or root always produces a stem (14c). Finally, the combination of prefixes, the verb root, (suffixes) and the FV produces a stem that is equivalent to a prosodic word. In all cases, addition of the final vowel produces a pronounceable unit that is called *stem* (14b-d). Apart from the FV, a complete word must consist of the relevant prefixes for the verb form. The constituents that will be investigated in this dissertation have also been represented in recent literature (Hyman and Inkelas 1997, Hyman 1998a, Downing 2000) in a hierarchical manner, as illustrated in (15).

(15) Inflected stem (I-stem)

Morphological derivational stem (M-Dstem) Inflectional final suffix (IFS)

Root Derivational suffixes

The characterisation of the FV (the Inflectional final suffix in (15)), in Bantu linguistics is a contentious issue, with the view that in some languages it consistently plays an inflectional role, while in other Bantu languages, a change in the final vowel is restricted to specific tenses or moods, otherwise the default /a/ is used. In Bemba only the optative mood (-*e*) and the perfect (-*ile*) have FV's distinct from the default /a/. The mandatory FV implies that morphological (and phonological) processes on the verb root or base, apply before the FV is added. This is defined by the M-Dstem in (15). The FV is as such outside the area of morphological and phonological processes. This is not to say that the addition of the FV is not a

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[25] When bases contain frozen suffixes, i.e. suffixes that are no longer productive, these are referred to in Bantu linguistics as *expansions* and a root with a frozen suffix as an *expanded root*. I will make limited use of these terms but rather refer to all extended roots as bases, regardless of whether the suffixes involved are productive or not. In cases where it is necessary to make this distinction I will refer to the latter cases as *frozen bases*.

morphological or phonological operation but is rather to distinguish it as being systematically inactive with respect to undergoing phonological processes. The FV is therefore never subject to processes such as vowel harmony, fusion or assimilation. The absence of the FV in morphological and phonological processes implies that the output of these operations is consonant-final.[26] This is in violation of the GP requirement that every domain ends in a nuclear position that acts as the licensor of a preceding onset. Consider the simple verbal derivation in (16).

(16)	verb		suffixation of applicative -*il*-	
	pet-a	'fold'	pet-el-a	*peta-el-a

The problem here is to account for the derivation without assuming that the verb form *peta* 'fold' loses its domain-final licensor at some point in the derivation. We could assume that the morphological root has an empty nucleus that is deleted whenever a vowel-initial suffix follows, but this creates unnecessary redundancy. Such an analysis is best reserved for languages like English where word formation processes are based on words (e.g. *look* → [[*look*] *ing*]). Given that there are no verb forms in Bemba that end in a consonant, the possibility of having derivation on consonant-final forms is directly related to the fact that the FV always appears at the end of the derivation. I will characterise this as involving some form of *licensing-at-a-distance*, where the domain-final position is statically defined. I present this as a condition on domain-final licensing that may be considered parametric.

(17) Condition on domain-final licensing

The domain-final licensor may be lexically specified

This condition permits languages whose derivation is not on the word level, to leave out the FV in derivation. The lexical specification for the final vowel is therefore a filled nuclear position that contains the vowel /a/ by default. I consider this final /a/ to be semantically void and as merely playing the phonological role of identifying a filled domain-final position. This will allow specific tense signs that come specified with a FV (the perfective and optative), to override the default /a/. We can thus say that the parameter on word-final empty nuclei is switched [off] in Bemba: words *must* end in a realised vowel and in addition, this domain-final licensor is lexically specified as excluded from morphological and phonological processes.

2.2.2 Constituent Structure

The constituent structure of Bemba can be straightforwardly described in traditional terms as systematically consisting of open syllables. The only clusters to be found are either Consonant-Glide (CG) or Nasal-Consonant (NC) combinations, which

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[26] Bases, which are by definition consonant-final, will be seen to play a crucial role in the processes of spirantisation and imbrication that are discussed in chapters 4 and 5, respectively.

can, pre-analytically, be described as contour segments and coda-onset sequences, respectively. An analysis that assumes the ‘open syllable’ structure of Bemba will be presented for NC clusters in Chapter 3. This syllable structure type entails that even in the most traditional versions of Government Phonology, Bemba would be characterised as a language without branching onsets. Apart from long vowels, there is no need for branching structure in Bemba. This leads me to employ a version of GP where no branching structure is assumed.

Lowenstamm (1996) puts forth the idea that all syllables are universally CV. The idea is based on alternations of long vowels and consonant clusters in Semitic languages, but alternations in other languages such as the Latin *kasnus* development to *ka:nus* ‘grey’, are also considered. Standard Italian for example, allows both geminate consonants (*fatto* ‘fact’) and long vowels (*fa:to* ‘fate’) in words, but words with a long vowel followed by a geminate consonant are unattested (**fa:tto*). Such alternations are argued to find a principled explanation in a strict CV representation. Take the Latin alternation for example, where the word-medial cluster would be represented as a coda-onset sequence in standard GP. In such a representation, vowel lengthening after coda deletion does not follow naturally from the assumed structure and would require amendment of the structure or a representation of a long vowel as contained within a nucleus and a coda. In strict CV, on the other hand, vowel lengthening is expected. Consider the strict CV structure of *kasnus* below.

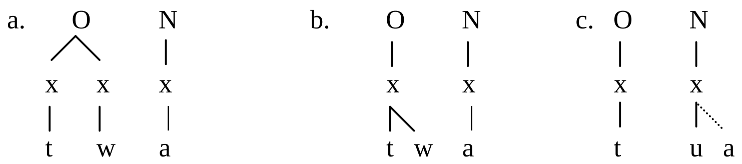
(18) kasnus → ka:nus ‘grey’

```
C V C V C V C V     →     C V C V C V C V
| | | | | | | |           | | | | | | | |
x x x x x x x x           x x x x x x x x
| | |   | | |             | |.....  | | |
k a s Ø n u s             k a:      n u s
    ↓
    Ø
```

The strict CV structure in (18) allows for a spreading site for the vowel after the ‘coda’ consonant is deleted and thereby accounts for the vowel lengthening effect.

Given the ‘open’ syllable structure of Bemba I will assume the strict CV version of GP, represented as sequences of non-branching ON pairs. The choice here is merely representational, so I still assume (as does strict CV) all the basic tenets of GP that, under a strict CV structure, will require some exemplification. However, since there are no branching structures it is pointless to assume that all nuclei are dominated by rhymes. The constituent rhyme is thus no longer a valid constituent in the version of GP assumed here.

Consonant-Glide (CG) clusters, which generally result from vowel gliding (see discussion in section 2.5) will be represented as onset-nuclear sequences, where the glide is part of the nucleus in a structure akin to light diphthongs.[27] Compare the three possible structures for CG sequences in (19) for the verb *twa* ‘pound’.

(19)


The structure in (19a) presents a branching onset where the two branches are in a governing relation. (19b) treats the CG cluster as a contour segment and (19c) is the preferred light-diphthong structure. The governing relation imposed in the structure in (19a) implies that we expect to have restrictions in the distribution of CG clusters as seen in languages with genuine branching onsets. Thus in English, for example, in onsets that consist of voiced stops and the lateral liquid, /bl, gl/ are allowed while /dl/ is not. This is not the case in Bemba CG cluster distribution where any consonant may occur with a following glide. The structure in (19b) that imposes no governing relation between its branches seems to account for the distributional facts in the same way that (19c) does. However, the structure in (19b) fails to reflect the fact that CG clusters in verbs always result from gliding when vowel fusion takes place and thus only occur followed by a long vowel and can as such not be independent segments in the language. In the traditional view, the structure in (19b) does not have to be underlying but can be regarded as resulting from the shift of /u/ or /i/ from a nucleus to a preceding onset and thereby allowing for compensatory lengthening. Gliding results from the articulation of the high vowels in the onset, which is mainly interpreted as secondary articulation. Such changes in syllabification or constituent structure in the course of a derivation are in violation of the GP Projection Principle discussed in section 2.1. Thus in essence the structure in (19b) is viable but the representation in (19c) is assumed. In addition, the distributional facts of CG clusters follow more strongly from (19c) where the consonant and the glide are in independent constituents; we expect no restriction on what consonants may occur in an onset preceding the glide in nuclear position. The structure in (19c) also makes the additional prediction that given vowel fusion in Bemba, /i-a/ and /u-a/ vowel sequences will never undergo total fusion, where total fusion here means an amalgamation of the elements involved in the fusion to produce a unit segment. An investigation of fusion and gliding in section 2.5 proves this prediction correct.[28]

[27] Rhee (2002: 32) also proposes the same structure for the representation of glides in Korean. In Bemba the structure of CG sequences when the glide is derived from the fusion of two adjacent vowels will result in a heavy diphthong, i.e. will involve two skeletal points containing the glide and the long vowel derived from compensatory lengthening. See discussion in section 2.5.1.

[28] See also the discussion on glide-initial stems in prefixation in chapter 3 (section 3.4) that supports this representation of CG clusters.

For the representation of vowels, non-branching structure will also be assumed following the strict CV approach, although vowel length is distinctive in Bemba. The representation of long vowels will thus be as in (20b) rather than (20a).

(20)

constituent government inter-constituent government

The representation in (20a) gives the standard GP representation of long vowels where the leftmost skeletal position governs the one on its right. In (20b) the long vowel is represented as a sequence of nuclei separated by a non-contentful onset. The two nuclei in the long vowel representation enter into a government relation that proceeds from right to left.

Within GP, there is no systematic way of characterising empty onsets, whether they have a skeletal point or not.[29] In fact, it is not clear exactly when onsets are to be represented as pointless or not. I will characterise empty onsets as also following from the Empty Category Principle that has been proposed for the description of empty nuclei particularly in languages with vowel~zero alternations such as French (Charette 1990), Polish (Kaye and Gussmann 1993) or Czech (Scheer 1996).

2.2.2.1 The Empty Category Principle

Kaye (1992a) introduces a notion of p(rosodic)-licensing in GP that regulates the manner in which nuclear positions may be allowed to appear without content in a phonological representation.[30] Consider the definition of the phonological ECP in (21).

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[29] A notable effort is Charette's (1991: 90ff) initial empty onset licensing by a following realised nucleus in *h'aspiré* words. This is to account for the fact that vowels of vowel-final articles in French, such as *la* 'the (fem.)', are retained before *h'aspiré* words, as opposed to vowel-initial words; thus *l'ami* 'the friend' versus *la hache* 'the axe'. Charrette treats vowel-initial words as having pointless onsets, resulting in a sequence of nuclear positions when a vowel-final article precedes vowel-initial words. The sequence of nuclei is simplified as a reflex of the Obligatory Contour Principle (OCP). This is under an interpretation of the OCP as also applying to constituent structure.

[30] The idea comes from the syntactic ECP as proposed in Chomsky (1981). The details of implementation here are quite different from the syntactic ECP.

(21) The Phonological ECP (Kaye 1992a: 305ff)
A p-licensed (empty) category receives no phonetic interpretation.

P-licensing
An empty category may be p-licensed if it is:

(i) domain-final (parameter)
(ii) properly governed
(iii) a nucleus within an inter-onset domain
(iv) magically p-licensed

As seen earlier, final nuclei in Bemba must always be realised, so the parameter setting for (21(i)) is [off] in Bemba. P-licensing of nuclei as stipulated by (21(iii)) is a possibility that will be explored in the representation of NC clusters in chapter 3. Possibility (21(iv)) is specifically reserved for s+C sequences that are represented as coda-onset structures, where the initial /s/ is in a rhymal complement headed by an empty nucleus (Kaye 1992a). In versions of GP where governing domains may not be crossed (here, the inter-constituent government relation between an initial /s/ and following C), there is no local source of p-licensing for the nuclear position in the nucleus that contains /s/, hence the term "magic licensing".[31] The final option for P-licensing in (21(ii)) involves proper government, which is as defined in (22).

(22) Proper government
α properly governs β iff:

(ii) α is adjacent to β on the nuclear projection
(ii) α is not itself p-licensed
(iii) α is not a government licensor (for its onset)

Proper-government, then, allows segments that are adjacent at some projection, viz. the nuclear projection for nuclei, to be in a relationship where the realised member allows the second member to be unrealised.

Can we, then, in the representation of long vowels given for Bemba in (20b) find a way of licensing the intervening onset between the flanking nuclei? We can extend the option of p-licensing in (21(iii)) to this case. Thus if two adjacent identical nuclei contract a government relation in order to avoid an OCP effect, then the sandwiched onset will be licensed to remain unrealised. This gives the structure of the long vowel in (20b). If we take this to mean that the nucleus N_2 in (20b) fails to

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[31] One of the reasons for assuming that governing domains may not be crossed are cases where properly governable nuclei fail to be governed when they are separated by a governing domain. In the French word *sәkre* 'secret', the initial nucleus fails to be properly governed and hence fails to be inaudible because the final nucleus is unable to govern it over the governing domain consisting of the branching onset. In strict CV, this can be explained by the fact that the final nucleus properly governs the nucleus between the two onsets *sәkØre* (Scheer 1998). In this latter view, an initial sC cluster has the structure sØCV i.e. CVCV.

license the onset O_2 as required in every ON pair, because government takes precedence over licensing and inter-nuclear relations have precedence over nuclear-onset relations, then O_2 being unlicensed cannot have a skeletal position.[32] That N_2 does not license O_2 also follows from the fact that it is the licensor of O_1 - it is part of the long vowel contained in N_1 and N_2 that acts as the licensor of O_1. In addition, the fact that O_2 does not have a skeletal position means that, firstly, a long vowel is systematically represented as consisting of two timing slots, and secondly, that the onset position O_2 can never be realised. The latter prediction is totally borne out in all the vocalic processes in the language, no long vowel can, in the course of phonological processing, be broken up by a glide, or any other epenthetic consonant, for that matter. The restriction of long vowels to two skeletal positions is also seen in the lack of fusion of long vowels with following simplex vowels, as will be seen in section 2.5.

Empty onsets, such as the one in the long vowel representation in (20b), are different from empty onsets in vowel-initial words. As discussed earlier, well-formed phonological units consist of sequences of *Onset-Nuclear* pairs, so that vowel-initial words are also represented with an initial onset. Vowel-initial words, and verb forms, in Bemba, occur frequently and have no special status. As opposed to (20b), the initial onset position in vowel-initial stems *is* licensed by the following realised nucleus and is not subject to being silenced by flanking nuclei. Being licensed, this onset must have a skeletal point. How then can word-initial empty onsets be licensed in the ECP? We could try and formalise proper government over onsets, but we are immediately faced with the problem of the level of projection where such a governing relation could take place, given that adjacency is not possible because of the intervening realised nuclei that project to the nuclear projection.[33] Research on the definition of phonological domain boundaries has long shown that word edges demand some special status in the phonologies of many languages and many phonological processes can be related to the right or the left edge of the word. In Optimality Theory, for example, this has been formalised by way of Alignment constraints. I will capture the special status of the word-initial position with respect to empty onsets as a universal parameter, which, like the parameter on domain-final empty nuclei, allows some languages to have

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[32] I return to the idea of precedence relations in government and licensing within a domain in sub-section 3.4.5 of chapter 3, but notice that since a nuclear head locally licenses other nuclei which then license onsets, the licensing relations of nuclei are prior to those of nuclei and the onsets in their ON pairs. There is some concern over the similarity and overlap between *government* and *licensing* in GP. Thus while licensing is a general mechanism by which constituents or positions are sanctioned, government is a more specific version of licensing that has specific requirements on the governed constituent or position. A governed position is also licensed by its governor, hence the precedence of government over licensing in any situation where a competition of the two processes arises.

[33] Having said this, we must keep in mind that there are consonantal processes that take place to the exclusion of nuclei (Bantu nasal consonant harmony is an example), which remain only vaguely characterised within the theory (but cf. an account of nasal consonant harmony in chapter 4). The incorporation of proper government for onsets would therefore not evoke any additional problems for the theory that do not already exist.

vowel-initial words. Thus parametrically, languages may p-license word-initial empty onsets.

A parametrically p-licensed onset has a skeletal point because it is licensed to do so by a following nucleus. By allowing word-initial onsets to have skeletal points, we predict that these empty onset positions can, during the course of a derivation, acquire melodic content. This prediction is borne out in Bemba verb forms of the 1st person singular. A detailed discussion of this and other related phenomena of the 1st person singular prefix *n-* is given in chapter 3. Consider the complex verb form in (23), which acquires an epenthetic consonant /dʒ/ before the vowel-initial verb *eba* 'tell'.

(23)	ni-	n-	jeb-	a	ati	ba-	a-	is-	a
	TAM	SM1SG	*tell*	FV	COMP	SM2	PRES	*come*	FV
	'I have said that they are here'								

Data such as (23) support the representation of initial empty onsets as having skeletal points. [34] This characterisation of empty onsets in GP will be assumed for the remainder of this dissertation and results in an extension of the ECP restated in (24).

(24) Extended Empty Category Principle

A p-licensed (empty) category receives no phonetic interpretation

P-licensing: an empty category may be p-licensed if it is:

(i) domain-final (parameter)
(ii) properly governed
(iii) a nucleus within an inter-onset domain
(iv) magically p-licensed
(v) *domain-initial (parameter)*
(vi) *an onset within an inter-nuclear domain*

We can thus sum up Bemba syllable structure as having the parameter settings in (25).

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[34] This process is reminiscent of liaison in northern varieties of French. In liaison, a consonant that is normally mute can appear between two closely related words if the second word begins with a vowel (*h'aspiré* words are excluded from this). Thus *les amis* [lez̠ami] 'the friends', *petit ami* [pətit̠ami] 'small friend', as opposed to *les chats* [leʃa] 'the cats', *petit chambre* [petiʃambre] 'small room'. The fleeting consonant can be considered a latent consonant that is part of the phonological representation of a liaison word, and which is only preserved when it is followed by a vowel-initial word. If the vowel-initial word is treated as beginning in a licensed empty onset position, then a floating /s/ of the plural definite marker *les* can be parsed into the initial empty onset position. Cf. Morin and Kaye (1982), Durand (1986), among others, for analyses of liaison.

(25) Bemba Parameter settings

Parameter on branching structure	[off]
Parameter on domain-final empty nuclei	[off]
Parameter on domain-initial empty onsets	[on]

This concludes the discussion on the basic syllable structure of Bemba. We now turn to the segmental structure and see how the segments of Bemba can be derived from the set of elements assumed in section 2.1.

2.3 Segmental structure

In GP, the inventory of segments of a language can be characterised by sets of licensing constraints (LC's) that regulate the combinatory possibilities of the elements available in the language. The idea is that there is a pool of theoretically possible phonological expressions, given a set of elements, from which language specific inventories are derived by the postulation of LC's. Particular language inventories are therefore subsets of the pool of theoretically possible expressions. The choice of LC's is in direct relation to the phonological processes and contrasts expressed in the language under investigation.[35] Let us, in order to illustrate this perhaps not so obvious relation between processes and the choice of LC's, have a look at two very similar vocalic inventories and see what factors may come into play in deciding on a set of LC's.[36]

There are two issues at play here; the LC's that define a static set of segments for a language, and the notion of dynamic process constraints (PC's) (cf. Kula and Marten 2000). LC's are determined on the basis of the PC's present in a given language, i.e. PC's inform the choice of licensing constraints. Let us, in this respect, consider the asymmetric vowel height harmony systems of Swahili and Herero.

2.3.1 Licensing Constraints and Process Constraints

Bantu vowel height harmony is a lowering process of high vowels in suffixes that are preceded by mid vowels in the root.[37] In Swahili, a suffix vowel -*i*- is lowered to /e/ before the mid vowels {e, o}, while a suffix vowel -*u*- is lowered to /o/ only following an /o/. Suffixes with /a/ show no vowel harmony. The vowel harmony process is characterised as *asymmetric* because in the case of suffixes containing /u/, the mid vowel /e/ fails to trigger the processes. Hyman (1999) cites eleven Bantu

[35] Similar ideas are also expressed in OT where, because there are no constraints of any kind on input forms, language inventories are derived from the way that constraints on output forms interact with freely chosen feature combinations, cf. Pulleyblank (1997).
[36] See Kula and Marten (2000), for more details on the relation between licensing constraints and process constraints.
[37] See Hyman (1999) for a detailed survey of vowel harmony processes in Bantu.

languages, Bemba among them, with this type of harmony. Consider the Swahili (G. 42) data in (26) and (27).[38]

(26)	verb		applicative	
a.	pit-a	'pass'	pit-i-a	'pass for'
b.	fung-a	'close'	fung-i-a	'close for'
c.	kat-a	'cut'	kat-i-a	'cut for'
d.	let-a	'bring'	let-e-a	'bring for'
e.	som-a	'read'	som-e-a	'read for'

(27)	verb		separative	
a.	zib-a	'plug'	zib-u-a	'unplug'
b.	fung-a	'close'	fung-u-a	'open'
c.	pak-a	'load'	pak-u-a	'unload'
d.	teg-a	'set (of trap)'	teg-u-a	'set off (of trap)'
e.	song-a	'press'	song-o-a	'sqeeze out'

The data in (26a-c) show no harmonisation of the applicative suffix, while (26d) and (26e) do. The asymmetric nature of the harmony process is seen in the data in (27), where only the mid vowel /o/ triggers harmony (27e), while /e/ does not (27d). In approaches employing monovalent features such as GP, the analysis of vowel harmony involves spreading processes where one or several elements of the dominant nucleus (here the root vowel which is the trigger of harmony), spread to recessive nuclei. Spreading is here meant to express the ultimate sharing of features between the dominant and the recessive nuclei. Spreading processes are part of the language specific phonological process that may take place in a given language. Such processes must therefore be stipulated per language in order to characterise what elements spread and whether there are any restrictions on the spreading process with respect to the phonological shape of the trigger or the target, or whether spreading involves a change in head status.

Given the five vowel system of Swahili, we can characterise the five vowels using GP elements as; a (A), i (I), u (U), e (A.I) and o (A.U). At this stage, we do not speculate on the head status of these elemental representations. Consider now the vowel harmony process, which we can characterise as involving the spread of the element (A) into (I) and (U), to result in the complex mid vowels. For the alternation between /i~e/ and /u~o/ illustrated by the applicative in (26) and the separative in (27), respectively, (A) spreads into (I) for the applicative and into (U) for the separative. Recall, however, that simplex (A) does not trigger vowel harmony (26c) and (27c). We can capture this disparity by assuming some head status in the expressions containing (A), namely a difference between a spreading and a non-spreading (A). If we take it that simplex expressions are always headed,

[38] The applicative suffix adds a benefactive reading to the verb, but see Marten (2002) for a different view. The *separative* suffix is referred to in more traditional literature as the *reversive*; see Schadeberg (1982) for motivations of the term *separative*.

then simplex (A) will be headed and conversely the spreading (A) can be a non-head. We can capture this by PC (i): ‘A spreads as operator’.[39] By this PC, (A) will spread into headed ($\underline{\mathrm{I}}$) and ($\underline{\mathrm{U}}$) to give the mid vowels ($\underline{\mathrm{I}}$.A) and ($\underline{\mathrm{U}}$.A) (underlining here marks the head element). Simplex ($\underline{\mathrm{A}}$) which is headed, will not spread into headed ($\underline{\mathrm{I}}$) and ($\underline{\mathrm{U}}$) as this violates PC (i). With respect to the geometry, this means that simplex (A), (I), (U) are defined in the stricture sub-gesture and are as such heads. Complex expressions are represented as having (I) and (U) in the stricture sub-gesture and dependent (A) in the primary location sub-gesture. For vowel harmony, the PC ‘A spreads as operator’ captures the fact that the dependent locational gesture spreads. Thus no spread of simplex (A) is expected because it is defined in the stricture sub-gesture.

Consider now the harmony process with the separative suffix *-u-* in (27), which we may express as the spread of (A) into (U). Under PC (i), we correctly predict the output /o/ after /o/ (A spreads as operator), but also wrongly predict that the mid vowel /e/ will harmonise the separative suffix vowel to /o/; it contains an operator (A) element that can spread into (U). The correct descriptive statement about the harmonisation of (U) is that there is a further restriction on the trigger of the harmony process: it must contain (U). Consider now the two PC’s that capture the Swahili vowel harmony.[40]

(28) Process Constraints for Swahili vowel harmony

(i) A spreads as operator
(ii) A spreads into U via an U-bridge

With PC (i), we have the effect of (A) spreading into simplex (I) and (U) from the mid vowels in dominant position to give the outputs in (29), of which (29d) is illicit. PC (ii) then rules out (29d) by not allowing (A) to spread from /e/ into /u/. All instances of simplex (A) spread are blocked by PC (i).

(29)	trigger	A-spread	target	output
a.	($\underline{\mathrm{I}}$.A)	→	($\underline{\mathrm{I}}$)	($\underline{\mathrm{I}}$.A)
b.	($\underline{\mathrm{U}}$.A)	→	($\underline{\mathrm{I}}$)	($\underline{\mathrm{I}}$.A)
c.	($\underline{\mathrm{U}}$.A)	→	($\underline{\mathrm{U}}$)	($\underline{\mathrm{U}}$.A)
d.	*($\underline{\mathrm{I}}$.A)	→	($\underline{\mathrm{U}}$)	($\underline{\mathrm{U}}$.A)

[39] The term *operator* is a GP term that refers to an element that assumes a non-head position in a phonological expression. *Co-operator* will also be used to refer to operators that occur in the same phonological expression.
[40] There are several different proposals to account for this type of vowel harmony in GP (Harris 1994, Cobb 1997, Marten 1997, Kula 1997). The point being made here does not depend on the details of the analysis. Cf. also Beckman (1997) for an analysis in OT. The term *U-bridge* is a GP term that is used to capture the fact that both the target and the source of spreading must contain the element (U). The same expression can also be used to characterise the same requirement for other elements, viz. *A-bridge* or *I-bridge*.

Given these process constraints we can now define the licensing constraints that define the vocalic system of the language.

(30) Licensing Constraints for Swahili vowels → Swahili vocalic system

(i)	I must be head	i ($\underline{I}$)	u ($\underline{U}$)
(ii)	U must be head	e ($\underline{I}$.A)	o ($\underline{U}$.A)
(iii)	Phonological expressions must be headed.	a ($\underline{A}$)	

The constraints in (30) thus define the static lexical vocalic system of Swahili as shown above, which gives the five-member subset that Swahili makes from the universal set of 19 possible vocalic expressions derivable from the combination of the elements (A), (I) and (U). I will assume the same analysis for the identical asymmetric vowel harmony in Bemba and hence the same PC's.

Let us now turn to the Herero (R. 31) vocalic system which is on the surface identical to that of Swahili, and which has an almost identical process of vowel harmony. The difference in the Herero vowel harmony is that, in contrast to Swahili, Herero /a/ also triggers harmony. Consider the data in (31) involving the applicative -*ir*- in Herero.

(31)	a. pit-a	'go out'	→	pit-ir-a	'go out for'
	b. tuk-a	'shake'	→	tuk-ir-a	'shake for'
	c. pat-a	'close'	→	pat-er-a	'close for'
	d. vet-a	'hit by throwing'	→	vet-er-a	'hit for'
	e. ror-a	'taste'	→	ror-er-a	'taste for'

As in Swahili, the mid vowels trigger vowel harmony (31d) and (31e), but in addition, /a/ also triggers the process (31c). Herero is identical to Swahili with respect to suffixes containing (U) – simplex (A) and mid vowel /e/ (A.I) do not harmonise (U). The question here then is, should this difference in phonological processes with respect to the details of vowel harmony reflect a different set of licensing constraints for Herero despite the actual similarity between the vowels of the two languages? I claim it should. The process constraints of Swahili cannot serve to characterise the vowel harmony system of Herero since there are no restrictions on the spread of (A), at least not with respect to /i/ as the target. We must therefore postulate PC's specific and unique to Herero. This also implies that the geometric structure of Herero vowels is different from Swahili. Thus while simplex (I) and (U) are defined in the stricture sub-gesture, simplex (A) is defined in the locational sub-gesture in Herero. The PC's of Herero are given in (32). These process constraints lead to the LC's in (33).[41]

[41] This serves to illustrate a general point on how licensing constraints of languages are derived and why they differ. From a typological point of view, however, the choice may not be so straightforward, as Kula and Marten (2000) show. Within Bantu, we may want to characterise the division between five-vowel and seven-vowel systems that occurred in Proto-Bantu as reflected in the LC's. This would entail an identical

(32) Herero Process Constraints

(i) A spreads into I unconditionally
(ii) A spreads into U via an U-bridge

(33) Herero Licensing Constraints → Vocalic system of Herero

(i) I must be head	i (<u>I</u>)	u (<u>U</u>)
(ii) U must be head	e (<u>I</u>.A)	o (<u>U</u>.A)
(iii) Only I and U can be head	a (A)	

The vocalic system of Herero can also be captured with the sole constraint 'expressions are headless' in which case a headless (A) would spread. It could also be captured by the LC's of Swahili where all expressions are headed but (I) and (U) must be head. The choice of the set of licensing constraints is also probably influenced by other vocalic processes in the language, but goes far beyond the present discussion. The point of the foregoing is clear: process constraints based on dynamic phonological processes inform licensing constraints that define the static lexical segmental inventory of a language.

From a representational point of view, the vowel harmony process lends support to the postulation of a nuclear projection. In vowel harmony, the back vowel /u/ blocks harmony whenever it fails to be harmonised. Thus Bemba *pen-uk-il-a* 'fall back on someone' contrasts with *kont-ok-el-a* 'break on someone' where the latter form allows vowel harmony to proceed through the domain and the former one does not. Under the assumption of a nuclear projection these data are straightforwardly accounted for, as opposed to an analysis that considers the spreading feature as affecting segments specified for a specific feature such as [front]. Consider the GP representation of vowel harmony in (34).[42]

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set of LC's for the five-vowel system languages as opposed to another set of LC's for seven-vowel languages. Differences within systems, such as that seen between Swahili and Herero, would be captured by postulating different process constraints. The two systems can be captured under the licensing constraints:

(i) I and U must be head
(ii) Phonological expressions must be headed

And the vowel harmony facts can be captured under the processes constraints:

(iii) *Swahili*: A spreads as operator
A spreads into U via an U-bridge

Herero: A spreads into I unconditionally
A spreads into U via an U-bridge

Under these PC's, the spread of simplex (A) in Herero will involve loss of headship since (I) and (U) must be head in complex expressions. The system in (33) above avoids this by making (A) operator. The same effect can be achieved by making (A) head in all expressions.

[42] I give a full characterisation of the representation of NC clusters in chapter 3.

(34) a. nuclear projection

	N_1 ↛		N_2		N_3		]	N_4
	|		|		|		]	|
O	N	O	N	O	N	O	]	N
|	|	|	|	|	|	|	]	|
x	x	x	x	x	x	x	]	x
|	|	|	|	|	|	|	]	|
p	e	n	u	k	i	l	]	a

b.

	N_1 →		N_2 →		N_3		]	N_4
	|		|		|		]	|
O	N	O	N	O	N	O	]	N
|	|	|	|	|	|	|	]	|
x	x	x	x	x	x	x	]	x
|	|	|	|	|	|	|	]	|
k	o	nt	o	k	e	l	]	a

As seen in (34), the nuclear projection provides the correct representational level for the strict adjacency that is required in the harmony process. N_3 in (34a) is a perfect candidate for vowel harmony and its lack of harmonisation can be attributed to non-locality alone. Notice that the FV is outside the domain of harmony. Let us now turn to the characterisation of the vowel inventory of Bemba.

2.3.2 Bemba inventory

The vocalic system of Bemba consists of five vowels (with long counterparts) that are historically derived from the seven-vowel system of Proto-Bantu by a reduction process that consisted of the loss of two vowels, as shown in (35).[43]

(35)

Proto-Bantu vowel system:	*į *i	*e	*a	*o	*u *ų
Bemba vowel system:	i	e	a	o	u

These vowels have the GP representations in (36), under the licensing constraints in (37), which are based on the phonological processes operative in Bemba. One of these processes is vowel harmony, which is also defined by the Swahili PC's given in (28). As already discussed, GP follows the age-old view that mid vowels are formed by a combination of high and low vowels, which has also been investigated in Anderson and Jones (1974), Schane (1984), Rennison (1986), among others. The long vowel counterparts to the short ones in (36), have an identical representation to the short vowels, and differ only with respect to constituent structure - long vowels stretch over two nuclear positions, as has already been illustrated in section 2.2.2.

[43] Starred segments in (35) are reconstructed. The difference between the two *i*'s and *u*'s of Proto-Bantu (PB) has two interpretations in PB reconstructions. One school characterises it as a difference between tense and lax following the reconstruction of Meeussen (1967), in which case Bemba has lost the tense~lax distinction, while another treats it as a difference in height, following the reconstruction of Meinhof (1932), in which case we can regard reduction as the collapse of two height levels into one. In general, languages that have retained the seven vowels show a tense~lax distinction in the mid vowels. Cf. the Nyamwezi vocalic system / i ɪ ɛ a ɔ ʊ u / as presented in Maganga and Schadeberg (1992).

(36) Bemba vowels

i ($\underline{\text{I}}$) u ($\underline{\text{U}}$)
e ($\underline{\text{I}}$.A) o ($\underline{\text{U}}$.A)
a (A)

(37) Bemba vocalic Licensing Constraints

(i) I must be head
(ii) U must be head

Following the definition of head as representing the most salient feature in a phonological expression or what we might term the *canvas* on which other elements are superimposed, I will treat all simplex expressions as headed. This also follows from the geometry assumed. Thus /i a u/ consist of simplex headed expressions.[44] We are able to capture the vocalic inventory of Bemba by the two licensing constraints in (37), which determine the head in complex expressions. These two constraints also rule out the possibility of complex expressions containing three elements by ruling out the combination of (I) and (U).

Consider now the consonantal inventory of Bemba. An important issue in determining LC's, particularly for consonantal inventories, is the number of contrasts expressed in a language. For example, a language that has both aspirated and non-aspirated stops needs phonological representations of these segments that capture this contrast. In this respect, Bemba has a reasonably simple consonantal system consisting of 15 consonants including two glides.

(38) Bemba consonantal Inventory

stops:	p	t			k
fricatives:	β	f	s	ʃ	
affricates:				tʃ	
nasals:	m	n		ɲ	ŋ
liquid:		l			
glides:	w			y	

As seen in (38), apart from the voiced bilabial fricative /β/, there are no voiced consonants underlyingly. All voiced consonants are derived and appear only after a

[44] In the remainder of this dissertation, the leftmost member in a complex expression will represent the head of that expression.

nasal which itself undergoes place assimilation. For this reason, 'voiceless' is assumed to be the unmarked voice feature. Thus, consonants without voice specification will take the unmarked voice specification and be voiceless by default. *Voice*, which cannot be the head feature of any segment, will be represented by an (L) element in operator position. By contrast, when the element (L) assumes head position, it represents nasality in nasal segments and since voicing is by default a characteristic of nasal segments, nasality will imply voiceness. In this way we simultaneously capture nasality and voice in nasal segments by a head (L) element. In the geometry presented in (10) above, this means that only (L) occupies the phonation sub-gesture, which, when it is dependent on stricture, contributes voicing. When it is head, with some dependent in the locational sub-gesture, it contributes nasality. Place of articulation will be represented by the elements (I) for palatals, (R) for coronals and (U) for labials in the primary location sub-gesture. (A), which defines laryngeals and pharyngeals, will have no role to play in the consonantal system of Bemba. Velarity will be represented by the lack of a place element, following the geometry. The contrast *stop* versus *non-stop* will be captured by (ʔ) in stops and (h) in fricatives in the stricture sub-gesture. Affricates will be treated as basically *stops* but composed of an amalgamation of two segments.[45] Finally, glides will have the same representation as the vowels /i/ and /u/ and will only be differentiated by their position in constituent structure. The consonantal system of Bemba is thus derived from the interaction of the set of elements {ʔ L R h I U}, under the licensing constraints given in (39).

(39) Licensing constraints for Bemba consonants

(i) ʔ must be head
(ii) h must be head
(iii) L can only license R U I
(iv) R U I cannot license operators
(v) R U I cannot mutually be co-operators
(vi) only h can license L
(vii) R and L cannot be co-operators
(viii) I and L cannot be co-operators

LC's (i) and (ii) are parallel to LC (iii) in the sense that while the former two, by stipulating the head, imply that it can license any element in an expression, the latter stipulates what elements (L) can license when it is head; any place element, which gives the four nasals in the language. The LC's in (iv) and (v) capture the fact that place elements are dependent on a stricture feature in order to be realised and can as such not be heads in expressions, and also, that they may not co-occur - no segment can have two place features concurrently. The final three LC's militate against

[45] /tʃ/ is a commonly found realisation of a palatal stop in many languages, see for example, Wolof and Bambara.

voiced segments; LC (vi) gives us the only lexical voiced segment while LC's (vii) and (viii) rule out any other occurrences of (L) as operator when (h) is head.
These constraints give a representation of the consonant inventory of Bemba. In (40) I give representations of both lexical and derived consonants, in order to capture the representation of all the consonants that have a surface appearance in the language. The derived consonants are [b d g dʒ]. Only lexical consonants are derived by the licensing constraints. (Derived consonants are in square brackets).

(40) Bemba consonant inventory in GP

stops:	p (ʔ.U)	t (ʔ.R)				k (ʔ)
	[b (ʔ.U.L)]	[d (ʔ.R.L)]				[g (ʔ.L)]
fricatives:	β (h.U.L)	f (h.U)	s (h.R)	ʃ (h.I)		
affricates:				tʃ(ʔ.I)	[dʒ (ʔ.L.I)]	
nasals:	m (L.U)	n (L.R)		ɲ (L.I)		ŋ (L)
liquid:		l (R)				
glides:	w (U)			y (I)		

Notice that all the derived consonants are voiced and I have represented them here by adding (L) as operator to their voiceless counterparts. An investigation of the conditions under which they are derived will show whether these are valid representations.

In coming chapters, we will see how the assumption of these constraints interacts with the phonological processes attested. In the next section, I consider supra-segmental structure, in particular tone.

2.4 Supra-segmental structure

In this section I give a brief sketch of tone in Bemba. The tonal system of Bemba is very complex and requires much more space and time than I will award it here; see Sharman and Meeussen (1955) and Philippson (1999), for some discussion.

2.4.1 Bemba tonal patterns

There are basically two tones, a high (H) and a low tone (L), which may in combination result in rising (LH), or falling (HL) tone. Every verb form is lexically specified as being either high or low-toned. Verb roots that do not have any extensions, i.e. CVC-FV, are always either HH or LL. This can be expressed by leaving the final vowel lexically unspecified for tone.[46] Prefixes, as opposed to derivational suffixes, can be lexically specified for tone. There are four basic tonal patterns that can be recognised in the verb.

(41) Tonal patterns [47]

	lexical		surface
(i)	HLL	→	HHL
(ii)	LHLL	→	LHHL
(iii)	HLH	→	HLH
(iv)	LHH	→	LHH

Tonal pattern (41(i)) represents a high tone followed by any number of low tones. The output shows that Bemba has a tone-doubling rule (TD) that is restricted to a single application. (41(ii)) shows that tone doubling is a rightward process. (41(iii)) shows that tone doubling is blocked when only one low tone separates two lexical high tones. This may seem a constraint against adjacent lexical high tones but the pattern in (41(iv)) shows this is not the case. (41(iv)) also illustrates that Meeussen's rule, a dissimilation process that turns the second high tone in a series of two into a low tone, does not apply in Bemba.[48] Consider the data in (42) that illustrate these tone patterns. High tone is represented with an accent and no marking indicates low tone.

(42) HLL → HHL

a.	tu-	ka-	bútuk-	a	→	tu-ka-bútúk-a	'we will run'
	SM1PL	FUT	*run*	FV			
b.	bá-	ka-	lim-	a	→	bá-ká-lim-a	'they will cultivate it'
	SM2	FUT	*cultivate*	FV			

LHLL → LHHL

c.	tu-	bá-	kulul-	e	→	tu-bá-kúlul-e	'we should pull them'
	SM1PL	OM2	*pull*	optative			

[46] As will be seen in the next section, lack of tone specification will be interpreted as low tone in surface forms. This follows the treatment of low tone as the unmarked tonal feature (Pulleyblank 1986).

[47] I am oversimplifying here, by presenting tone as though it is always mapped from left to right. In object relatives where the subject prefix has a high tone, there is a complex LH tone that attaches to the FV after the root, and which derives different tone patterns depending on the size of the base. In some verbs the H of the complex LH associates to the FV and L to all available vowels after the root; '*éko tú- ka pítililá*' 'to which we will proceed directly'. When only one vowel separates a root H and the FV (i.e. CVC-VC-FV) then either the H of the root doubles and the H of the LH has to float '*éko tú- ka- bútúka*' 'from which we will run', or tone doubling is blocked and the H of the final complex LH attaches to the final vowel '*éko tú- léé- sápiká*' 'where we are looking for'. The patterns in (41) thus only illustrate the basic patterns and suffice to interpret the data that will be surveyed in this dissertation.

[48] Leben (1973) points out that there is an OCP effect at the melodic level of the grammar that requires adjacent tones to be distinct, so that HHL must really be interpreted as HL at the melodic level. However, Odden (1986) surveys a number of cases in Shona where this interpretation of the OCP is not always tenable, showing that while underlying representations respect the OCP, derived representations do not.

HLH → HLH

d. bá-	ka-	fík-	a	→	bá-ka-fík-á	'they will arrive'
SM2	FUT	*arrive*	FV			

LHHL → LHHHL

e. tu-	bá-	céle:k	e	→	tu-bá-célé:k-e	'we've made them late'
SM1PL	OM2	*delay*	PERF			

As can be seen from (42), the 1st person plural marker *-tu-*, and the remote future tense marker *-ka-*, are lexically low toned, and only acquire tone by TD from a preceding high-toned morpheme such as the class-2 marker *-bá-*. All suffixes after the verb root have low tone and thus only acquire high tone from TD.

2.4.2 Tone in GP

With respect to constituent structure, tone is represented on a separate tier from segmental and melodic structure in GP, i.e. on a tonal tier. The elements (L) and (H) are used to represent tone on this tier. Tonal representations are generally regarded to be subject to the well-formedness conditions proposed in Goldsmith (1976).

(43) Goldsmith's well-formedness conditions

a. all vowels are associated with at least one tone
b. all tones are associated with at least one vowel
c. association lines do not cross

Assuming Goldsmith's well-formedness conditions (WFC's), does not mean also assuming association conventions where tones are treated as initially separate from the tone bearing units and sequences of tones are mapped onto sequences of tone bearing units as proposed in Pulleyblank (1986).[49] Rather, at least for Bemba, tone bearing units are lexically specified for tone and are subject to tonal processes that result in the attested surface tones. Under this view there is no notion of automatic tone spread, as implied in Goldsmith's WFC (43a).

As already alluded to I consider the unmarked tonal feature of Bemba to be *low* and unless otherwise specified, verb forms are treated as being low-toned. In GP representational terms, this means that only high tone will be phonologically represented by an element (H), while the lack of a tonal element will be interpreted as low tone. This means that only one element will be used to represent tone and implies that the tonal sub-gesture in Bemba only contains one element, (H). There are thus no complex tones. This is borne out in Bemba because even in cases where it is claimed that there are complex tonal melodies (LH) or (HL), these systematically never attach to one vowel but must be spread over two vowels, and

[49] Tone bearing units (TBU's) refer only to vowels. In Bemba all realised vowels are TBU's.

can as such still be captured by only assuming one element. Given the tonal patterns in (41), and their illustration in (42), we can formulate the following tonal process constraints for Bemba.

(44) Bemba Tonal PC's

(i) H doubly links to a following TBU
(ii) H does not doubly link if a TBU specified as H immediately follows the target

PC (i) captures rightward TD and the fact that it does not spread through the domain even if more low-toned vowels follow. PC (ii) reflects that non-adjacent lexical highs in the input must emerge as non-adjacent in the output, resulting in the blocking of TD as illustrated in the data in (42d). That (H) does not doubly link to a following vowel specified as (H) follows from standard assumptions in GP: no phonological expression may contain a duplication of the same element, i.e. *(H.H). The licensing constraints that capture our one element tonal system are given in (45).

(45) Bemba Tonal LC's

(i) H must be head
(ii) H does not license operators

Let us illustrate the tonal processes as specified by the PC's in (44) using example (42c), repeated here as (46). This example illustrates both the rightward linking of high tone, where there is a low-toned vowel to the left of the first high that is left unaffected, as well as the spread of high tone only to a following low toned vowel and not to any other following lows.

(46) LHLL → LHHL

a. tu- bá- kulul- e → tu-bá-kúlul-e
SM1PL OM2 *pull* optative ‘we should pull them’

b.

					H					tonal tier						H				
					|											|				
O	N	O	N	O	N	O	N	O	N	constituents	O	N	O	N	O	N	O	N	O	N
|	|	|	|	|	|	|	|	|	|		|	|	|	|	|	|	|	|	|	|
x	x	x	x	x	x	x	x	x	x	skeletal tier	x	x	x	x	x	x	x	x	x	x
|	|	|	|	|	|	|	|	|	|		|	|	|	|	|	|	|	|	|	|
t	u	b	a	k	u	l	u	l	e	melodic tier	t	u	b	a	k	u	l	u	l	e

This gives us an impression of the tonal patterns in Bemba verbs and how they are represented in GP terms as the double linking of an (H) element under specified conditions.[50] In the remainder of the data cited in this dissertation, I will only mark lexical tone, which must then be assumed to undergo the tonal processes just discussed. Tone will be marked with an accent on the vowel, rather than by an element (H) on the tonal tier, for ease of representation, since tone is not the focus of this dissertation. In the next section, with the GP assumptions made so far, I look at some vocalic processes in Bemba.

2.5 Vocalic Processes

As earlier alluded to, Bemba has a process of vowel harmony that lowers high vowels in suffixes when they are preceded by a mid vowel in the root. This process affects the suffix domain. An analysis along the lines of that offered for Swahili has been assumed for this process. In this section I will consider vocalic processes in the prefix domain, i.e. to the left of the verb root, which generally involve fusion and may also result in gliding.

2.5.1 Vowel fusion and gliding

Vocalic processes to the left of the verb root generally involve vowel fusion between morphemes in the verbal complex. There is no vowel hiatus between short vowels in Bemba. The only sequence of vowels allowed with hiatus is a long vowel followed by a short vowel. Short vowel sequences therefore result in fusion or coalescence that may also result in gliding. In GP vowel fusion is treated as the merger of the elements within the short vowels that undergo the process. Kashoki (1968) lays out the outputs of all the possible fusions between the five vowels of Bemba as shown in the table in (47).

(47) Vowel fusion in Bemba (Kashoki 1968: 25)

V2 / V1	i	e	a	o	u
i	ii	yee	yaa	yoo	yuu
e	ee	ee	yaa	yoo	yoo
a	ee	ee	aa	oo	oo
o	wee	wee	waa	oo	oo
u	wii	wee	waa	oo	uu

Vowels from the first column are the first member in the fusion while those in the first row are the second. Let us first have a look at the simplex vowels /a, i, u/. According to (47), when /i/ is the first vowel there is no (total) fusion but gliding of the high front vowel and lengthening of the second vowel. The only exception to

[50] See also Kaye (2001) for a description of tonal representations in GP.

this is, of course, if it is adjacent to another /i/, in which case a long vowel results. A parallel can be drawn with /u/, which also, as a first member in fusion, does not result in total fusion but gliding of /u/. However, both vowels as a second member trigger some fusion. In contrast to this, /a/ always results in fusion when it is the first member and never when it is the second member. Consider the three paradigms in (48).

(48) *a*, *i*, *u* vowel fusions

	A	B	C
(i)	*a* + i e o u	*i* + e a o u	*u* + i e a o
	↓ ↓ ↓ ↓	↓ ↓ ↓ ↓	↓ ↓ ↓ ↓
	e: e: o: o:	ye: ya: yo: yu:	wi: we: wa: o:
(ii)	i e o u + *a*	e a o u + *i*	e a o i + *u*
	↓ ↓ ↓ ↓	↓ ↓ ↓ ↓	↓ ↓ ↓ ↓
	ya: ya: wa: wa:	e: e: we: wii:	yo: o: o: yu:

There is a clear restriction on fusion with respect to which vowel comes first in a sequence. The distribution in (48) can be captured by the process constraint: ‘A spreads’. As opposed to vowel harmony, there are no restrictions on (A) spread in the fusion process. This constraint implies that (I) and (U) do not spread, which explains the lack of fusion when either of these vowels is initial in a sequence (48B(i)) and (48C(i)). The remaining cases where some fusion is seen (48A(i), 48B(ii) and 48C(ii)) are all a result of (A) spread. Note here that given the vocalic inventory of Bemba defined by the LC’s in (37), (A) loses its head status when it spreads from a simplex expression into /i/ or /u/ since the LC’s demand that (I) and (U) must be heads in complex expressions. The notion of spreading must here be understood as, in essence, element sharing rather than the actual transfer of an element from one nuclear position to another. Thus the use of the term *spreading* implies *sharing*.

If the second vowel in the fusion is /a/, no fusion is seen despite the presence of the harmonising element (A); the sequences /i - a/ and /u - a/, in (48A(ii)), fail to trigger fusion. This illustrates that the direction of element sharing is crucial here and must be from left to right, where the shared element is on the left. This is in line with the direction of vowel harmony in the language and might thus be treated as the preferred spreading direction in the language (and not as a universal tendency). Rightward sharing explains why no sharing of (A) takes place in (48A(ii)): directionality would be violated if sharing took place. Let us consider some representations of the following examples.

(49) a. /a + i → e:/
a-la-ib-a → aleeba
SM1-HAB-*steal*-FV
'he steals in general'

b. /i + a → ya:/
a-li-afy-a → alyaafya
SM-PRES-*difficult*-FV
'he is a difficult person'

government

```
a.                            b.
   O  N1 O  N2 O  N3             O1 N1 O2 N2 O3 N3
   |  |  |  |  |  |              |  |  |  |  |  |
   x  x  x  x  x  x              x  x  x  x  x  x
   |  |     |  |  |              |  |_____|  |  |
-  l  a     i  b  a           -  l  i     a  fy a
      A →   I                    R  I     A
```

In (49a), (A) in N_1 can be shared in a rightward fashion with N_2 which has a government relation with N_1 resulting in the long vowel /e:/. The elements in the head N_2 are interpreted over the two nuclear positions. In (49b), on the other hand, no rightward spreading of (A) can take place, because N_1 does not contain (A). A government relation is contracted between N_2 and N_1 and the elements of N_2 are interpreted over the two positions. The element (I) that fails to be incorporated into the long vowel (because it cannot spread to the head position N_2 under the PC 'A spreads') is interpreted as a glide in a heavy diphthong structure. This illustrates that only elements in the head represent the long vowel and gliding results from the lack of total fusion.

Notice that in the representations in (49a) and (49b) long vowels are represented with an onset that has a skeletal position. The onset is licensed to remain unrealised by the government relation of the two flanking nuclei. This difference in representation shows these long vowels to be derived rather than lexical. The structure of the onset reflects the history of the derivation, which, under GP assumptions, cannot be undone; licensing relations are defined at the lexical level and remain stable throughout a derivation. Let us now, in the same vein, consider cases with complex vowels that result in partial fusion.[51]

[51] The data used here are not verbal forms because there are no prefixes that end in /o/ or in a short /e/. The point with respect to fusion that is being made here is still valid. NCP in (50b) stands for noun class prefix.

(50) a. /e + o → yo:/
Puule oba→ Puul<u>yoo</u>ba
Proper name *row*-imperative
'Puule row!'

b. /o + i → we:/
itʃi-kopo itʃi → itʃikop<u>wee</u>tʃi
NCP-*tin*NP demonstrative
'this pot'

government

```
a.                                  b.
    O1 N1 O2 N2 O3 N3                  O1 N1 O2 N2 O3 N3
    |  |  |  |  |  |                   |  |  |  |  |  |
    x  x  x  x  x  x                   x  x  x  x  x  x
    |  |     |  |  |                   |  |     |  |  |
......l  e     o  b  a              ......p  o     i  c  i
       A←→ A                              A →
       I     U                            U     I
```

The representation in (50a) shows that (A) can be shared from a complex expression and that government proceeds as usual. Since only (A) in N_1 is linked to the governing head N_2, (I) of N_1 fails to be incorporated into the long vowel and is interpreted as a glide. We expect a similar effect if N_1 only contained (A), i.e. a long vowel where (A) is shared, would result. In (50b) we see that the decomposition of elements is a reality since N_2 only acquires (A) from N_1. Interpretation of the long vowel via government again results in (U) having glide interpretation. The interaction of the complex vowels seen here reveals an interesting point about complex expressions, namely that the elements of which they are composed do not have to behave as a unit but can engage in independent interaction. This independent interaction is taken one step further in constituent structure where elements may share a constituent but not have a unique phonetic interpretation. We are thus able to fully characterise the vowel fusion processes in Bemba by the PC: 'A spreads', which in conjunction with the LC's of Bemba derives the correct outputs.[52] These processes also illustrate the point made earlier in section 2.3, viz. that PC's are dynamic while LC's are static. Notice also that the fusion of adjacent vocalic prefixes following the formulae in (48), suggests the absence of active phonological domain boundaries between prefixes.

Let us to conclude the discussion of vocalic processes in the prefix domain, consider a case of non-fusion between a long vowel and a following short vowel. I use the progressive aspect marker *-laa*. Contrast the case in (51) below with (49a) above.

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[52] Mann (1999:7) presents interesting fusion possibilities in Bemba although no raw data is provided, and my informants fail to give consistent data for these fusions. The data are nonetheless an interesting area of investigation. They involve fusion of lexical glide-vowel sequences and following short vowels. Forms where no mid vowels are involved offer no surprises, but forms such as /*we + a → wa*:, *we + i → we*:, *we + u → wo*:, *yo + a → ya*:, *yo + i → ye*: and *yo + u → yo*:/, although supporting rightward (A) spread, require at least element delinking to account for the loss of (I) or (U) in the resulting forms.

(51) /aa + i → aa + i/
a-ka-laa-ib-a → a-ka-laa-iba (*a-ka-lee-b-a/*a-ka-laa-yib-a)
SM-FUT -PROG-*steal*-FV
'he will be stealing'

```
                                          government
      O1 N1 O2 N2 O3 N3 O4 N4
      |  |     |  |  |  |  |
      x  x     x  x  x  x  x
      |                |  |  |
  -   l        a-      i  b  a
```

In (51) the order of the vowels in N_2 and N_3, with respect to rightward sharing, is satisfied but element sharing fails to take place because N_2 is already in a governing relation with N_1. Simultaneous government relations as would result here between N_1 and N_2 and between N_2 and N_3 are not licit in GP because this would require N_2 to simultaneously be head (of the initial governing relation) and dependent (of the final governing relation).[53] O_3 being licensed by N_3 has a skeletal position and remains unrealised by the domain-initial parameter and thus there is also no possibility of the initial vowel of the verb gliding into this position to produce an output such as the ungrammatical **a-ka-laa-yiba*. Thus the lack of fusion here cannot be attributed to the presence of a phonological domain boundary between the prefix and the following stem but rather to the inability of the structural conditions for fusion to be met.

2.6 Summary

In this chapter I presented the basic tenets of Government Phonology that will be assumed in the remainder of this thesis. I have opted for a version of GP where constituent structure consists of non-branching constituents, based on the syllable structure of Bemba. I have also presented an extension of the ECP with respect to the sanctioning of empty onsets in phonological representations. I have selected seven elements as necessary for the characterisation of Bemba segments and argued that these elements are presented in a geometry that defines head-dependent relations between the elements. I have used the notion of licensing and process constraints to show how inventories of languages can be represented, and how the process constraints defined in a language relate to phonological processes therein, such as for example vowel harmony, fusion and compensatory lengthening. I have also drawn parallels between GP and Dependency Phonology showing how the two approaches complement and contrast with each other.

In the foregoing, the behaviour of vowel-final (e.g. subject markers) and vowel-initial (e.g. tense aspect markers) prefixes suggests that there are no

[53] In chapter 5, we will see a nearly identical case to (51), where under very specific conditions, loss of the government relation in a long vowel is the preferred option.

phonological domain boundaries within the prefix domain. In the discussion of fusion we observed that total fusion between adjacent vowels only occurs under rightward linking of (A), otherwise partial fusion, where the first vowel is interpreted as a glide and the second vowel lengthens, results. Since the government relation in a long vowel proceeds from right to left, given rightward A-linking, a long vowel created between a prefix and a following vowel-initial verb, indicates that the verb stem vowel acts as governor while the affix vowel is the governee. On the phonological domain level this implies that the phonological domain of the verb is the head of the wider phonological domain created by the verb stem and the prefixes, i.e. (prefix^n (verb stem)). In the following chapter I explore the validity of this phonological domain structure by considering phonological activity between a consonant-final prefix and the verb stem.

3 Prefixation

This chapter covers non-vocalic phonological processes that result from prefixation in the verb. We have already seen how vowels interact in processes of fusion and gliding in the prefix domain in chapter 2. This chapter will thus be restricted to consonantal interaction in the prefix domain i.e. to the nasal prefix, which marks the 1st person singular subject or object. The nominal class 9/10 nasal prefix triggers identical alternations. Prefixation with the nasal prefix produces NC clusters that will be treated as sequences rather than as unit segments. We will begin by looking at the characterisation of prefixation in GP and then consider motivations for analysing NC clusters in Bemba as sequences of segments that contract an inter-onset government relation. I will consider various data for this purpose and also look at other Bantu languages in order to see whether the analyses developed for the phonological processes in NC clusters in Bemba can be extended to these languages. Finally, we will consider the predictions that prefixation processes make for the visibility of morphology in phonology.

3.1 Derivations and interfaces in Government Phonology

In GP, the interaction of phonology and morphology follows the proposals made in Kaye 1995. According to the description of GP given in chapter 2, phonology is seen as a function that is applied to an input string for the purpose of parsing and to act as a lexical addressing system. Viewing phonology as a function implies that there is only one phonological level and as such there cannot be cyclic applications of phonology. Morphological structure is regarded as consisting of units relevant to phonology in its function as an addressing device. Therefore the interaction of phonology with morphology is restricted to the ability of phonology to access the internal domains of morphology. In GP this is subsumed under either of two types of morphology (Kaye 1995):

(1) (i) Analytic morphology:
-φ (concat (φ (A), B)) e.g. English past tense suffix as in *peeped*
-φ (concat (φ (A), φ (B)) e.g. English compounds as in *blackboard*

(ii) Non-analytic morphology:
-φ (concat (A, B)) e.g. English negative prefix *in-* as in *irrational*

In analytic morphology, morphology is either partially or fully visible to phonology. Using φ as the phonological function, the derivation of the past tense form of English *peep*, for example, proceeds as follows: apply phonology to the verb, then affix the past tense suffix *-ed* and apply phonology to the resulting form. Compounds such as *blackboard* provide a case where morphology is fully visible to phonology and each string in the morphology corresponds to a phonological domain, where a phonological domain is understood as a string to which phonology applies. In non-analytic morphology, on the other hand, phonology is blind to morphology, showing no recognition of morphological complexity but treating the concatenated form as one phonological domain. Words that are derived from this type of morphology are indistinguishable from lexical words.

Prefixation is either analytic, such as the English *un-* which has no restrictions on what consonant may follow it, or non-analytic, for all irregular prefixation such as the negative prefix *in-* which may totally assimilate to the initial consonant of the base it attaches to (*in-rational* → *irrational*). The analytic structure [A [B]] is claimed to be unattested in any language according to Kaye (1995). I will claim that this is the structure for prefixation with the nasal prefix that must be assumed in Bemba. Let us begin by considering the analytic structure of the word 'unclip' as presented in Kaye (1995: 305).

```
(2)    [[ O  N1 O  N2 ] [ O    N3 O  N4 ]]
          |  |  |  |      |\   |  |  |
          x  x  x  x      x x  x  x  x
             |  |         | |  |     |
             u  n         k l  i     p
```

In (2) N_2 is licensed by the parametric domain-final licensing given in the ECP clause (iii) in Chapter 2. In the absence of a phonological domain boundary between *un* and *clip* there would be no way of licensing N_2 without crossing over the governing domain in which the onset cluster is contained, which is not allowed. In irregular morphology, only one phonological domain is assumed, so interaction between the prefix and the base is expected (thus prefixed forms such as *irrelevant*, *illegal* arise). Like all other irregular morphology, these forms are also considered lexically stored. Given that the parameter on domain-final licensing is off in Bemba, the structure in (2) is not an option because N_2 could not be licensed. In addition, there are no consonant clusters in Bemba to block proper government applying from N_3 to N_2, if it was operative. Assuming the structure in (2) or its analytic counterpart [A [B]], implies the assumption that NC clusters are sequences rather that contour or unit segments. Let us review reasons for assuming NC clusters to be sequences.

3.2 NC clusters as sequences

As has already been alluded to, prefixation with the 1st person singular subject or object nasal prefix here denoted as N-, results in the formation of nasal + consonant clusters (NC clusters, henceforth) in a language that, as shown in chapter 2, has a strictly CV syllable structure type. The question is whether to consider these NC clusters as forming unit segments comparable to prenasalised stops or not. There are several arguments that are traditionally presented in favour of the treatment of NC clusters as unit segments. Most frequently these include; (a) the nasal and the following stop are always homorganic, (b) they have the surface duration of simple segments, (c) they are widely attested in languages that have a strictly CV syllable pattern and (d) they are psychologically real to native speakers whose syllabification patterns regard them to be unitary. Let us treat these in turn.

Homorganicity between a nasal and the following consonant in NC clusters is regarded as evidence for a unit segment analysis particularly in feature geometric models such as, Archangeli and Pulleyblank (1994), Clements (1985), Sagey (1986), where the nasal and consonant share a single place node, resulting in a singly articulated single segment with an initial nasal burst. Although in the majority of Bantu languages with NC clusters, the nasal and the following consonant are homorganic, this does not hold true in all cases. In fact it is possible to have both homorganic and non-homorganic NC clusters within the same language. In Nyanja (N.31) the nominal class 9/10 prefix /N-/ assimilates to a following consonant but the class 3 nominal prefix /m/ does not.[54] Consider (3) below.

(3)	assimilation with /n/		no assimilation with /m/	
	mbale	‘plate’	mpeni	‘knife’
	nzeru	‘skill’	mzere	‘line’
	nsaru	‘cloth’	mseru	‘cleared path’
	ŋkuni	‘firewood’	mkazi	‘woman’

Apart from data such as (3), homorganicity should not in itself strictly lead us to selecting a unit segment as the correct representation of NC clusters, since the homorganicity effects can be derived by other means such as, for example, in a structure where the nasal is ambisyllabic (Herbert 1986).[55]

Coming to the argument on duration, we can at best only say that there is contradictory phonetic evidence in this regard. According to Herbert (1975: 353), on evidence from Luganda, the duration of a syllable with an underlyingly long vowel is equivalent to a syllable with a lengthened vowel plus nasal assuming that the nasal in an NC cluster is syllabified in the preceding syllable with the compensatorily lengthened vowel. If two segments can have the same duration as three segments as Herbert’s findings suggest, then phonetic data sheds no light on what the correct syllabic organisation of these segments is. On the other hand, Van de Weijer (1996), citing phonetic data from Herbert (1986), Sagey (1986) and Maddieson (1989), makes the observation that prenasalised stops have approximately the same duration as single segments. Further still, Hubbard (1995: 252), considering consonant durations in Runyambo (E.21), Sukuma (F.21) and Luganda (E.15) concludes that NC clusters are not timed like single segments in any of the cases she examined, but

[54] /n/ and /m/ here derived from Proto-Bantu */ni/ and */mu/ (Meinhof 1910: 30), where the vowels were lost. By comparison, in Bemba some forms still retain the vowel in */mu/; umusebo ‘road’, umwa:nakashi ‘woman’. The Bantu languages cited will be given following Guthrie’s (1969-1973) classification of Bantu languages by geographical zones that are denoted by a letter and a number (cf. appendix II for a map of the Bantu language zones). Bemba is classified as M.42.

[55] There are also homorganicity effects in Germanic languages such as *lamp* (English) or *schraŋk* ‘cupboard’ (German), even though these languages clearly have no prenasalised segments.

rather the duration of NC clusters is anywhere from one and a half to almost four times that of a singleton segment. Note also that there is inconsistency in the durational evidence given for the same language so that while Herbert (1975) reports Luganda prenasalised stops to be equal in duration to single segments, Hubbard (1995) reports them to be at least twice as long as singleton segments. Thus although phonetic evidence may aid us in understanding how NC clusters are perceived, it does little in determining what the syllable affiliation of these clusters must be. Indeed, only phonological evidence as shall be shortly presented, can aid us in this respect.

With regard to NC clusters being highly attested in Bantu languages that are generally of the CV syllable structure type, this is not enough ground on which to presuppose a unit segment analysis. Agreeably, it is easier to formalise NC clusters as unit segments in comparison to ambisyllabic and sequence structures that may require additional motivation, but we cannot seriously argue that one analysis is better than another merely on grounds of ease of formalisation.

On the final point regarding native speakers intuitions, we must admit that this is influenced by the surface representation, while our investigations are trying to characterise abstract structures that give us a better understanding of the phonological phenomena triggered by a particular configuration of segments such as the NC clusters under consideration here.

Let us now turn to arguments for considering NC clusters as sequences rather than units. One notable fact about NC clusters in Bantu is their restricted distribution in morpheme initial position. In Bemba, for example, where the entire set of consonants occur in word-initial position, NC clusters do not, but are rather only to be found in C_2 or C_3 position. This would be a surprising distribution if NC clusters were unit segments since all segments contrast in word-initial position in Bemba. NC clusters only occur in initial position if they are part of a morphologically complex structure involving prefixation. This suggests that their structure cannot be identical to that of single segments. Conversely, in one of the very few Bantu languages with word-final consonants, Ewondo (A.72) (Abega 1969), NC clusters are not allowed in final position. Again they fail to pattern with other single consonants. This asymmetry follows if we consider NC clusters to have a more marked structure than simple unitary segments.

Another argument in favour of viewing NC clusters as sequences comes from the well-known dissimilation process called Dahl's Law, which voices the first consonant when two successive syllables begin in voiceless consonants.[56] The process is exemplified by Kinyamwezi (F.22) in (4), contrasted with Bemba that does not undergo the process. (Starred forms represent reconstructed forms).

[56] Meinhof (1932) reports that Dahl's observation was based on Kinyamwezi where when two successive syllables each begin with an aspirate, the first loses its aspiration and becomes voiced, in close resemblance to Grassmann's Law. The more general version given here is now assumed.

(4)		Kinyamwezi		PB		Bemba	
	a.	-gátí	«	*-kati	»	-kati	‘(in the) middle’
	b.	-dátʊ́	«	*-tatu	»	-tatu	‘three’
	c.	-βɪtá	«	*-pita	»	-pita	‘pass’

In other Bantu languages where Dahl’s Law is also operative, such as Tharaka (E.54), Nwimbi (E.53) and Gusii (E.42), voiceless NC clusters are also subject to the process (Davy and Nurse 1982). Thus in Gusii, for example, the rule has regularly affected /*nk/ to give /ŋg/. These facts are predicted by a representation of NC clusters as sequences of nasal + consonant.

Languages like Yao (P.21) that have syllabic nasals in NC clusters also support the representation of NC clusters as sequences rather than units. In a unit segment analysis it would not be impossible to represent the syllabicity of the nasal in an NC cluster.

Finally, considering another widespread phenomenon in Bantu languages that assimilates recessive liquids to nasals following a nasal, we see that the blocking effect of NC clusters in such cases follows if we consider them to be sequences.[57] Nasal consonant harmony languages include Bemba (M.42), Chokwe (K.11), Herero (R.31), Ila (M.63), Kikongo (H.16), Kwanyama (R.21), Lamba (M.54), Lunda (L.52), Subiya (K.42) and Tonga (M.64). Striking in all these languages is that NC clusters do not trigger nasal harmony effects. Consider the Herero perfective suffix -*ire* that is changed to -*ine* only after simplex nasals (5b-d) and not after NC clusters (5e-g). Herero data are from Marten et al., (2000).

(5)			
	a.	mba hit-ire	‘I had entered’
	b.	mba mun-ine	‘I had seen’
	c.	mba man-ene	‘I had finished’
	d.	mba pem-ene	‘I had blown my nose’
	e.	mba kumb-ire	‘I had asked’
	f.	mba hiŋg-ire	‘I had chased’
	g.	mba jend-ere	‘I had walked’

Under a simple spreading analysis where some feature [nasal] spreads from the stem-final nasal to the following onset, the distribution in (5) would be odd if NC clusters are treated as unit segments that would have the triggering feature [nasal]. In such an analysis, we would have to impose restrictions on the spreading conditions of [nasal] within the feature configuration of the prenasalised segment. In a feature geometric approach, an analysis is not possible if the NC cluster is treated as a unit, in which case it must have one specification for the feature [$\pm$ nasal], since the two

[57] Greenberg (1951) suggests that the process may have been more widespread in Bantu, operating also in stems as can be remnantly seen from the many stems that have nasals in both C_1 and C_2 position. Greenberg (1951) reconstructs present day Bantu *mena* ‘grow, sprout’ from Proto-Bantu **mel-a*, for example.

values of binary features are assigned on the same tier and may as such not co-occur.[58] In other frameworks, such as van de Weijer (1996), which treat NC clusters as complex segments, it is crucial to have strict ordering within the complex NC segment with only the initial part specified for nasality as shown in (6).

(6) C

stop stop

nasal

The implication is that the complex segment consists of two parts that occur in sequence, so the NC cluster is only a unit in as far as it has one root node. The data in (5) can thus be correctly predicted as following from the inability of nasal to spread over the stop part of the NC cluster. It is clear even from this analysis that the ability to independently refer to the parts of the NC cluster is desirable. In the same spirit, Herbert (1975, 1986) regards NC clusters as sequences underlyingly but as undergoing a process of *unification* at some late stage in the derivation. In a view of NC clusters as sequences, no stipulation on ordering need be made, and resyllabification is unnecessary. Only adjacency restrictions need be called upon to explain the asymmetry in (5).[59]

The remainder of this chapter is dedicated to illustrating how under a sequence analysis of NC clusters we are able to adequately account for the range of processes triggered in prefixation with the nasal prefix. I will also explore the constituent structure that best captures the representation of NC clusters as sequences. The chapter ends in a characterisation of the phonological domain structure in the prefix domain.

3.3 Prefixation in Bemba

There are four phenomena related to the formation of NC clusters in Bemba that I will discuss: homorganicity, consonant hardening, epenthetic consonants, and a dissimilation process called Meinhof's Law. In addition to these processes I will also consider three other processes, namely, post nasal voicing, stop assimilation to a nasal and nasal deletion before fricatives, which are frequently attested in the formation of NC clusters in Bantu languages.[60] I begin this section by first

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[58] Even if the two parts of the unit segment were regarded as separately specified for the feature nasal, which in itself distorts the unit segment analysis, and the consonant in the NC cluster is specified as [- nasal] hence blocking the spread of [+ nasal]. Such analyses still beg the question of the phonological relevance of features such as [- nasal]. Cf. Harris and Lindsey (1995) for arguments on the supremacy of monovalent over binary features.

[59] Adjacency restrictions have to be treated as language specific properties since there are languages like Yaka (Hyman 1995b), where adjacency seems to play no role in the nasal harmony process.

[60] Various versions of what follows has been presented in joint work with Lutz Marten in Kula and Marten (1998) as well as in Kula (1999).

presenting the data illustrating the various different processes involved in NC cluster formation. I then formalise inter-onset government as the apt configuration for the representation of NC clusters in the next section, and then taking this mechanism on board present analyses of the phonological processes resulting from NC cluster formation.

3.3.1 Homorganicity

Like in many Bantu languages, the nasal prefix is usually homorganic to the stop of the following word to which it attaches. In (7a-j) the place of articulation of the nasal prefix is homorganic to that of the following stop, surfacing as coronal before coronals, labial before labials, velar before velars and palatal before palatals.[61] This presents the four types of nasals in Bemba.[62]

(7)		verb stem		N+verb stem	
	a.	pat-a	‘hate’	mpat-a	‘I hate’
	b.	fut-a	‘pay’	ɱfut-a	‘I pay’
	c.	mas-a	‘plaster walls’	mmas-a	‘I plaster walls’
	d.	tan-a	‘refuse’	ntan-a	‘I refuse’
	e.	sal-a	‘choose’	nsal-a	‘I choose’
	f.	nak-a	‘get tired’	nnak-a	‘I get tired’
	g.	ʃit-a	‘buy’	nʃit-a	‘I buy’
	h.	tʃááp-a	‘wash’	ntʃááp-a	‘I wash’
	i.	kúl-a	‘grow’	ŋkúl-a	‘I grow’
	j.	ɲu:ng-a	‘sieve’	ɲɲu:ng-a	‘I sieve’

I assume the underlying or default nasal type of the prefix to be coronal /n/. This can be seen when the 1st person singular marker (N-) is used before a vowel-initial tense such as the past tense as shown in (8).

(8) prefix tns verb

a. N - a βomb-a → n -a -βomb -a
‘I have just worked’ 1SG-recent past -*work* -FV

b. N - a βomb-ele ŋgaanshi → n -a -βomb-ele ŋgaashi
‘I worked a lot’ 1SG-remote past-*work* -PERF ADV

As seen in (8a) and (8b) the nasal prefix is coronal following a vowel of the past tense morpheme. Assimilation between the coronal nasal prefix and a following

[61] Before nasal initial stems such as (7c), (7f), and (7j), nasal geminate that are produced with increased fortis articulation are created.
[62] The nasal prefix before thefricative /f/ is labio-dental although it is written as a bilabial nasal in the standard orthography.

stem-initial consonant will be treated as the sharing of the place element of the stop between the nasal and the following stop in sub-section 3.4.2.

3.3.2 Consonant Hardening

There is a hardening process that changes the fricative /β/ and the liquid /l/ to the stops /b/ and /d/, respectively, when preceded by the nasal prefix. Consider (9).

		verb stem		N+verb stem	
(9)		verb stem		N+verb stem	
	a.	βil-a	'sew'	mbil-a	'I sew'
	b.	lek-a	'stop'	ndek-a	'I stop'

This process turns voiced continuants into non-continuants and is also widespread across other Bantu languages, as the data in (10) show. The Kwanyama (R.21) data are from Tirronen (1977a) and the Kikuyu (E.51) data from Armstrong (1940).

(10)		verb stem	N+verb stem		
	a.	lond-a	o:ndod-o	'ascend'	(Kwanyama)
	b.	vevel-a	o:mbelel-a	'dip into food'	(Kwanyama)
	c.	reheet-e	ndeheet-e	'I have paid'	(Kikuyu)
	d.	ɣoreet-e	ŋgoreet-e	'I have bought'	(Kikuyu)
	e.	βor-a	mboreet-e	'lop off'	(Kikuyu)

These processes will be analysed in sub-section 3.4.3 as consisting of a change in the elemental configuration of the hardened segments.

3.3.3 Epenthetic Consonants

When the nasal prefix is attached to vowel-initial words it is mandatory that an NC cluster is formed despite the lack of a realised onset in the stem. Prefixation to vowel-initial stems yields different and interesting results as (11) shows. In this case NC clusters are formed with either insertion of /g/ before /a o u/ or /dʒ/ before /i e/.[63] These cases together with the strengthening cases in (10), are the only occurrences of voiced obstruents in Bemba, excluding word-internal NC clusters which I hope will be amenable to the same analysis as morphologically complex NC clusters.

[63] /dʒ/ is also optionally inserted before *u* initial stems in closely related dialects.

(11)		verb stem		N+verb stem		
	a.	alul-a	'redirect	ŋgalul-a	'I redirect	
	b.	olol-a	'straighten'	ŋgolol-a	'I straighten'	
	c.	ubul-a	'peel'	ŋgubul-a	'I peel'	
	d.	isul-a	'open'	ndʒisul-a	'I open'	
	e.	eleel-a	'forgive'	ndʒeleel-a	'I forgive'	

Glide initial stems are subject to the same epenthetic process with /y/ initial stems having epenthetic /dʒ/ and /w/ initial stems taking epenthetic /g/. These cases may also be treated as sonorant hardening, depending on the status of the glides in the language in question. Swahili (G.42) data are from Ashton (1944) and Ndali (M.21) from Vail (1972).

(12)	a.	w-a	'fall'	ŋgw-a	'I fall'	
	b.	y-a	'go'	ndʒ-a	'I go'	
	d.	wati		mbati	'hut poles'	(Swahili)
	e.	yuki		juki	'bee'	(Ndali)

Epenthetic consonant insertion can also be seen in Luganda (E. 15) where y → dʒ and Ø → g. Kwanyama (R.21) also has epenthetic insertion of /b g dʒ/, in the formation of nouns from verbs (13). These data are taken from Tirronen (1977a: 52).

(13)	a.	ol-a	→	ombolo	'rot'
	b.	umb-a	→	oŋgubu	'throw'
	c.	end-a	→	oŋgendi	'walk'
	d.	imb-a	→	ondjiba	'sing'
	e.	yelek-a	→	ondjele	'measure'

Notice that the vowel-initial stems in (11) and (13) are subject to parametric onset initial licensing, as discussed in chapter 2. The data in (12) with glide initial stems will for Bemba also be treated in sub-section 3.4.4 as having a structure that is identical to vowel-initial stems in order to account for consonant epenthesis.

3.3.4 Meinhof's Law

Meinhof's Law is traditionally described as a dissimilation process involving NC clusters occurring in a sequence. The rule simplifies the first or the second NC cluster, depending on the language, to a simple homorganic nasal or to a nasal geminate. Meeussen (1963) suggests that Meinhof's Law was operative in Proto-Bantu, at least in the eastern half of the domain. This coincides with the synchronic distribution of the rule in Guthrie's zones E, F, G and M. Meinhof's (1913) original description of the rule reads:

> Wenn auf die Verbindung eines Nasals mit einem Stimmhaften Konsonanten in zweiter Silbe wieder eine Nasalverbindung oder ein Nasal folgt, so bleibt von der ersten Nasalverbindung nur der Nasal übrig. (1913: 274)

Examples of the rule from Luganda (E.15) where this phenomenon was first observed are given in (14). Data are from Ashton (1954).

(14)	a.	n-ge:nd-a	→	ŋŋe:nd-a	‘I go’
	b.	n-bu:mb-a	→	mmu:mb-a	‘I mould’
	c.	n-li:nd-a	→	nni:nd-a	‘I wait’
	d.	n-limi	→	nnimi	‘tongues’

Luganda like a few other Bantu languages produces geminate nasals in Meinhof’s Law. In most of the other languages, the result is a simple nasal as will be seen in later discussion. Luganda, on which the original formulation of the rule was based, also simplifies NC clusters before simple nasals. In a later reformulation Meinhof (1932: 183) lists only NC clusters as the triggers of the rule. In the majority of languages where only NC clusters condition the change, only voiced NC clusters act as triggers of the rule.[64] This is the case in Bemba, as a comparison of (15a-c) and (15d) shows. (15e) shows that the two NC clusters may only be separated by a vowel for the rule to apply. Vowels preceding NC clusters are always long as all the forms in (15) show. I will not mark this predictable vowel length in the remainder of this chapter.

(15)	a.	n-βó:mbel-e	mmó:mbel-e	*mbó:mbel-e	‘I have worked’
	b.	n-la:ndil-e	nna:ndil-e	*nda:ndil-e	‘I have spoken’
	c.	n-ó:ndel-e	ŋŋó:ndel-e	*ŋgó:ndel-e	‘I have become thin’
	d.	n-pá:ŋgil-e	mpá:ŋgil-e	*mmá:ŋgil-e	‘I have made’
	e.	n-βéle:ŋgel-e	mbéle:ŋgel-e	*mméle:ngel-e	‘I have read’

There are also other variants of Meinhof’s Law according to Schadeberg (1987), the most interesting of which involve simplification of the NC cluster by dropping the nasal rather than the stop, as in the regular Luganda and Bemba cases. This variant is found in some South Western Bantu languages as illustrated by Kwanyama (R.21) in (16).[65] Data are from Tirronen (1977a).

[64] There is wide variation in the degree of productivity of Meinhof’s Rule. In some languages it is restricted to particular series of NC clusters, e.g. Nilamba (F.31) where the rule applies only to /mb/ and /nd/. In Lamba (M.54) it is subject to grammatical information so that only nominals as opposed to verb forms attest the rule (Doke 1927: 20).

[65] The rule in Kwanyama does not simplify /ŋg/, take *ombiŋga* ‘side’ and *ondiŋge* ‘younger siblings’, for example. The ungrammatical forms in (16) are the actual forms of closely related Herero (R.31). Ndonga (R.22) only simplifies /nd/.

(16)	a.	oŋgadu	←	*oŋgandu	‘crocodile’
	b.	oŋgobe	←	*oŋgombe	‘beast’
	c.	ombabi	←	*ombambi	‘steenbuck’
	d.	ombadje	←	*ombañdje	‘jackal’
	e.	oñdjabi	←	*oñdjambi	‘reward’

The task here will be to characterise these dissimilation effects and provide a uniform analysis while at the same time allowing for language specific variation. Detailed analyses if these facts are presented in sub-section 3.4.5.

3.3.5 Other processes

There are a number of other processes that are usually involved in the formation of NC clusters particularly in Bantu, that do not have a role to play in Bemba but are worth mentioning.

3.3.5.1 Post-nasal voicing

In many Bantu languages, such as Herero, only voiced NC clusters are allowed and all stems with initial voiceless obstruents become voiced. Consider the example of Yao (P.21) post-nasal voicing with the moraic nasal prefix of the 1st person singular object. The Yao data come from Ngunga and Hyman (1997: 135).[66] Kikuyu data are from Armstrong (1940).

(17)	a.	ku - N- pélek-a	→	ku:mbélek-a	‘to send me’	
	b.	ku - N- túm-a	→	ku:ndúm-a	‘to order me’	
	c.	ku - N- tʃápil-a	→	ku:ɲdʒápil-a	‘to wash on me’	
	d.	ku - N- kwéel-a	→	ku:ŋgwéel-a	‘to climb on me’	
	e.	N - tom-a	→	ndomeet-e	‘send’	(Kikuyu)
	f.	N - kom-a	→	ŋgomeet-e	‘sleep’	(Kikuyu)

Many languages that exhibit post-nasal voicing only have a set of voiced NC clusters and the process seems to result from the avoidance of voiceless NC clusters. An analysis for these data will have to investigate the representation of voiceless segments in these languages.

[66] Ngunga and Hyman (1997) discuss the fact that the syllabic nasal does not trigger these alternations but allows voiceless NC clusters. Note also here that the prefix vowel /u/ in *ku-* is lengthened before an NC cluster. This type of compensatory lengthening in the formation of NC clusters does not occur in Bemba.

3.3.5.2 Stop deletion

This process deletes the stop in the formation of an NC cluster, after the nasal has assimilated to the stop. Consider these examples from Givón (1970b) for Siluyana (K.31). Kihehe (G.62) data are from Odden and Odden (1985).

(18)	a.	N - poko	→	moko	'arm, knife'	
	b.	N - tabi	→	nabi	'prince'	
	c.	N - kuku	→	ŋuku	'chicken'	
	d.	N - teefu	→	neefu	'red mats'	(Kihehe)
	e.	N - kaanzi	→	ŋaanzi	'walls'	(Kihehe)

This process is also characteristic of voiceless NC clusters and offers an alternative to the voicing process in (17) in the avoidance of voiceless NC clusters.

3.3.5.3 Nasal deletion before a fricative

Nasal deletion before a fricative is also quite a widespread phenomenon in Bantu. It affects voiceless fricatives, which seem to be least preferred in NC clusters even among languages that allow voiceless NC clusters.[67] Swahili also has nasal deletion before voiceless stops.[68]

(19)	a.	N - sev-a	sev-a	'I dig'	(UMbundu, Schadeberg 1982)
	b.	N - fel-a	fel-a	'I cook'	(UMbundu)
	c.	N - fimbo	fimbo	'stick'	(Swahili, Ashton 1944)
	d.	N - simba	simba	'lion'	(Swahili)
	e.	N - supa	supa	'soup'	(Siluyana, Givón 1970)
	f.	iN -fuwa	ifuwa	'hippo'	(Ndali, Vail 1972)
	g.	iN - satu	isatu	'python'	(Ndali)

This process is not restricted to languages that disfavour NC clusters in general but is rather a reflection of the preferences of different Bantu languages in NC cluster types. Rosenthall (1993) presents the following schema on the preference of voiced NC clusters to voiceless ones in Bantu, where Bantu languages that prefer voiceless NC clusters or prenasalised segments present the most marked cases.

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[67] Padgett (1994) argues that nasal place assimilation to a fricative creates nasalised fricatives: (+nas, +cons, +cont), which are extremely rare and hence not favourable for creation by phonological rules. Other options to avoid N+fricative clusters include a default place for the nasal, or assimilation of the nasal with simultaneous hardening of the fricative to a stop or affricate. See Padgett (1994) and references therein for a detailed survey.

[68] Such processes as well as the stop to nasal assimilation in (18) and the post-nasal voicing facts in (17), have led Pater (1995, 1999), to postulate a universal constraint against voiceless NC clusters. Bemba is not a good representative of this constraint since voiceless NC clusters are the preferred unmarked case.

(20)

Prenasalised voiced stops	Prenasalised voiceless stops	Prenasalised voiced fricatives	Prenasalised voiceless fricatives	Language
yes	no	no	no	Ndali, Kikuyu
yes	yes	no	no	Rwanda Kinga
yes	no	yes	no	Swahili, Zande
yes	yes	yes	yes	Rundi, Luganda

(20) presents voiced prenasalised segments or voiced NC clusters as the most unmarked case (Ndali M.21 and Kikuyu E.51), while the most marked is presented by Rundi (D.62) and Luganda (E.15), which have both voiced and voiceless prenasalised stops and fricatives. This is not to say there are no Bantu (or any other) languages that prefer voiceless prenasalised segments and NC clusters. Hyman (1998b) discusses Bantu languages in the Sotho-Tswana group that only have voiceless NC clusters with processes of post nasal devoicing to avoid voiced NC clusters. At the same time, a comparison of NC clusters consisting of a stop as opposed to a fricative, favours NC clusters with stops, over those with fricatives. Perhaps this sheds some light on the process of nasal deletion following a fricative as seen in (19). The representation in (20) is merely meant to show the distributional tendencies of NC clusters across Bantu and not meant to make predictions over NC cluster types and their distribution. Thus nothing hinges on this distribution and different distribution patterns from those shown in (20) are possible. Notice that Bemba is a case where voiceless and voiced stop NC clusters and voiceless fricative NC clusters are attested to the exclusion of voiced fricative NC clusters.

We have surveyed the data and the phonological processes that result from prefixation of the nasal prefix in Bemba; assimilation of the nasal to the stop rather than the stop to the nasal; consonant hardening that converts laterals and fricatives to stops; consonant epenthesis that inserts a voiced stop before vowel and glide initial stems; and Meinhof’s Law that simplifies a voiced NC cluster to a nasal geminate when it is immediately followed by another voiced NC cluster. These processes, as well as the related processes of post-nasal voicing and stop and nasal deletion in NC clusters, illustrated by other Bantu languages, will be shown to follow from the representation of NC clusters assumed. We now turn to a characterisation of this representation.

3.4 Representation of NC clusters

The representation of NC clusters that will be adopted here aims to account for the spectrum of phenomena raised in the foregoing sections. Various positions with respect to the representation of NC clusters may be taken in GP. In Standard GP, at least three positions are possible; they can be represented as coda-onset sequences (21a), as branching onsets (21b) or as contour segments in a non-branching onset (21c). In strict CV phonology (Lowenstamm 1996) on the other hand, all clusters are by definition represented as sequences separated by an empty nuclear position (21d). The competing structures are given in (21).

(21) Standard GP Strict CV

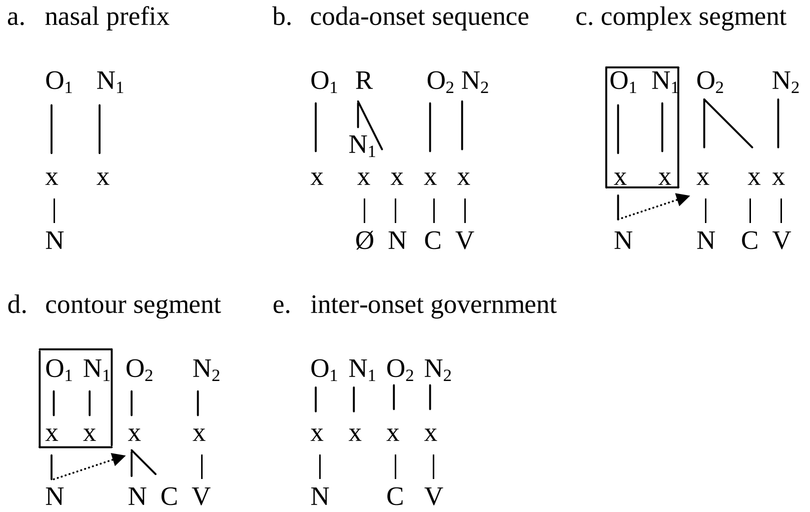
a. coda-onset sequence b. branching onset c. contour segment d. ONO

Having already opted for strict CV phonology in chapter two, I will support the structure in (21d), but also show that there is compelling evidence for this choice.[69] The idea is to convincingly show how the processes outlined in sections 3.3.1 - 3.3.5 follow from the representation of NC clusters assumed.

Let us start by looking at the word-initial NC clusters that always result from a prefixation process. One thing we might want to consider is whether the morphological boundary created by the concatenation of the prefix and the verb stem, is phonologically visible, that is whether we want to treat the prefix and the verb stem as two separate domains or as one phonological domain. The implications of the choice are not identical, but discussion is delayed until section 3.5. For now, let us assume that there are no phonological boundaries between prefixes and between prefixes and the verb stem. This gives the representations in (22b-e) that correspond to the possible structures of NC clusters given in (21). (22a) gives the structure of the nasal prefix given GP assumptions. The structures in (22b-e) represent the left edge of the word after the nasal prefix in (22a) is added. The structure that fares the best is the one that retains the structure of the nasal prefix as given in (22a). In the representations in (22b-e) O_1 and N_1 correspond to the constituents of the nasal prefix as shown in (22a).

[69] The representation of consonant clusters as ONO sandwiches is generally accepted in GP, particularly in vowel~zero alternation languages. Examples include Charette (1992) for Khalkha Mongolian, Gussmann and Kaye (1993) and Cyran and Gussmann (1999) for Polish, Frost (1995) for Luganda, Lee (1999) and Rhee (2002) for Korean.

(22)



With the lexically specified prefix structure as (22a), the derivation of the representations in (22b-d) requires to change the lexical representation of the prefix. In (22b) (which results from changing (22a) to a coda-onset sequence) the nasal prefix will move from onset position (O_1) to a coda position of the following empty nuclear position N_1. N_1 will have to create this coda position for the displaced nasal prefix despite its lack of a realised vowel. This results in the marked structure in (22b) that has only been suggested for initial s+C clusters. The major problem is the lack of a local source to license the initial empty nucleus (N_1). Thus (22b) is in violation of the Projection Principle since the nasal prefix that starts out in an onset ends up in a coda.

In order to derive the representations of the nasal prefix as either contained in a complex or a contour segment consisting of the nasal and the initial consonant of the stem, the nasal prefix must leave its own constituent (O_1) and move into the initial onset of the stem (O_2 in both (22c) and (22d)). Both these processes are followed by a process of reduction or erasure, which removes the redundant O_1 and N_1 presented in frames in (22c) and (22d).[70] Reduction is mandatory because the empty ON pair cannot be licensed under the ECP. Apart from the undesirable effect of deletion of structure (22c) also raises the problem of creating an unsatisfactory branching onset autosegmentally. Given rightward government in branching onsets, the head of the onset is the nasal, which being more sonorous than its dependent is in violation of the *Sonority Sequencing Generalisation* (SSG) (Selkirk, 1982). In GP, following the formulation in Harris (1994), the SSG is captured by demanding that a governing head be at least as complex as its governee. In standard GP a nasal is elementally less complex than a stop, but as will be discussed in the proposed analysis of NC

[70] Reduction is defined in Gussmann and Kaye (1993: 433) as the removal of an empty nucleus and a following pointless onset from any phonological representation in which they occur. I will consider reduction to be the removal of any constituent or material that fails to be licensed.

clusters other properties such as headship can also play a role in precisely defining what 'more complex than' may refer to. Needless to say, syllabifying an NC cluster in a branching structure would require some justification.[71] (22e) thus seems by far the least complicated structure, with the structure of the prefix fully retained and N_1 able to be licensed within the ECP as long as we assume head-final inter-onset government between the nasal and the following consonant. I therefore adopt this structure for the representation of NC clusters. This structure does, however, present a marked structure for a Bantu language where the first vowel in a stem is always realised. In the following discussion of the implications of inter-onset government it becomes clear that this is not a problem at all.

3.4.1 Inter-Onset government in GP

Inter-onset government relations in GP were proposed to complement proper government in the characterisation of vowel~zero alternations in languages with sequences of more than two consonants, where vowels that were not properly governed remained unrealised. The problem was having two unrealised empty nuclei in sequence. This is contrary to the predictions of proper government from which it follows that in a sequence of empty nuclei an unrealised nucleus will always alternate with a realised one. With inter-onset government, it was possible to account for one of the unrealised nuclei as falling within an ONO sandwich, while the other could still be taken care of by proper government. The implementation of inter-onset government extends intra-constituent relations that are generally reserved for nuclei to inject licensing within a word domain, or for onsets to license preceding codas. However, owing to the origin of inter-onset government - the need to license empty nuclei in sequence - it has been argued that this government relation should only be reserved for languages with vowel~zero alternations. If, on the other hand, we accept this extension of the theory, then we must allow inter-onset government to function as an additional tool assisting us in achieving the goal of characterising the phonologies of natural language. In fact, the ability of inter-onset government to function independently of proper government provides empirical support for its existence.

One of the main concerns of postulating relations between onsets is deciding the level at which such relations should hold. Since nuclei are regarded to be the heads of ON pairs they are projected to a nuclear projection at which level the head nucleus licenses other nuclei in the domain, which then in turn license their onsets. Processes such as vowel harmony, which does not affect onsets, support the existence of such a projection. However, consonant harmony processes that affect only consonants within a domain are occasionally attested. One case is the coronal harmony processes described in Shaw (1991). These harmony processes suggest that onsets can have relations with each other, to the exclusion of nuclei, which may be

[71] This is not to say that there cannot be sequences of segments in word-initial position in mono-morphemic words that have decreasing sonority. Lowenstamm (1996) discusses some Semitic languages that have no restrictions on what may be initial clusters.

regarded as transparent to the consonantal processes. Whether this mandates an onset projection is still a matter to be resolved. In either case, i.e. in the presence or absence of an onset projection, onset-to-onset processes will always have an intervening nuclear position. The configuration being described here is not identical to that where harmony processes take place, but rather runs parallel to branching onsets in as far as there are two consonants facing each other without any intervening material. It is probably due to this that ONO sequences are regarded as being in a government relation that demands the same requirements on whichever is the head in the pair, as in a branching onset. The government relation that is contracted between the two onsets is deemed to license the intervening nucleus to be empty, and must itself be licensed by a following realised vowel. Licensing of the nucleus sandwiched in an inter-onset government domain is captured in the final tenet of *p-licensing* in the Phonological ECP. Let us consider proposals for inter-onset government in different versions of GP.

3.4.1.1 C-to-C government

Szigetvári and Dienes' (1999) (henceforth S&D) propose a version of GP called *VC Phonology*. Although under a different guise, the notion of inter-onset government still plays a role in VC Phonology. The central claim of VC Phonology is that all phonological strings start in a V-position and end in a C-position. This makes it possible to characterise all languages as ending in a C position that is realised in languages that allow words to end in consonants and remains unrealised in languages that allow words to end in vowels. S&D define V and C positions as having inherent properties of loudness (V-positions) and muteness (C-positions). This means it will be easier to keep C-positions quiet because this is their unmarked characteristic; hence final empty C positions can occur. Another motivation for this syllable structure type stems from the representation of consonant clusters, in particular the disparity between the ability for coda-onset clusters as opposed to what they term *bogus* clusters (clusters with increasing sonority that are not possible branching onsets, such as *dn, tn*), to be realised in word-final position. S&D argue that a C-to-C government relation, where the second C governs the first can only be contracted between two consonants if their melodic content is apt. This means that whereas coda-onset clusters can enter into a C-to-C government relation, bogus clusters cannot. Distributionally this means that only coda-onset clusters will be allowed word-finally while bogus clusters, which require a following realised nucleus to license the V between the two consonants, will not. In (23a), then, the coda-onset cluster is in C-to-C government and creates a burial domain for the intervening nucleus that must remain inaudible; it is licensed within the ECP to remain silent. In (23b), on the other hand, with no C-to-C government and no following realised vowel, there is no way to license the empty nucleus between the consonants. (23b) is therefore illicit word-finally. (Lower case v's and c's denote empty categories).

(23) C-to-C government

a. V C v C
a r t

b. * V C v C
a t n

S&D also suggest that a consonant that is governed cannot itself govern, just as a governed vowel cannot itself govern in proper government. This explains why in three member consonant clusters the last two consonants cannot form a coda-onset cluster. The same reasoning explains the frequently attested phenomenon of closed syllable shortening; a governed C cannot govern the C slot within a long vowel. Consider (24) where C_3 governs C_2 and C_2 being governed fails to govern C_1, thereby banning a long vowel before a coda-onset cluster, *-*a:nt*-.

(24)

*V c_1 V C_2 v C_3
a n t

This structure is exactly what is predominantly attested in Bantu languages and the structure that will be defended for the representation of internal NC clusters in Bemba. Thus S&D's VC phonology will have no role to play in the characterisation of NC clusters in Bemba.

3.4.1.2 Infra-segmental government

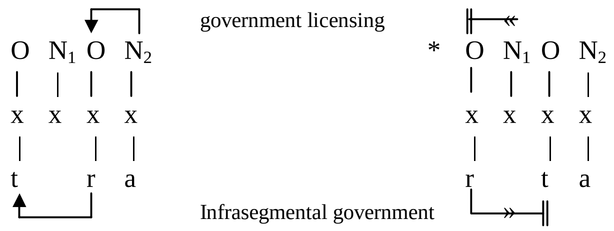
Scheer (1996, 1998) presents another proposal for the representation of clusters as being in a governing relation in a theory of consonantal interaction that he terms *infra-segmental government*. Infra-segmental government is a relation that holds between two consonants, allowing the nucleus between them to be quiet. Scheer surveys distributional facts of word-initial consonant clusters where he observes that while there are languages which only have consonant clusters of increasing sonority in initial position (e.g. some Indo-European languages), there are none which have only sonority-decreasing clusters, as seen in some Semitic languages, in initial position. Lowenstamm (1996) makes the same observation and distinguishes them as type 1 and type 2 languages, respectively. Scheer claims that this complementary distribution can be explained by the possibility versus impossibility of the formation of an infra-segmental government relation between the consonants in the consonant clusters. While an infra-segmental government relation can be created in the former case, it cannot in the latter case. Scheer defines infrasegmental government as in (25).

(25) *Infrasegmental Government* (Scheer 1996: 294)

> Iff a phonological primitive faces an empty position on a given autosegmental line, may it govern that position.

This is to say that more complex consonants will govern less complex consonants since every empty position in consonant B that consonant A is specified for on a particular autosegmental line, increases the complexity of consonant A over B by one. Note that this is in contrast to the Complexity Condition as proposed in Harris (1994), where it is possible for consonants of the same complexity to be in a governing relation. We have discussed and adopted Harris' version of the complexity condition in chapter 2. In Scheer's configuration, /r/ is more complex than /t/ and therefore infrasegmentally governs /t/. As in standard GP following Charette (1991), Scheer assumes government licensing to be active so that the head of an infrasegmental government relation must be licensed to govern a dependent. This means a following realised nucleus (N_2 in (26a)) must government-license the head /r/. In a reversed order of the cluster (26b), such a government-licensor is not available for the head /r/, because the following vowel N_1 is unrealised. This explains the absence of languages that only have sonority-decreasing initial consonant clusters.

(26) a. b.



From these operations Scheer concludes that infrasegmental government is head-final or right headed universally.[72] I do not subscribe to the universality of the directionality of government relations in inter-onset government, but also assume the process to be head-final in Bemba, although in contrast, initial NC clusters present a case of decreasing sonority clusters.[73] As seen in the representation of Bemba consonants in chapter 2, sonorants are less complex than obstruents, meaning that Scheer's treatment of sonorants as governors will not be implemented in Bemba.

At least two points come across strongly from the analyses of word-initial and word-final clusters by S&D and Scheer. Both analyses are in agreement with respect

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[72] Its not clear to me how Scheer deals with word-internal or final /rt/ clusters, particularly when no following nucleus is available to act as a proper governor in, for example, English /harp/. We may have to assume that languages like English parametrically allow empty nuclei to act as government-licensors.

[73] Charette (1992) argues for head-initial inter-onset government in Khalkha Mongolian.

to the complexity of consonants that may be in a government relation; the head must be more complex than its dependent. Secondly, both analyses agree that this inter-consonant relation ensures the silence of the intervening nucleus. One disparity that is noteworthy is the representation of sonorants as more complex and hence governors in Scheer's approach but less complex and hence governees, in S&D's approach. This follows directly from the direction of government as head-final in both approaches.

3.4.1.3 Strict CV

Let us now consider inter-onset relations in strict CV by looking at a possible analysis for type 2 languages, which have both clusters of increasing and decreasing sonority in initial position. Lowenstamm (1996) notes that if both clusters of rising and falling sonority were represented as CVC sequences, where a following realised nucleus licenses the uninterpreted vowel between the cluster by proper government, then the falling sonority clusters of the type /rb, lg, rd/ could not be represented as more marked than clusters with rising sonority. Indeed it would be difficult to justify the existence of type 1 languages (those with only increasing sonority clusters in initial position), since the reverse order of their clusters would be equally possible. It would also imply that proper government is not sensitive to the identity of the consonants flanking the target vowel. To allow for a representational difference, Lowenstamm posits an initial empty CV unit that acts as the marker of a domain boundary.[74] This gives the representation of initial clusters as in (27) (unrealised positions are in lower case).

(27)

proper government

a. $c_1\ v_1\ [\ C_2\ V_2\ ]$ — b a

b. $c\ v_1\ [\ C\ v_2\ C\ V_3\ ]$ — r b a

proper government over a closed domain

c. $c_1\ v_1\ [[\ C\ V_2\ C]\ V_3\ ]$ — b r a

(27a) presents a simplex word-initial onset C_2, where the following realised nucleus V_2 licenses and properly governs V_1 in the initial CV unit. V_1 being licensed,

[74] I am made to understand from Tobias Scheer that the initial empty CV is a part of morphology that is only superimposed into phonology. Under this view, Languages with initial decreasing sonority clusters can be regarded as parametrically not transferring the morphological initial empty CV to the phonology.

licenses the preceding C_1, which as such remains uninterpreted. In (27b) the realised vowel V_3 properly governs V_2. V_2 itself being governed is unable to govern the initial V_1, which is thus unlicensed. The idea is that languages differ with respect to whether they license the initial CV. Clusters with falling sonority are therefore marked because they fail to license the initial CV unit. (27c) presents the unmarked case of initial onset clusters with rising sonority. Following Scheer (1996), Lowenstamm considers such clusters as forming a closed domain that cannot be penetrated by proper government. The following realised vowel V_3 therefore licenses and properly governs the initial $V_{1,}$ which in turn licenses its onset C_1 making the initial CV unit licensed. Notice the parallel between (27a) and (27c), the unmarked cases, which identically license the initial CV.[75] Thus Lowenstamm and Scheer complement each other in considering sonority-decreasing clusters as more marked in initial position. In a sense, S&D concur with this by considering sonority-decreasing clusters to be preferred in final position. I do no employ the initial empty CV in my version of Strict CV GP.

As can be seen in the foregoing, a crucial matter for the representation of clusters in any strict CV approach is the status of the intervening nucleus. We clearly want to make a distinction between inert empty nuclei and those that may still act as proper governors or be subject to vowel~zero alternations. In effect, there are empty nuclei that will never be realised under any circumstances: hence the ‘closed domain’ of Scheer and Lowenstamm or the ‘burial domain’ of S&D. The logical conclusion of these assumptions is to assume that nuclei that are silenced by the interaction of two onsets in an inter-onset government domain, or an infrasegmental government domain or indeed a C-to-C government domain, (depending on one’s persuasion), are inert and unable to license and hence do not project to the nuclear level. This means that the government elation of the two onsets does not apply across a nucleus that projects to the nuclear projection. In these terms, Lowenstamm’s (27b) projects the silenced nucleus to the nuclear projection while (27c) does not. This means that we do not expect to have onset interactions of the sort being considered here in vowel~zero alternation sites.[76] This follows from the fact that whenever a nucleus is flanked by onsets that are in a governing relation, it remains inert. I prefer to refer to the relationship as government, because the governing head onset imposes restrictions on the content of the governed onset. In NC clusters, the government relation proceeds from the stop to the nasal, meaning that the stop acts as the governor and the nasal as the governee. I follow Szigetvári (1999) in regarding government to be a destructive power that reduces a position’s ability to maintain

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[75] It remains unclear to me how C_1 in both (27a) and (27c) is licensed to be empty. Under proper government a constituent that is properly governed is itself not a proper governor, thus V_1 being properly governed cannot act as a proper governor of C_1. Perhaps we can make recourse to the extended ECP presented in chapter 2 and allow the initial C_1 to be parametrically p-licensed. Needless to say the initial empty CV adds a number of complications to the theory.

[76] Consider the lack of such governing relations between consonants that are separated by properly governable empty nuclei in Polish, cf. Gussmann and Kaye (1993), Rowicka (1999).

melodic content.[77] With this definition we can view government not only as a difference in complexity but also as a difference in potential to support melodic material, express contrasts or license other segments. A governed segment will therefore move downwards on an activity scale. Let us now consider the case of NC clusters.

3.4.2 NC clusters in inter-onset government

As already asserted NC clusters will be treated as inter-onset government relations where the nasal is the governed member. One of the restrictions that the governor will impose on its governee is a requirement that the governee be homorganic to the governor. In other words, the governed nasal will lose its ability to specify its own place of articulation. If the nasal and consonant in an NC cluster do not stand in a government relation then we would expect (a) non-homorganic clusters to be legitimate, so /nb ng md/, or (b) assimilation going in the opposite direction to also be possible, so that the stop assimilates to the nasal; /np → nt/, /mk → mp/ or /ŋt → ŋk/.[78] This, however, is not the case in Bemba. The unique governing relation that holds within NC clusters can be demonstrated by a vowel epenthetic process in Mòoré, a Gur language spoken in Burkina Faso. Like in many Bantu languages, every nominal radical in Mòoré belongs to a given nominal class and thus appears with suffixes characteristic of its class. Certain radicals of the shape CVCC have a vowel appearing between the last two consonants or between the last consonant of the radical and the initial consonant of a suffix when the radical is suffixed with the plural marker *-re*. However, when the final two consonants of the radical are an NC cluster, such free variation is not possible. Consider the data in (28) taken from KLV (1990: 224).[79]

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[77] There is no notion of head in the Szigetvári framework, meaning that there is no complexity restriction on what may govern but simply that whatever is governed will have less ability to express its inherent property. In Ségéral and Scheer's (1999) Coda Mirror this comes down to the differentiation between weak and strong positions; weak positions are governed and strong positions are ungoverned. This may also be interpreted as the inability to license certain elements, or at least have a diminished range of contrasts. Brockhaus (1995) utilises the latter option in her analysis of obstruent final devoicing in German, where due to diminished autosegmental licensing, obstruents are unable to license the (L) element that contributes voicing.

[78] Non-homorganic NC clusters can be found in Dyirbal and Yidiɲ in addition to homorganic NC clusters (cf. Dixon 1972 and 1977 respectively). The homorganic clusters can here be treated as in a government relation and the non-homorganic ones as involving proper government of the intervening empty nucleus.

[79] The plural marker *-re* is realised as /-de/ when the stem ends in a nasal consonant, e.g. *wa<u>m-de</u>* 'bottle', *kã<u>n-de</u>* 'spear'. There is no /ɨ/ insertion in these cases either. Thus the lack of /ɨ/ insertion in (28) is not to do with the homorganicity of the clusters involved given the possibility of /md/ accross a suffix boundary. The epenthetic vowel transcribed as /ɨ/ in KLV (1990) is actually a schwa (cf. Rennison 1993, 1997.).

(28)	radical	radical+plural -*re*	
a.	wagd-	wagd-ɨ-re / wag-ɨ-d-re	‘thieves’
b.	kɪgb-	kɪgb-ɨ-re / kig-ɨ-b-re	‘buttocks’
c.	kumb-	kumb-ɨ-re *kum-ɨ-b-re	‘eggplants’
d.	pond-	pond-ɨ-re *pon-ɨ-d-re	‘bullfrogs’
e.	leŋg-	leŋg-ɨ-re *leŋ-ɨ-g-re	‘wooden dishes’

The lack of epenthetic /ɨ/ in (28c-e) can be best analysed by assuming a governing relation between the stop and the nasal that keeps the intervening vowel quiet and inert. The direction of the assimilation process in homorganic clusters points to the stop as the head of the governing relation rather than the nasal.[80]

Now going back to Bemba, we have already established that the nasal prefix is not a placeless nasal but rather a coronal nasal, from its realisation in vowel-initial tenses in (8). On the melodic tier this will imply that the place element of the governor must be shared or imposed on the governee. This implies loss or lack of interpretation of the coronal element.[81] We will consider the coronal place to be suppressed following the LC in Bemba that disallows two place elements within the same expression. Suppression is a process that allows elements not be submitted to the speech signal in the course of phonological processing (Harris and Lindsey 1992). There are language specific restrictions on when elements may be suppressed as we will see in the Bemba case. Suppressed elements will be presented in angled brackets. Given the elemental representations of the consonants of Bemba in chapter 2, homorganicity can be characterised as in (29). (Only the elemental representations of segments relevant to NC clusters are given and heads are underlined for ease of reference).

[80] From a perceptual point of view, Ohalla (1990) argues that the non-nasal consonant in an NC cluster is perceptually more salient than the nasal because it is released into a realised vowel as opposed to the nasal. The perceptually less salient segment then assimilates to the more salient one.

[81] Since Bemba does not have doubly articulated sounds, one of the places of articulation must be lost. That the place of the stop is chosen over that of the nasal follows from the fact that the nasal is subordinate to the stop in the government relation. Halle, Vaux and Wolfe (2000), in consideration of Irish nasal place assimilation, also assume that the articulator feature coronal delinks when it is in competition with the dorsal articulator feature, (ng → ŋg). It is, however, not clear how this follows from the geometric representation.

(29) a. tana → ntana 'I deny' b. pata → mpata 'I hate'

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      inter-onset government
O N O N O N                  O N O N O N
| | | | | |                  | | | | | |
x x x x x x                  x x x x x x
|   | | | |                  |   | | | |
n   t a n a                  n   p a t a
L   ʔ                        L   ʔ
R ← R        place sharing   U ← U
                             «R»

/n  t a n a/                 /m  p a t a/
```

In both (29a) and (29b) the place element of the governing head is imposed on the governee by a spreading operation. Spreading the coronal element (R) in (29a) achieves the same objective as when nothing is done, since the place of the nasal is already coronal. In (29b), on the other hand, the override is plain to see; spreading of the labial place means suppression of coronal. This process of homorganicity also applies to nasal initial stems and results in initial geminates where the second member governs the first. The structure assumed here is consistent with that assumed for long vowels in chapter 2.

Failure of a government relation to be established between the nasal prefix and a following consonant would result in a simplification processes such as stop deletion as illustrated by Siluyana in (18), or nasal deletion as seen in the data in (19). For these languages there must be a constraint at play that disallows particular segments, here voiceless stops and fricatives, to be governors, based on their elemental composition.

3.4.3 Consonant hardening

Under the government relation illustrated in (29) the representations of the stop and the nasal are of equal complexity. The government relation thus satisfies the version of the complexity condition adopted. Consonant hardening will be here treated as resulting from a situation where the potential governor is less complex than the governee, i.e. the non-nasal consonant is less complex than the nasal. In this case, where the complexity condition fails to be met, the governor seeks to improve its status on the strength hierarchy by acquiring additional elements. The only source of elements is the governee over which the governor has this dominating power. The acquisition of additional elements results in the strengthening of the governor /l/ that only has one element (R). (R) thus acquires the (L) element from the nasal, which is interpreted as voicing in non-nasal consonants, hence strengthening. Strengthening can thus be viewed as resulting from the sharing of an (L) element between the governor and governee. Hardening of /β/ thus also occurs because (L) is present in the two segments in a governing relation. This captures the fact that voiced NC clusters result from hardening.[82] The representations in (30) illustrate the process of consonant hardening.

(30) a. leka → ndeka 'I stop' b. βila → mbila 'I sew'

inter-onset government

O	N	O	N	O	N
|	|	|	|	|	|
x	x	x	x	x	x
|		|	|	|	|
n		l	e	k	a
$\underline{L}$	→	L			
R	←	$\underline{R}$			
/n		d	e	k	a/

L-sharing = hardening

O	N	O	N	O	N
|	|	|	|	|	|
x	x	x	x	x	x
|		|	|	|	|
n		β	i	l	a
$\underline{L}$		L			
U	←	U			
«R»		«$\underline{h}$»			
/m		b	i	l	a/

(30a) shows the spread of (L) from the nasal to the segment that contains a single element. The resulting elemental configurations would be identical if the (L) from the nasal retained its headedness in the stop. I therefore assume (L) to spread under switching, following earlier work in Kula and Marten (1998). As discussed in the element geometry in chapter 2, an (L) head represents nasality while an (L) operator represents voicing in onsets. Switching of heads, which here just refers to the fact that (L) fails to retain its head position in the target, must take place; otherwise we would predict a nasal geminate. In fact, we see exactly this output in Meinhof's Law discussed in sub-section 3.4.5. The switching of heads follows from the geometry because (L) spreads from the phonation sub-gesture to the stricture sub-gesture where it cannot be head. In this way we avoid a violation of the OCP, which might result from two adjacent identical representations. In the case of (30b) we must assume the hardening effect to result from L-sharing and that this causes (h) to be suppressed and a stronger stricture element is assumed i.e. (ʔ).[83]

The same analysis of (L) or 'voice' spread can be extended to the cases of Kwanyama and Kikuyu hardening in (10), as well as the post-nasal voicing of Yao and Kikuyu in (17). These languages, which avoid voiceless NC clusters, could be regarded as having voiceless stops as the unmarked consonant type with as such no (H) element to express voicelessness and therefore more susceptible to the spread of (L).

[82] The head versus dependent relation is also decided by the phonological domain structure assumed. The prefix is dependent on the root, which forms an independent internal phonological domain. See discussion in section 3.5.

[83] I think it is not strictly necessary to assume that (h) is replaced by (ʔ) but rather that (h) gets elevated to (ʔ) interpretation under (L) sharing. I refine the idea of (L) sharing as actually involving spreading or at least sharing of the (L) in the nasal, in the discussion of Meinhof's Law in sub-section 3.4.5.

3.4.4 Consonant epenthesis

Let us now turn to the cases involving consonant epenthesis when the nasal prefix is affixed to vowel-initial stems. The expected resulting structure before epenthesis in such cases would be as in (31a). Compare this structure to (31b) with a vowel-final prefix. Brackets indicate morpheme boundaries.

(31) a. [O_1N_1 [O_2N_2 O_3 N_3]]

| | | | | |
x x x x x x
| | | |
N e b a

/ndʒeba/ 'tell'

b. [O N_1 [O N_2 [O N_3 O N_4]]

| | | | | | | |
x x x x x x x x
| | | | | |
a l a e b a

/a leeba/ 'he/she tells (habitual)'

From (31a), *neeba* could be derived with compensatory lengthening of the stem vowel to the preceding empty position in the prefix, in line with (31b) where N_2 and N_3 fuse to give *aleeba* 'he/she tells (hab)'. In fact, vowel compensatory lengthening only results from hiatus situations, namely where two vowels face each other. Consider the following examples of the infinitive prefix *uku-* with vowel-initial stems.

(32) a. uku-ásuka → ukwá:suka 'to answer'
b. uku-oba → uko:ba 'to oar'
c. uku-íba → ukwí:ba 'to steal'

Although examples like these are generally treated as fusion, it is clear that a case for compensatory lengthening can be made, where the first vowel in a sequence of two loses its vocalic interpretation by being interpreted as a glide and thus results in lengthening of the second vowel (32a) and (32c). We have referred to this process as partial fusion in chapter 2. Given this, it seems that compensatory lengthening only takes place in Bemba as hiatus resolution. In (31a), where no such hiatus is available, compensatory lengthening of N_2 fails to take place; rather epenthetic insertion of /g/ in O_2 takes place.[84] The other possibility would be to delete the sequence of empty nucleus and onset in (31a), N_1 - O_2, resulting in *neba* with short /e/. However, this is counter to the Projection Principle, which demands that licensing relations should be kept intact. Deleting O_2 would mean N_2, which formerly licensed O_2 would now license O_1.

An epenthetic /g/ segment is a direct result of (L) spreading from the nasal to the empty onset position. The sharing of (L) implies hardening and since there is no

[84] This is reminiscent of Itô's (1986) Onset Principle, which states that languages want to optimise onsets. In Optimality Theory (Prince and Smolensky 1993), this is captured by the markedness constraint ONSET.

place element, the resulting segment is velar, /g/.[85] In (31a), epenthetic /g/ is palatalised to /dʒ/ by a palatalisation process that changes /k g → tʃ dʒ/ before the front vowels /e i/.[86] (33a-b) illustrate epenthetic /g/ insertion before stems beginning with /e i/ on the one hand and those beginning with /o u a/ on the other.

(33) a. eba → ndʒeba 'I tell' b. uβula → ŋguβula 'I peel'

```
a.                                  b.
[O1N  [O2N  O  N]]                  [O1N  [O N  O  N  O  N]]
 |  |   |  |  |  |                   |  |   |  |  |  |  |  |
 x  x   x  x  x  x                   x  x   x  x  x  x  x  x
 |         |  |  |                   |         |  |  |  |  |
 N         e  b  a                   N         u  β  u  l  a
 L  →  L                             L  →  L
       I←I                          «R»
 R  →  R
       ↓                             ↓      ↓
      /dʒ/                          /ŋ/    /g/
/n     dʒ e  b  a/                  /ŋ      g  u  b  u  l  a/
```

In both (33a) and (33b), (L) spreads to increase the complexity of the governing onset, which is empty. Acquisition of elements in the parametrically licensed stem-initial onset allows it to be phonetically interpreted. In (33b), the governee O_1 suppresses its coronal place because it must share place with its governor, which being empty, results in the velar nasal /ŋ/. The idea is not to postulate an actual empty element that represents velar, but rather that if a phonological expression consists of a simplex non-place element, it is interpreted with velar place. The same process of (L) spread is seen in (33a) but in addition, a palatalising (I) element spreads from the following front vowel resulting in a voiced palatal. The complexity scale being satisfied, O_1 retains its default coronal place. (33a) thus illustrates the inability of velar place to surface in the presence of more than one element. The resulting voiced palatal affricate is thus articulated with the nasal's coronal place. Note that with the addition of (I), O_2 already satisfies its complexity requirements for a governing head - it is as complex as O_1. The spreading or sharing of (R) therefore merely takes place to ensure that the stop has a place of articulation.

The glide initial stems given in (12) are subject to the same analysis as long as the glides are viewed as syllabified in the nucleus rather than the onset. Consider the representations in (34) where the glides are part of light diphthongs.

---

[85] This also fills the gap in the consonant inventory where /k/ does not have a voiced counterpart. The other voiceless stops /p/ and /t/ do at least have their voiced counterparts in NC clusters through the strengthening of /β/ and /l/ respectively. Palatalised /g/ realised as /dʒ/ also gives the voiced counterpart of the voiceless palatal affricate /tʃ/.

[86] This process is almost fossilized and occurs only in stem-initial position. Thus while no *ki/*ke may be found word-initially, these sequences do occur between the root and following suffixes; *sek-esh-a* 'make laugh'.

(34) a. wa→ ngwa

```
O  N  O  N
|  |  |  |
x  x  x  x
|        |\
n        u  a
L  → L   U
«R»

↓     ↓  ↓
/ŋ    g  w  a/
```

b. ya → ndʒa

```
O  N  O  N
|  |  |  |
x  x  x  x
|        |\
n        i  a
L  →  L
R  →  R
      I← I
↓     ↓  ↓
/n    dʒ y  a/
```

The light diphthong representation of glides in nuclei in both (34a) and (34b) is consistent with the representation of glides in CG sequences in word-internal position as heavy diphthongs, given in chapter 2. (34a) is parallel to (34b) with (L) spreading rightwards under switching. In (34a), (R) is suppressed in order to satisfy complexity requirements between the governor and the governee, giving *ŋgwa* ‘I fall’ as the output. If, on the other hand, the glide element (U) was represented in the onset, we would be faced with an almost identical situation as the hardening of /β/ to /b/ as shown in (30b), with /mb/ as the predicted output. This is probably the representation of glides that is required in Swahili where *wati* becomes *mbati* ‘hut poles’ (cf. examples in (12)). Like in the vowel fusion processes discussed in chapter 2, (U) fails to undergo total fusion and results in gliding, hence the form *ŋgwa* ‘I fall’ in (34a).[87] In the same vein, syllabification of the palatal glide in (34b) as a complex nucleus, gives the output *ndʒya,* which under absorption of the glide into the affricate is pronounced as *ndʒa* ‘I go’. Hyman (1994) also argues that absorption is responsible for the lack of /-shy-/ sequences in Bemba, which have become /sh/. Absorption in both these cases involves incorporation of the element (I) into a preceding consonant.[88]

So far we have seen how under an inter-onset government relation, we are able to account for the Bemba data with respect to homorganicity, hardening and epenthetic consonant insertion in NC clusters. The latter two processes show that there is a process constraint in NC clusters that requires (L) to spread rightwards. Let us now extend the same analysis to the Meinhof’s Law cases and see whether rightward (L) spread has any role to play in the process.

[87] Another possible representation would be to represent the glide in an ambisyllabic structure where /u/, for example, is syllabified in the nucleus to show its source, but is also simultaneously syllabified in the onset to motivate its glide interpretation. This is not possible in GP as it consists of a violation of the projection principle.

[88] As will be discussed in chapter 4 absorption only results from floating segments, hence in (34b) we assume that the historical process leading to I-absorption must have first involved the delinking of /i/ from the light diphthong structure. It is worth pointing out that the pronunciations of the two forms *ndʒa* versus *ndʒya* are hardly distinguishable between speakers.

3.4.5 Meinhof's Law

As already described in sub-section 3.3.4, Meinhof's Law in Bemba simplifies the first NC cluster in a sequence of two. Crucial to this process is the fact that only a hardened i.e. voiced NC cluster preceding another voiced NC cluster is simplified. We have already characterised hardening as occurring under the influence of the rightward spread of (L). Also part of the voicing and hardening process is the switching of heads that takes place, namely an (L) head spreads from a nasal to assume a non-head position in the resulting voiced segment. Consider the illustration in (35) where the lateral /l/ becomes /d/. Only partial structures are given. (Complete structures for hardening processes are given in section 3.4.3 (30a) and (30b)).

(35)	/N/		/l/	→	/n/		/d/
	x	x	x		x	x	x
	|		|		|		|
	$\underline{L}$				$\underline{L}$	$\longrightarrow$	L
	R		R		R		$\underline{R}$

In (35), headed (L) spreads from the nasal to /l/ where it assumes operator position. This change in headship from source to target phonological expression will be referred to as switching. If switching failed to take place in this case, then a geminate /nn/ would result because (R) would be demoted to operator position. In fact, given that (R) is in the location sub-gesture that is a dependent of phonation, the spread of an element from phonation to lower structure implies it assumes head position. This is not the case here. We can thus relate the Meinhof cases where hardening fails to take place, as resulting from the failure of switching, which results in the nasal geminates /mm/, /nn/, and /ŋŋ/. The question is of course why switching should fail to take place. In Kula and Marten (1998), we have speculated that switching may require external licensing that fails to take place in this configuration. I believe this idea is essentially correct and here present a more elaborate interpretation of the licensing mechanisms involved in Meinhof's Law. A crucial part of the explanation lies in the adjacency of the NC clusters involved since NC clusters that are separated by a consonantal segment do not undergo the Law, as shown in (36a). In addition nothing changes if we lengthen the word with a suffix (here the perfective suffix *-ele*) (36b). Similarly, simplification still takes place in an extended stem with adjacent voiced NC clusters (36c).

(36)	a. mbele:ŋga	'I read'	*mmele:ŋga
	b. mbele:ŋgele	'I have read'	*mmele:ŋgele
	c. mmo:mbele	'I have worked'	*mbo:mbele

The relevant configuration for NC cluster simplification is therefore a domain that encompasses the two NC clusters separated by a single vowel. This domain consists of the root of the verb since the vowel that separates the two NC clusters is the root vowel i.e. [NØCVNØC], where the initial N- is the nasal prefix. As has already been seen in chapter 2, the root is central to affixation processes and can also act as the trigger of processes such as vowel harmony. The importance of the autonomy of the root will also be illustrated in chapters 4 and 5 from which it will be concluded that the root forms a phonologically relevant domain. Part of the reasoning for this position follows from phonological processing. In simplex verbs, the root is accessed from the lexicon followed by affixation of the lexical FV. The same process is also postulated for complex verb forms. I will claim that the use of the root for lexical access results in a restriction on how much the root may be altered.

Since the typical shape of the root in Bemba is a CVC- with voiceless consonants, an increase in the complexity of this structure implies an increase in the alteration made to the root. Thus the domain of Meinhof's Law that contains two voiced NC clusters is the most complex structure that could be possible in a root because it consists of a total alteration of the root consonants, i.e. it imports voiced segments into the root. I will claim that it is for this reason that simplification occurs in a sequence of two voiced NC clusters; lexical contrast cannot be totally neutralised in the root. I call this requirement to retain lexical contrast in the root *Licensing Saturation* defined as in (37).

(37) Licensing Saturation: the complexity within the root domain may not result in total loss of lexical contrast

The retention of lexical contrast in (37) implies the retention of non-derived segments. (38) gives the possible root structure from the most unmarked and thus least complex structure (38a), to the most marked and thus most complex and illicit structure (38f).[89]

(38)	root	C_1	C_2
a.	C_1VC_2-	voiceless	voiceless
b.	C_1VNC_2-	voiceless	voiceless
c.	NC_1VNC_2-	voiceless	voiceless
d.	NC_1VNC_2-	voiceless	voiced
e.	NC_1VNC_2-	voiced	voiceless
*f.	NC_1VNC_2-	voiced	voiced

The aim of (38) is to show that since Bemba does not have lexically voiced consonants their derivation, which is only in the environment of a preceding nasal increases the complexity of the root. Why should this be so? Following Harris (1992, 1997) and the basic GP assumption of licensing within a domain, I deduce that the more licensing tasks that are sanctioned in a domain, the more complex the structures that may be expressed. In other words, the longer the licensing path in a

[89] I here include the initial N that is technically not part of the root but is in an inter-onset government relation with the root initial consonant. The structures in (38c-e) thus refer to the second phonological domain that contains the prefix and the root.

domain is the more complex the derived structure is. To understand how the complexity of a domain may increase with licensing relations let us first consider the *Licensing Inheritance Principle* of Harris (1992).

(39) *Licensing Inheritance Principle* (Harris 1992: 384)
A licensing position inherits its autosegmental licensing potential from its licensor.

Prosodic licensing and autosegmental licensing
p(rosodic)-licensing sanctions the presence of positions at different levels of projection from the skeletal tier upwards.[90]
a(utosegmental)-licensing determines the melodic content of a particular position.

The Licensing Inheritance Principle (LIP) implies that all licensing within a domain is sanctioned by inheritance from one position to another following Kaye's licensing principle that requires all positions apart from the head, to be licensed in a domain. LIP sanctions the presence of positions and then the segments that may occupy these positions. I will take LIP to also involve licensing of the processes that these segments are associated with.

As earlier stated licensing is simply to be understood as the sanctioning of some constituent or process. As seen in chapter 2, licensing is extended to processes in Charette (1991), where a governing head cannot license its governee unless a following nucleus gives it the mandate to do so (government licensing). This explains why in some languages that have vowel~zero alternations, like French, properly governable nuclei fail to be properly governed following consonant clusters that are in a government relation - the government licensors in these languages must be realised nuclei. Owing to this need to sanction either constituents or processes, I will claim that in essence, all processes within a domain must be somehow sanctioned, i.e. licensed. This I think is already implied in Government Phonology's *Non-arbitrariness* fundamental principle (KLV 1990: 194), which demands that there must be some non-arbitrary relation between a phonological process and the context in which it takes place. We can interpret this to mean that phonological processes must be licensed to take place in the contexts that they do.

In this undertaking, it will be necessary to distinguish more basic licensing functions from less basic ones. We have already accepted as part of the GP mechanism that a nucleus licenses other nuclei within a domain. The nuclei in turn license onsets in their ON pair, so that even vowel-initial words are represented with initial empty onsets. We will consider this type of licensing to be the most basic and call it 'licensing to exist'. This gives us the strict CV type of languages. In Charette's government licensing, a nucleus licenses an onset head to govern a

[90] The use of p-licensing here is different from its use in the ECP. In addition to sanctioning the presence of positions, p-licensing in the ECP also requires these positions to remain empty and hence uninterpretable.

dependent and thereby sanctions the existence of consonant clusters. We will recognise such licensing potential of a nucleus (i.e. to be a government-licensor) as inherited from another nucleus in the licensing path and call this 'license to be a government-licensor'. This moves us up from CV structured languages to languages having consonant clusters that are in a governing relation (generally of increasing sonority). By p-licensing in the ECP, we then get languages that have clusters with decreasing sonority. This will lead to clusters that involve p-licensing, such as inter-onset government. Finally, we have the licensing of elements affecting the internal shape of segments under which for Bemba we will assume 'licensing to switch', that allows the change of headship discussed in sub-section 3.4.3 that facilitates the voicing expressed in hardened NC clusters.

Licensing that affects the internal structure of segments will be part of the licensing ability that a nucleus acquires from its nuclear head when it is licensed to exist. The distinction between more basic (licensing to exist, licensing to govern, licensing to be a government-licensor) and less basic licensing functions (licensing to govern (resulting in decreasing sonority clusters), p-licensing, licensing to switch) distinguishes between less marked structure and more marked structure. We can thus create a licensing scale as in (39), with room for language specific variation.

(39) Hierarchy of different licensing functions in a domain:

nuclear licensing » onset licensing » licensing nuclei to be government-licensors » licensing to govern » licensing to switch » p-licensing to be empty

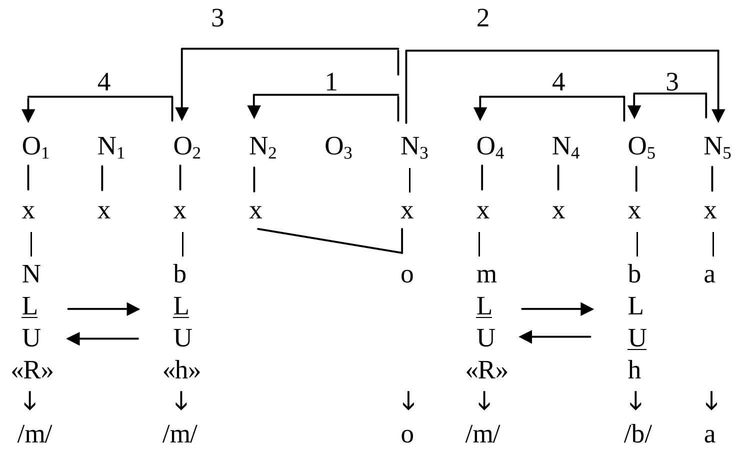
The licensing scale in (39) tries to distinguish between the two types of licensing a nucleus is involved in. Licensing outside of its own domain i.e. to other nuclei, and licensing within its own domain (the ON pair). Let us call these local and non-local licensing relations, respectively, and assume that local licensing takes precedence over non-local licensing. This means nuclei license other nuclei before they license onsets. With these assumptions, we can now tackle NC cluster simplification in Meinhof's Law in Bemba.

3.4.5.1 Meinhof's Law as licensing saturation

For the licensing relations in the Bemba verb, the head nucleus is located in the root because the root acts as the head of the phonological domain structure. In the prefix domain this is reflected by the fact that the consonant in the root is the governor in an inter-onset government relation with a prefix consonant. In chapter 2 we have also seen how, because the root expresses the full contrast of vowels, it is the trigger of vowel harmony. In addition, the root vowel can be lexically specified for tone while following suffix vowels are toneless and only acquire tone by Tone Doubling. For LIP this means that licensing starts in this position and is then transmitted to the remainder of the domain. Given this head position, let us consider a derivation of

Meinhof's Law in Bemba. Licensing relations in (40) are numbered in order of occurrence.

(40) N + βó:mba → mmó:mba *mbó:mba 'I work'



/mmomba/

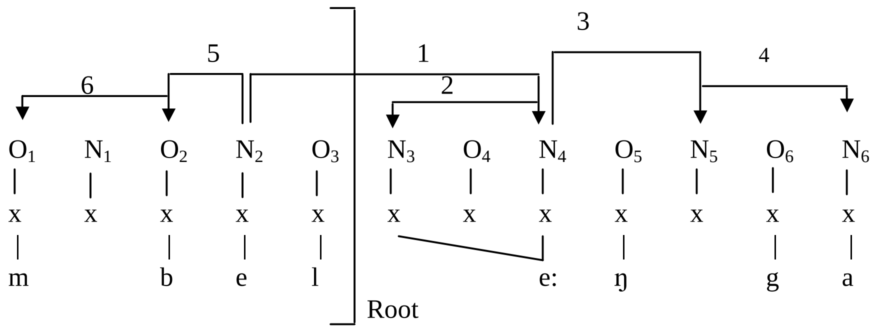
In (40), the head of the domain is the root vowel N_3, which is part of a long vowel. N_3 thus governs and licenses its dependent N_2, in order to define the long vowel. N_3 also licences the final nucleus N_5 to exist and to be a government-licensor, so that N_5 can license O_5 to govern O_4. In addition, N_3 also licenses its onset O_2 to exist and to govern O_1. Simplification results from the fact that under licensing saturation N_3 fails to license switching in O_2.[91] Since switching is already licensed in the second NC cluster that is then voiced, licensing of switching in the first NC cluster would result in a root that loses all its consonantal lexical contrast. Switching in O_2 is therefore blocked resulting in simplification consisting of a nasal geminate. In (40) this is illustrated by the lack of change in headship in the (L) element that spreads from O_1 to O_2 as opposed to the spread from O_4 to O_5 where switching and hence hardening takes place. The government relation between O_2 and O_1 is still licensed despite the lack of switching, so that government takes place and the governing head imposes its place element on the governee to produce a nasal geminate in a manner akin to long vowels. One consequence of an increase in complexity is an increase in licensing relations. Thus by comparison, a root of CVC- shape has less licensing relations that one with complex structures.

Given this account of Meinhof's Law, we can account for why simplification does not take place with voiceless NC clusters; switching that leads to lexical contrast neutralisation never has to be licensed in these instances. Similarly in forms

[91] N_3 also licenses all the other processes in O_2 whether directly or indirectly. The spreading of (U), for example, is licensed via the licensing of government. Only the licensing relations relevant to simplification are given here for ease of exposition.

like /ndekaŋ/ and /mbeleŋga/ no simplification of the initial voiced NC cluster takes place, because in both cases the second lexical consonant in the root is maintained. Consider (41). (The right bracket in the structure demarcates the root). Again the numbering on the arrows reflects the order of licensing. Only licensing relations relevant to the discussion are shown.

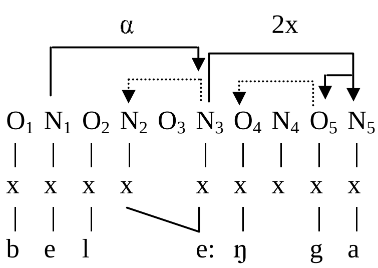
(41) N + βele:ŋga → mbele:ŋga (*mmele:ŋga) ‘I read’

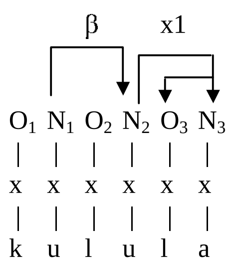


By comparison to the representation in (40), i.e. by merely looking at the number of arrows in the root, we see that less licensing takes place in (41). This follows from the fact that only one NC cluster is present in the root. Since the lexical representation of the consonant in O_3 is maintained simplification does not take place.

With respect to the systematic long vowel that is found before NC clusters, I consider it to be lexical and to follow from the fact that this vowel has the additional task of licensing the following nucleus to license government in the NC cluster. Under this view, a long vowel inherits more licensing potential than a short vowel. This implies that a long vowel following the head nucleus demands more licensing power than a short vowel does. Consider the illustration in (42) where the dotted arrows represent government and the sold arrows represent licensing relations.

(42) a. bele:ŋga ‘read’ b. kulula ‘drag’





(42) shows a comparison between the licensing potential that the head nucleus N_1 in both (42a) and (42b) confers on the following vowel which is long in (42a) and short in (42b). If we term the two amounts of licensing potential in question as α and β as illustrated in (42), then α is greater than β. Why should this be? The claim is that long vowels acquire more licensing potential than short vowels because they get extra licensing potential to allow them to license their dependent (N_2 in (42a)). The dependency of N_2 on N_3 is reflected in the governing relation that holds between the two nuclei. Having more licensing potential allows long vowels to license following nuclei with more licensing power than a short vowel would be able to license following nuclei. Thus in (42a), the long vowel in N_3 is able to license N_5 with sufficient licensing power to license at least three tasks: licensing O_5 to exist, licensing O_5 to govern O_4 and licensing switching within the NC cluster that results in hardening. By comparison, the short vowel in N_2 in (42b) which gets less licensing potential, licences N_3 with an even more impoverished licensing power than itself so that N_3 is only able to license one task: licensing O_3 to exist.

Under such licensing conditions, it follows that the vowel before an NC cluster is always long because it must license a following nucleus with enough licensing potential to license the NC cluster, in addition to fulfilling other licensing tasks.[92] The demand for greater licensing power for NC clusters is also reflected by their occurrence in word-initial position where they are licensed by the head nucleus that boasts the greatest licensing potential. Let us now consider the variants of Meinhof's Law in Bantu.

3.4.6 Meinhof's Law in Bantu

Let us now consider other Bantu languages and see whether the characterisation of Meinhof's Law as a failure of switching can provide some insight into the attested variants of the law. Schadeberg (1987), in a survey of Meinhof's Law recognises four variants as given in (43) with slight modifications.

(43) Variants of Meinhof's Law (Schadeberg 1987: 2 ff)

a. Ganda variant

NCvNv	→	NNvNv	en-limi	→	ennimi	'languages'
NCvNC	→	NNvNCv	n-genda	→	ŋŋenda	'I go'

b. Lamba variant

NCvNCv	→	NvNCv	in-lembo	→	inembo	'tattoo'
*NCvNv	→	NvNv	in-guma	→	iŋguma	'head injuries'

[92] This is not to say that all long vowels must license NC clusters, indeed long vowels occur irrespective of NC clusters. The restriction is rather that NC clusters can only occur in non-initial position following a long vowel, i.e. in a position where they can be licensed.

c. UMbundu variant

NCvNv	→	NvNv	n-lima	→	nima	‘farm’
*NCvNC	→	NvNCv	n-landa	→	ndanda	‘buy’

d. Kwanyama variant

NCvNC	→	NCvCv	n-gombe	→	oŋgobe	‘cattle’
*NCvN	→	NvNv	n-goma	→	oŋgoma	‘drum’

Bemba falls into the Lamba variant: simplification only occurs before another NC cluster and not before a nasal.[93] The Ganda variant, on the other hand, simplifies an NC cluster both before another NC cluster and also before a simple nasal. Simplification in Luganda produces geminate nasals. Given the simplification of an initial NC cluster before another NC cluster we can conclude that the nuclear head is initial in Luganda, in which case it is surprising to have simplification before a nasal. This has prompted an analysis which views NC cluster simplification in Luganda as triggered when a consonant is surrounded by nasals. One such analysis is given by Herbert (1977), who argues that Meinhof’s Law is the nasalisation of a consonant in an environment characterised by extreme nasality, where the nasalised consonant is preceded by a nasal consonant and followed by a nasal vowel and nasal consonant, i.e. - $NC_1\tilde{V}N$- where C_1 undergoes Meinhof’s Law in the form of nasalisation. This, however, does not explain the lack of nasalisation of voiceless stops and fricatives, which also occur in the same environment. In addition, we cannot extend this analysis to other languages that do not have nasalised vowels and do not simplify NC clusters before a simple nasal (the Lamba and Kwanyama variants). This analysis can also not be extended to UMbundu, since it fails to simplify an NC cluster before another NC cluster. Katamba and Hyman (1991), along the same lines, also view Meinhof’s Law as an assimilation rather than dissimilation process triggered by well-formedness constraints. They argue that only one specification for the feature [nasal] is allowed in a stem in Luganda, so that only identical nasals doubly linked to one feature specification are allowed. In line with this reasoning, Meinhof’s Law is motivated by a constraint on the feature [nasal] in stems. Katamba and Hyman (1991: 181) formulate the constraint as in (44).

(44) In an NDVN(C) string, no potential nasality bearing units should be wedged as D between nasals within the stem

Vowels are considered to be non-nasality bearing units, while voiced oral consonants are nasality-bearing units. Since only voiced NC clusters are subject to Meinhof’s Law Katamba and Hyman consider the nasalisation of D to only take place after hardening and homorganic nasal assimilation have made the segments

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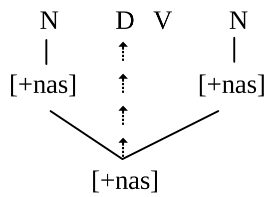
[93] The Lamba variant as presented in (43b) must undergo de-gemination under the view that these languages do not sanction geminates. Assuming de-gemination in Bemba does not affect the licensing relations and hence not affect the analysis just presented. De-gemination can be characterised as reduction after failure of switching if there is a bar on segments mutually governing each other.

/ND/ very similar to each other. Meinhof's Law results from the fusion of the nasal nodes (motivated by the OCP), after which nasality spreads to the potential nasal bearing unit. The process is shown in (45), adapted from Katamba and Hyman (1991: 199).

(45)



There is no Meinhof's Law with voiceless stops or fricatives because they are not nasality bearing units. The nasality bearing units derive from what Katamba and Hyman term *archiphonemes* represented as /B L J G/, surfacing as the voiced segments /b d j g/ after nasals and as /β l y Ø/ elsewhere, respectively. This very much parallels the Bemba case, where only hardened consonants are subject to Meinhof's Law. Consider, however, the following data presented in Katamba and Hyman that fail to trigger Meinhof's Law.[94]

(46)	a.	Ǹ-bàmà	→	m̀bámá	'I rush'
	b.	Ǹ-dùmà	→	ǹdúmá	'I bawl'
	c.	Ǹ-jéémá	→	ǹjéémá	'I rebel'
	d.	Ǹ-gèmèlà	→	ŋ̀gémúlá	'I bring a gift'

Katamba and Hyman treat the stem-initial obstruents in (46) as lexically specified as [- sonorant] and therefore fail to trigger the nasal spread rule which is only triggered by consonants which are identical to the voiced obstruents in (46), but which are specified as [o sonorant], i.e. have no specification for sonorancy. Obviously this is not a desired outcome since identical segments get different representations. In the proposed analysis for Bemba, only consonants that undergo hardening trigger Meinhof's Law because hardening involves switching, which fails to be licensed under licensing saturation assumptions. In Luganda we will also consider saturation to result from the avoidance of complexity where the derivation of voiced NC clusters involves an increase in licensing tasks as opposed to lexical voiced NC clusters. It seems that in Luganda the avoidance of complexity will have to be due to reasons other than the retention of lexical contrasts since Luganda as opposed to Bemba has voiced consonants in its lexical consonantal inventory. If the stem-initial consonants in (46) are lexical, as Katamba and Hyman suggest, then we can account for the fact that they do not trigger Meinhof's Law - they do not undergo a process of hardening because they are lexical. In the domain where these segments occur, then, the head nucleus will have to license government to ensure assimilation, but

[94] The nasal prefix is syllabic and tone bearing in Luganda unlike in Bemba.

will not license switching because the element (L), being inherent to the lexical /b d j g/, does not spread from the nasal prefix. The Luganda data are therefore amenable to a licensing analysis.

Coming now to UMbundu where NC cluster simplification does not take place before another NC cluster but only before a nasal, we are, I think, faced with the greatest challenge because given the foregoing assumptions from Licensing Inheritance, an environment that requires more licensing power (two NC clusters in a sequence) is sanctioned over one that requires less licensing power (an NC cluster followed by a simplex nasal). Let us consider in more detail the data of UMbundu. Consider the UMbundu alternations with the 1st person subject marker *N-* in (47) taken from Schadeberg (1982: 111 ff).[95]

(47) voiced NC clusters

a.	N - vànjá	→	mbànja	‘I look’
b.	N - làndá	→	ndànda	‘I buy’
c.	N - yéva	→	njéva	‘I hear’
d.	N - ènda	→	ŋgènda	‘I go’

*voiceless NC clusters

e.	N - pópya	→	mópya	‘I speak’
f.	N - tuma	→	numa	‘I send’
g.	N - tʃil̃a	→	ɲil̃a	‘I dance’
h.	N - kwátá	→	ŋwátà	‘I take’

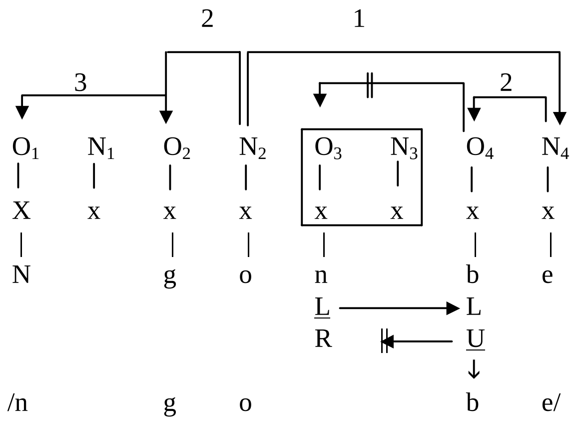
The process here characterised as Meinhof’s Law (47f), seems to be a more general process that bars voiceless NC clusters in the language (47e-h). Otherwise we would have to say there is NC cluster simplification before any following consonant. The process in (47e-h) is more fruitfully characterised as assimilation of the stop to the nasal or as stop deletion, as seen in (18). The lack of application of Meinhof’s Law in (47a-d) is therefore simply a result of the fact that the law is not active in this language.

Let’s finally consider the Kwanyama variant, where NC cluster simplification involves simplification of the second NC cluster by deletion of the nasal. Having simplification in the second NC cluster as illustrated here is positive evidence for syllabifying internal NC clusters in an identical manner to word-initial ones. The Kwanyama variant is somewhat of a mirror image of the Lamba variant, although simplification produces a stop rather than a homorganic nasal. It is interesting that in this language where both voiced and voiceless obstruents occur, simplification can have the option of leaving out the nasal rather than the stop. Simplification in this case results from the failure to license government in the second NC cluster in (48) which means the place feature of the stop fails to spread to the nasal in O_3.

[95] Before verb stems beginning with the voiceless fricatives /f s h/ or nasals, the nasal prefix is not pronounced at all. So *fèla* ‘dig!’→ *fèla* ‘I dig’. With the nominal class 9/10 nasal prefix N + k → h; *kwátá* in (47h) → *óhwáte* ‘captive’.

Switching is, on the other hand, licensed and (L) spreads from the nasal to the stop. In Kwanyama /v l/ become /b d/ after a nasal, respectively.[96] The process is illustrated in (48) where the numbering reflects the order of licensing relations.

(48) ŋgombe → oŋgobe ‘cattle’



The head nucleus N_2 licenses N_4 to exist and to government license O_4. N_2 also licenses O_2 to exist and to be a government licensor. Failure of O_4 to govern O_3 means failure to impose its place element on O_3 and consequently, the lack of a government relation means the intervening nucleus fails to be licensed under the ECP and is stray erased with O_3 under reduction as indicated by the framed structure in (48). As noted earlier, there is no simplification of /ŋg/ in Kwanyama, which would produce the non-lexical segment /g/ as opposed to the lexical /d/ that is produced in the simplification of /nd/. The application of Meinhof’s Law may thus, as in Bemba, be sensitive to the retention of lexical contrasts.

From the foregoing, we can see the viability of a characterisation of Meinhof’s Law as a restriction on the complexity that may be expressed in the root domain in Bantu. Simplification of complexity has resulted from the inability to license particular processes or relations, in particular switching and government. Simplification has also been illustrated to take various different forms in the variants of the law. In Bemba and Luganda it has resulted in a nasal geminate rather than a voiced NC cluster, and in Kwanyama it has ultimately led to the deletion of structure in the preservation of only the stop in a voiced NC cluster. An important area of investigation that remains for a characterisation of the variants of Meinhof’s Law is

[96] A full investigation of Kwanyama and all the languages surveyed here would have to be made so as to ascertain the Licensing Constraints at work in defining the various consonantal inventories. The point here is merely to show the applicability of the analysis proposed. Kwanyama like UMbundu does not allow voiceless NC clusters; *e:N-kaku* → *e:ŋaku* ‘shoes’, *oN-tana* → *onana* ‘little calves’, *e:N-pati* → *e:mati* ‘ribs’, cf. Steinbergs (1985: 97). Additionally /ŋg/ does not undergo simplification: *e:N-viŋga* → *e:mbiŋga* ‘horns’. There are obviously other segmental constraints involved as well.

the purpose of reducing complexity in the root domain. For Bemba this seems to follow from the need to retrain lexical contrasts within the root for purposes of lexical retrieval. I leave these questions with respect to the other variants of the law for future research.

Let us now, as a final excursion in the nature of NC clusters, turn to a different area of NC cluster formation involving reduplication.

3.5 Reduplication

Reduplication presents another way in which NC clusters may be formed in prefixation, as long as we consider it to be an operation that attaches some part of a stem, to the stem itself. Bemba has both partial and total reduplication in verb stems, although most of the partial reduplication forms are lexical, and the process cannot be regarded to be as productive as total reduplication. Consider the partial reduplications in (49).

(49)
a. sen-sent-a 'carry by hand (several people)'
b. tun-tumb-a 'carry a heavy load'
c. ten-temb-a 'handle with care'
d. ten-temuk-a 'descend a hill'
e. paa-paat-a 'plead'
f. too-toosh-a 'whisper'
g. lyalya-ly-a 'eat carelessly'
h. shasha-sh-a 'leave lying about carelessly'

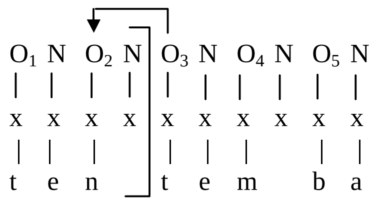
In (49), the reduplicant may be either CVC- (49a-d) or CVV- (49e) and (49f), or reduplication may involve tripling of a CV stem as in (49g) and (49h). We can deduce from these patterns that partial reduplication maximally involves copying of the initial CVC- with mandatory inclusion of the root vowel.[97] The only cases where the initial CVC- is copied involve NC clusters, because copying any other non-initial -C- would result in illicit CC sequences. Consider the long stem *pilibula* 'turn' that would be **pil-pilibula* if the initial CVC- was copied. The only other environment where we expect a non-initial -C- to be copied is in vowel-initial stems. This is borne out in lexical verbs such as *el-ela* 'forgive', *ol-ola* 'straighten'. Given the impossibility of **temu-temuka* as an output of (49d), but *shasha-sha* in (49h), the mandatory inclusion of the root vowel must be extended to mean only the root vowel can be copied.[98] The constraints on reduplication reflected in the data are best

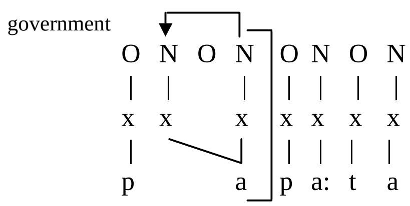
[97] The choice of only the initial CVC- to be copied as part of the reduplicant is related to this structure being part of the root of the verb stem that we have seen play a significant role in Meinhof's Law and that will get additional support for domainhood in chapters 4 and 5.

[98] **Te-temuka* is also not a possible output here: the nasal must be part of the reduplicant. This is not, however, a general principle for verbs of this structure since there are reduplicative stems of the form *se-sema* 'prophesy'. Although the reduplication of CV verbs seems to suggest the reduplicant must, in traditional terms, consist of two syllables or two moras, there are many counter examples (*su-sula* 'break off', *tu-tuma* 'shiver', *pa-pala* 'be flat'). The only systematic thing we can say about partial reduplication

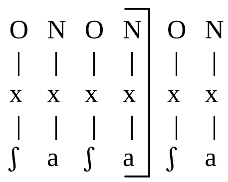
accounted for by assuming the shape of the reduplicant to be [CVCV]. This supports the representation of NC clusters as ONO sandwiches rather than as unit segments. Consider the representations in (50) that show the different shapes that a reduplicant [CVCV], here ONON, takes in reduplicated forms. The square brackets indicate the right edge of the reduplicant.

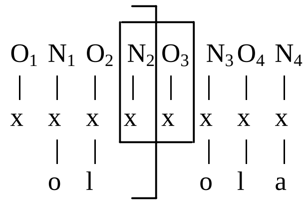
(50) a. ten-temb-a ‘handle with care’ b. paa-paat-a ‘plead’





c. shasha-sh-a ‘leave lying about’ d. ol-ol-a ‘straighten’





In (50a), with the reduplicant [CVCV], an inter-onset government relation is contracted between O_2 (governee) and O_3 (governor). As seen in the discussion of homorganicity, the final nasal of the reduplicant assimilates to the stem-initial consonant, thus changing from /m/ to /n/ and lending further support to the characterisation of the governor as imposing restrictions on the governee. In (50b) the second variant of reduplication where the vowel in the reduplicant is long also fits into the [CVCV] template with government applying as discussed for long vowels in chapter 2 and thereby licensing the intervening onset to remain empty. (50c) presents a case of CV stems that are tripled. Finally in (50d) we have the case of vowel-initial stems that we have already characterised as possessing an initial empty onset that is licensed by domain-initial parameter according to the extended ECP presented in chapter 2. Reduplication in these verbs involves the loss of the sequence N_2 and O_3 (enclosed in a box) by reduction. Reduction applies because a sequence of empty categories cannot be licensed under the ECP: N_2 cannot be licensed because Bemba has the parameter on domain-final empty nuclei switched off. If N_2 were lost from the structure because of this, then O_2 and O_3 would be adjacent and risk violation of the OCP, resulting in the loss of O_3 as well.

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is that the reduplicant only ever ends in a consonant if formation of an illicit CC will *not* result, i.e. only if an NC cluster will be formed.

In (51) I give a summary of how the four approaches to the representation of NC clusters fare with respect to accounting for the phonological processes associated with NC clusters. I here collapse the branching onset and the contour segment into complex segment since the two display more or less similar properties.

(51) ONO, Coda, and complex segment structures compared

	ONO O N O N C	Coda-Onset R O N V N C	Complex Segment O N C
Initial NC clusters	+	-	+ / -
Internal NC clusters	+ / -	+	+ / -
Homorganicity	+	+ / -	+
Strengthening	+	+	-
Meinhof Context	+	+ / -	+
Meinhof Process	+	-	-
Nasal Harmony	+	+	+/-
Reduplication	+	+	-

I consider the viability of each of the three structures for the representations of NC clusters given in (51) for each of the NC cluster environment or process listed in the leftmost column. For the representation of initial NC clusters, which as we have seen only result from prefixation, the ONO structure gives the best representation since it captures the fact that the nasal is a prefix and not part of the root as suggested by both the coda-onset and complex segment structures. For internal NC clusters both the coda-onset and the complex segment structure fare well although the complex structure that assumes a branching onset is bad because it violates the sonority sequencing generalisation. The ONO structure needs extra motivation in internal position, some of which may be provided by the simplification process seen in Kwanyama. Homorganicity is represented well in the complex segment structure since a unit segment has one place specification while the ONO and coda-onset structures capture this through a government relation. Notice though that for both the latter structures the government relation is inherent in their representation and not just introduced to capture homorganicity. Strengthening and hardening does not follow at all from the complex segment analysis while the ONO and the coda-onset structures can capture this as reflected in the governing relation that is created in the formation of the NC cluster. The representation of the context of Meinhof's Law, i.e. a sequence of two voiced NC's is most cumbersome in the coda-onset sequence because it fails to express the constituency of the NC clusters involved while this is done well by the ONO and the complex segment structures. Characterisation of the simplification seen in Meinhof's Law follows easily from the ONO structure that represents NC clusters as contained in unique constituents. The complex segment analysis implies affecting only one part of a unit segment. The coda-onset sequence structure again fares badly due to its inability to represent some constituency in the NC clusters. The blocking effect of NC clusters on NCH follows directly from the ONO structures where an onset intervenes between the trigger and the target. The coda-onset structure fares extremely well here since it has the nasal in a nuclear constituent. The complex segment structure could be salvaged by ordering within the constituent although this seems to move away from the unity that the structure aims to project. Finally for reduplication the ONO and the coda-onset structures express the fact that the nasal may be part of the reduplicant while the complex structure would involve resyllabification.

Given this comparison, the complex segment analysis seems by far the worst option. This is probably why even in analyses where the complex segment is considered to be the surface structure of NC clusters, the nasal and consonant are treated as underlyingly independent and only fusing at a late stage in the derivation (Herbert 1986, Downing 1991). The coda-onset sequence structure fares badly in initial position where the structure always implies an initial unlicensed nucleus. We can therefore conclude that overall inter-onset government provides a fuller characterisation of all the phenomena involved in NC clusters. Let us now consider what these processes entail for phonological domain organisation.

3.6 Prefixation and phonological domains

According to Kaye (1995), cited at the beginning of this chapter, prefixation generally takes the form of analytic morphology where the prefix forms an independent phonological domain from the stem to which it is affixed. Although such a structure is conceivable for the nasal prefix, namely [[NØ][stem]], it would be the only case where empty nuclei are licensed in final position. Since we have considered the parameter on word-final empty nuclei to be switched off in Bemba, because all words end in realised vowels, we would have to make some stipulation that the parameter setting is overridden in some environments. Although Kaye (1995) considers the structure ((A) B), where A is a prefix, unattested in any language, he does not consider all the logical possibilities of visibility versus invisibility between affixes and the phonology. Let us consider these in (52). The ordering crucially differentiates prefixes from suffixes.

(52) *Possible phonological domains in morphology*

Analytic morphology

a.	((stem) affix)	English regular past tense, ((peep) ed)
b.	(stem (affix))	?
c.	((stem)(affix))	possible
d.	((stem$_\alpha$)(stem$_\beta$))	compounds; English ((black)(board))
e.	((affix) stem)	unattested
f.	(affix (stem))	possible
g.	((affix)(stem))	English prefixes ((un)(clip))
h.	((affix$_\alpha$)(affix$_\beta$)	?

Non-analytic morphology

i.	(stem, affix)	English irregular past tense, (kept)
j.	(affix, stem)	English irregular prefixes (in-rational) → (irrational)

If (52e) is unattested on grounds of the impossibility of a stem being the dependent of an affix that is attached to it, then (52b) may be eliminated on the same grounds. This also puts (52h) with two affix domains very much into question. (52c) is the opposite of attested (52g) so we might expect languages with this structure. (52f) I will claim is the correct domain structure of Bemba prefixes. The nasal prefix is then dependent on the following stem so that phonology first applies to the stem and then to the combination of the stem and the prefix. In this way phonology never applies to the prefix alone and we do not have to find ways of licensing a final empty nucleus. As seen in the illustration in chapter 2, Bantu languages have a series of prefixes before the verb stem. This potentially makes the structures in analytic morphology more complex than presented in (52) above. Can we have phonological brackets in Bantu morphology of the type (affix$_4$ (affix$_3$ (affix$_2$ (affix$_1$ (Verb Stem))))) where each affix creates a unique phonological domain with the verb stem? The prefixes discussed in chapter 2 suggest no such phonological domains and in addition the inter-onset government relation that has been proposed for the representation of NC clusters implies that, as suggested in chapter 2, the verb stem, which contains the head of the governing relation, is the base of the prefixation process. This provides strong grounds on which to conclude that prefixes form one phonologically dependent structure on the verb stem. This is illustrated in (53).

(53) Phonological domains to the left of the verb root

[TAM - NEG - SM - NEG - TAM - OM [VERB STEM]]

The phonological domains to the right of the verb root will be discussed in chapter 4, at which stage we will be able to ascertain what structures Bemba allows in the array in (52).

3.7 Summary

In this chapter I have presented arguments for considering NC clusters to be sequences of segments rather than unit segments, and how under the assumption of an inter-onset government relation, we are able to account for the range of processes involved in NC cluster formation. A process of the rightward spread of (L) has been proposed to account for consonant hardening, post-nasal voicing and consonant epenthesis in vowel-initial stems. A principle of Licensing Saturation has also been proposed to account for the variant forms of Meinhof's Law as related to the licensing potential of a nuclear head within a domain. Reduplication has also provided support for inter-onset government as the correct configuration for NC clusters in Bemba. Finally, based on phonological interaction between prefixes in the prefix domain (discussed in chapter 2), and phonological interaction between prefixes and following verb stems seen in chapter 2 and in the NC cluster processes of the present chapter, we conclude that prefixes in Bemba form a phonologically dependent structure on the verb stem and thus do not consist of their own phonological domain. In the next chapter, I consider the phonological interaction of affixes to the right of the verb.

4 Derivational suffixation

This chapter deals with derivational suffixation and all the phonological processes that are triggered in this domain. The aim is to establish, following the assumptions on morphology in Government Phonology given in chapter 2, which morphological domains are relevant to phonology and thus establish which domains are relevant for parsing. Suffixation in Bantu generally involves derivational affixes although some inflectional suffixes, such as the perfect, do occur. The distinction between inflectional versus derivational suffixes is irrelevant for determining phonological domains. The phonological activity of the inflectional perfect suffix is discused in chapter 5. Central to suffixation processes in Bantu is the verb root. As stated in chapter 2, the verb root does not form an interpretable unit and cannot be used independent of the final vowel (FV). Suffixes are therefore attached to the verb root.[99] The final vowel is thus only added to the verbal base to make an interpretable unit, i.e. to signal the end of a domain. If this is the function of the FV then the output of morphological and phonological processes must produce a consonant-final base to which the FV can be added in order to retain the strict CV structure of Bemba. This accounts for the -VC- shape of suffixes illustrated in (1) from van Sambeek (1955: 83-92) with some modification.[100]

(1)	-w-	passive	-ul-/-ulul-	separative TRANS
	-il-	applicative/benefactive	-uk-/-uluk-	separative INTRANS
	-ish-	causative	-ilil-	completive
	-ish-	intensive	-an-	reciprocal
	-ik-	stative		

These suffixes are the most common and productive derivational suffixes in Bemba and which will play a central role in the remainder of this chapter.

In this chapter the morpho-phonological processes of spirantisation, palatalisation, depalatalisation and nasal consonant harmony, will be presented. From these processes I will conclude that in the unmarked case, the root must be treated as forming an autonomous unit that must be retained even though changes to the shape of the segments within the root are permissible. In cases where this autonomy fails to be retained, the root remains irretrievable for the remainder of the derivation and must be considered as forming one domain with all the following suffixes. It will also be established, in support of no bracketing derivation, that for phonology, all internal morphological domains of suffixes are invisible and cannot

[99] I will leave out the FV in some data citations where reference to the root is necessary.

[100] Historically, the affixal system of Bemba was more robust than this and included other suffixes which are now lexicalised, mainly to do with body orientation or interaction; *kont-am-a* 'bend', *ik-at-a* 'hold', *fufub-al-a* 'crouch', *tang-as-a* 'walk open legged', *suk-us-a* 'brush teeth', and the frequentative *tob-a-ul-a* 'break into many pieces'. There is also a long passive *-iw-* that is not very productive but can still be found.

be accessed by phonology and hence cannot be accessed by our parsing device either.

4.1 Spirantisation

Spirantisation, which is also referred to as frication (Sanderson 1922, 1954), or consonant mutation (Kisseberth and Abasheik 1975), is a process that involves the fricativisation of stops, or stop/spirant alternations where the spirant is phonologically determined by a following surface or underlying high vowel. Meeussen (1967), in Proto-Bantu reconstructions, describes four morphological contexts where spirantisation takes place. These are listed in (2). (Starred forms represent reconstructed forms).[101]

(2) contexts of spirantisation

(i)	*-ų -	adjectival derivational suffix
(ii)	*-į-	causative extension
(iii)	*-i	nominal - (especially agentive) - derivational suffix
(iv)	*-ide	perfect and/or past tense ending

In present day Bemba, only the causative suffix triggers spirantisation effects. The nominal agentive suffix had this effect in earlier stages of the language but is now fossilised.[102] Remnants of it can be seen in words like *aba-fyaa-shi* ‘parents’, derived from *fyaal-a* ‘to give birth’. The adjectival *-ų- and the perfect *-ide- never had a spirantising effect in Bemba.

There is some correlation between spirantisation and vowel reduction from a seven to a five-vowel system (discussed in chapter 2, cf. Schadeberg 1995), where languages that have undergone vowel reduction exhibit more spirantisation than those that have not. Labroussi (1999: 338) shows the following schema on the evolution of spirantisation and vowel reduction, where full spirantisation refers to languages which have spirantisation in all the four contexts in (3).

(3) no spirantisation	»	limited	»	extensive	»	full spirantisation
		-ų-,-į-		-i		-ide
7 vowel system						5 vowel system

According to this schema, full spirantisation is only exhibited in languages with five vowel systems. A survey of spirantisation in both seven and five vowel systems shows that while there is full absorption of the triggering agent in the five vowel

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[101] The term *spirantisation* rather than *palatalisation* is used to capture the fact that spirantisation is triggered by both /i/ and /u/ in the languages where it occurs and always produces strident fricatives (Thilo Schaderberg, p.c.). It is therefore not a lenition process.

[102] The agentive is now marked with the prefix *ka-* and ending *-a*, as in *ka-βuumb-a* ‘creator’ from *βuumba* ‘create’.

systems, there is only partial absorption in seven vowel languages.[103] We return to this distinction later. The schema in (3) also illustrates that the most frequent triggers of spirantisation are the causative and the adjectival derivational suffix. Let us now consider a detailed survey of the Bemba data in the following sub-section.

4.2 Bemba spirantisation Data

Spirantisation in Bemba is only triggered by the causative. There are two competing ways to form the causative; by suffixation of the causative suffix -*ish*- (4a-i), which I will refer to as the long causative, or by spirantisation of the root-final consonant (5a-k), which I will refer to as the short causative and for now represent as /i̯/, in line with Proto-Bantu reconstructions.[104] Note that I do not only consider obstruents in the spirantisation process, but also add nasals that produce palatalised nasals.

4.2.1 Simplex roots

The data in (4) and (5) give causativised verbs consisting of simplex roots that do not contain any other extension.

(4) long causative -*ish*-

a.	imb-a	'sing'	imb-ish-a	'make sing/instruct choir'
b.	pep-a	'pray'	pep-esh-a	'make pray'
c.	lol-a	'be awake'	lol-esh-a	'cause to be awake'
d.	sek-a	'laugh'	sek-esh-a	'make laugh'
e.	pet-a	'fold'	pet-esh-a	'make fold'
f.	beleng-a	'read'	beleng-esh-a	'make read'
g.	tem-a	'chop'	tem-esh-a	'make chop'
h.	min-a	'swallow'	min-ish-a	'make swallow'
i.	nw-a	'drink'	nw-ish-a	'make drink'

[103] Absorption is to be understood as the internal change of a segment by assuming the properties of another segment so that in the resulting form only the mutated consonant is present with no trace of the triggering agent, here the causative suffix -*i̯*-. Absorption will be illustrated by Bemba where, for example, the causative of *lek-a* 'stop' is *lesh-a* 'make stop' with no trace of the triggering causative suffix.

[104] I have observed that the long causative generally suffixes to transitive roots and the short causative to intransitives. There are, however, many overlaps and it is not possible to systematically divide the two suffixes into these two categories as the criterion determining which suffix is used. I therefore consider them to be in a competing relation.

(5) short causative -*į*-

a.	lub-a	'be lost'	lufy-a	'cause to be lost'
b.	leep-a	'be long'	leefy-a	'make long'
c.	tump-a	'be stupid'	tumfy-a	'make become stupid'
d.	end-a	'walk'	ensh-a	'make walk/move'
e.	pit-a	'pass'	pish-a	'make pass'
f.	kul-a	'grow'	kush-a	'make grow'
g.	pook-a	'burst'	poosh-a	'make burst'
h.	lung-a	'hunt'	lunsh-a	'make hunt'
i.	kos-a	'be hard'	kosh-a	'make hard'
j	pon-a	'fall'	pony-a	'cause to fall'
k.	kom-a	'be deaf'	komy-a	'cause to be deaf'

In (5), where the causative is expressed by spirantisation of the root-final consonant, the labials /p b/ in (5a-c) become [fy], the stops /d t l k g s/ in (5d-i) become [ʃ] and the nasals in (5j-k) become [ɲ] and [my] respectively. In the data in (4), on the other hand, we see that all the consonants that undergo spirantisation in (5) are also able to appear adjacent to the long causative with no spirantisation.

4.2.2 Complex roots

When verbal bases, i.e. roots already suffixed with one or more suffixes, are causativised with the short causative, multiple spirantisations to each of the consonants in the extensions, including the root-final consonant, occur. Multiple spirantisation also occurs with the long causative but never affects the root-final consonant. The data in (6) to (10), with the applicative, reciprocal and separative suffixes, illustrate the different effects of the causative. In all of these cases there is only one semantically interpretable causative.

(6) applicative -*il*-

	root		appl.	caus.appl.			
a.	lil-	'cry'	lil-il-a	lish-ish-a	*lish-il-a	*lil-ish-a	'make cry for'
b.	lek-	'stop'	lek-el-a	lesh-esh-a	*lesh-el-a	*lek-esh-a	'make stop for'
c.	lub-	'lost'	lub-il-a	luf-ish-a	*lufy-il-a	*lub-ish-a	'lose for'
d.	imb-	'sing'	imb-il-a	imb-ish-ish-a	*imb-il-ish-a		'make sing for'
e.	shit-	'buy'	shit-il-a	shit-ish-ish-a	*shit-il-ish-a		'sell for'
f.	lipil-	'pay'	lipil-il-a	lipil-ish-ish-a	*lipil-il-ish-a		'make pay for'

In examples (6a-c) the root is affixed with the applicative suffix -*il*- to give the benefactive readings 'cry for', 'stop for' and malefactive reading 'get lost on', respectively. When the causative is formed from these applicativised bases, the resulting causativised base spirantises the consonant of the applicative suffix and the root-final consonant. In (6d-f), where the roots take the long causative, the applicative is affixed with benefactive reading. When the long causative is attached to this base, the applicative *-il-* also undergoes spirantisation to *-ish-*. The root-final consonant is left intact, however. Consider now a case of multiple suffixation.[105]

(7) reciprocal+applicative *-il-+-an-*

	root	recip.	caus.recip.	appl.recip.	caus.appl.recip.
a.	pit-	pit-an-a	pish-any-a	pit-il-an-a	pish-ish-any-a
	'pass'	'pass e.o.'	'make e.o. pass'		'make pass for e.o.'
b.	sek-	sek-an-a	sek-esh-any-a	sek-el-an-a	sek-esh-esh-any-a
	'laugh'	'laugh at e.o.'	'make e.o. laugh'		'make laugh for e.o.'

In (7), two suffixes are added and, as in (6), the short causative (7a) causes palatalisation of the final reciprocal suffix and also subsequent spirantisation of the applicative and the root-final consonant as seen in the resulting form. The root in (7b) that uses the long causative shows mutation of all the suffix consonants but not the root-final consonant, as in (6d-f). So far, all the suffixes we have dealt with contain either *-i-* or *-a-*. Let us now have a look at suffixes containing /u/.[106]

(8) separative *-uk-/-uluk-* (INTRANS)

	root		intrans.sepr.		caus.intr.sepr.
a.	sel-	'move'	sel-uk-a	'be knocked over'	sel-ush-a
					'knock over'
b.	*ang-	'peel/trim'	ang-uk-a	'be peeled'	ang-wiish-a
					'make peeled'
c.	ab-	'immerse'	ab-uk-a	'come out of /cross'	ab-ush-a
					'make cross'
d.	fyant-	'be stuck'	fyant-uk-a	'come apart(obj.)'	fyant-ush-a
					'make unstuck'
e.	pet-	'fold'	pet-uluk-a	'be unfolded'	pet-ulush-a
					'make unfolded'
f.	*pilib-	'turn'	pilib-uk-a	'turn'	pilib-ush-a
					'turn around'

[105] 'e.o.' will be used as an abbreviation for 'each other' in reciprocal forms.
[106] /a i u/ are the only underlying vowels in suffixes in Bemba. /e o/ only result from vowel harmony. See discussion in chapter 2. Roots with an asterisk '*' represent roots that have no independent use and thus do not form a stem when the final vowel is added.

(9) separative *-ul-*/*-ulul-* (TRANS)

	root	trans.sepr.		caus.trans.sepr.
a.	sel-	sel-ul-a	'knock over'	selw-iish-a 'make knock over'
b.	*ang-	ang-ul-a	'peel'	angw-iish-a 'make peel'
c.	ab-	ab-ul-a	'remove from water'	abw-iish-a 'make remove…'
d.	fyant-	fyant-ul-a	'take apart'	fyantw-iish-a 'make take apart'
e.	pet-	pet-ulul-a	'unfold'	petululw-iish-a 'make unfold'
f.	*pilib-	pilib-ul-a	'turn around'	pilibw-iish-a 'make turn around'

The examples with the transitive separative in (9) are complements to those in (8) with the intransitive separative. In both these sets of examples, there is no distinction between roots that take the long or the short causative with respect to spirantisation of the root-final consonant. There is no root-final spirantisation in any of the examples here. Note also that there is, in addition, no spirantisation of the first consonant /l/ in the suffix *-uluk-* in example (8e). The transitive counterpart to this suffix *-ulul-* is unable to shed light on this effect, since in examples (9a-f) there is an additional process that deletes the /l/ of the separative suffix (*-ul-*) when it is followed by an /i/ -initial suffix, causing the /u/ to glide when the long causative is added.[107] The failure of the root-final consonant to spirantise in normally spirantising roots such as (8a), *sel-a* → *sesh-a* 'cause to move', must be related to the vowel /u/ in the separative suffixes. We can conclude from these data that /u/ has a blocking effect on spirantisation, as opposed to /a/ in the reciprocal *-an-* and /i/ in the applicative. The result of the causative of a root with a separative, an applicative and a reciprocal suffix as shown in (10), is therefore expected.

(10)		intr.-sepr.	intr.sepr.caus	sepr.appl.recip.
a.	pet-a 'fold'	pet-uluk-a	pet-ulush-a	pet-uluk-il-an-a

intr.sepr.+appl.+recip.+caus.
pet-ulush-ish-any-a 'make to be unfolded for e.o.'

Over-application of spirantisation in the causative is not a property of all Bantu languages that use the short causative. Thus while there are other Bantu languages which, like Bemba, also exhibit multiple spirantisation in causative verbal bases (Luganda E.15 and Yao P.21), there are also a large number that do not. Consider the examples in (11).

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[107] I investigate this process in detail in chapter 5 sub-section 5.3.6.

(11)

	root		caus.	perfect	perf.caus.	
	(Runyankore E.13, Morris and Kirwan 1957)					
a.	kol-	‘do’	koz-	kol-il-e	kol-iz-e	*koz-iz-e
b.	gul -	‘close’	guz-	gul-il-e	gul-iz-e	*guz-iz-e
	(Kirundi D.62, Meeussen 1959)					
c.	vug-	‘play music’	vuz-	vug-il-e	vug-iz-e	*vuz-iz-e
d.	og-	‘wash’	oz-	og-il-e	og-iz-e	*oz-iz-e

In Runyankore and Kirundi, therefore, spirantisation only occurs once at the end of either a simplex root (the causative column in (11)) or at the end of a verbal base (the *perf.+caus*. column in (11)). The analysis that will be proposed for the spirantisation effects of Bemba in section 4.4 will be readily extendable to such cases.

In the next sub-section I present a survey of some previous analyses of the effects of the causative in Bantu.

4.3 Previous analyses

4.3.1 Lexical Phonology approach

Hyman (1994) presents an analysis of multiple spirantisation in Bemba that employs a Lexical Phonology (Pesetsky 1979, Kiparsky 1982b,c, 1985, Mohanan 1982) perspective. Lexical Phonology (henceforth LP), as discussed in chapter 1, hinges on the interleaving of phonology and morphology in order to allow morphological operations to both precede and follow phonological operations. This is particularly useful in accounting for phonological rule over-application, i.e. cases where a phonological process applies even though it is not conditioned. Hyman (1994) utilises this cyclic force of LP to account for the multiple spirantisations of Bemba, arguing that the applicative is absent in the first cycle at which level the causative -į- spirantises the root-final consonant. The applicative suffix is then infixed between the spirantised root-final consonant and the causative suffix, resulting in spirantisation of the consonant of the applicative. This is illustrated in (12).[108]

[108] Hyman uses the term ‘interfixation’, which I understand to mean infixation. Infixation is not an active process in Bemba and is not crucial to the discussion here. Hyman’s term may be a reflection of the fact that as opposed to infixation that may be to any part of a stem, imbrication is systematically in the imbrication site. It is still possible to achieve Hyman’s objective by reduplication or suffix doubling of the causative suffix in morphologically complex stems, following Meeussen’s (1959: 58) observation that mono-phone suffixes such as the causative -į- and passive -ų- have a tendency to follow longer suffixes in Bantu.

(12) pita 'pass' → pish-ish-a 'make pass for'

UR→	morphology$_1$ →	phonology$_1$ →	morphology$_2$ →	phonology$_2$ →output
	(-į- suffixation)	(spirantisation)	(-il- infixation)	(spirantisation)
pit-	pit-į-	pish-į-	pish-il-į-	pish-ish-a

Hyman (1994:88) explains this derivation as follows: to the bare verb root add the causative suffix and then apply consonant mutation. Then add the applicative suffix *-il-*, inserting it between the verb root and the causative *-į-*. The interfixation creates a new derived environment, allowing the reapplication of consonant mutation. (12) thus represents the interpretation of a phonological process that relies on the interleaving of morphology and phonology so that spirantisation is properly conditioned each time it applies. The underlying representation *pit-* (root of the verb 'pass') serves as the input to the first application of morphology. This is suffixed with the causative morpheme and feeds the phonology that then locally spirantises the root-final consonant. The second application of morphology is in the form of infixation of the applicative suffix into a position that conditions spirantisation so as to produce the over-application effects seen in *pish-ish-a* 'make pass for'.

There are two fundamental assumptions of this analysis that may be brought into question. These are, firstly, the basic LP assumption that phonology consists of levels, and secondly the assumption that the causative morpheme is the Proto-Bantu vowel /į/. There are a number of criticisms in the literature that have been levelled against such a view of the architecture of the lexicon. I raise only two here. First, there are many examples where later cycles do not respect features derived at an earlier level. We will see an example of this in the Nyamwezi depalatalisation process in section 4.7, where a phonological process triggers palatalisation in a base. This palatalisation undergoes depalatalisation when the next morphological process adds a suffix to the base. There is also the familiar English stress example in the derivation of *oríginal* from *órigin* where initial stress derived on the first cycle is not preserved on the second cycle, but the penultimate stress of the second cycle is preserved in the third cycle that forms *orìginálity* (accents mark stress). One prediction of LP is that each cycle produces a word and hence that phonology applies to words. There is reason to believe that this is not the case for all languages, and that units smaller than the word, such as the root in Bantu, may also play a role in phonological processes (cf. Downing 1999a).[109]

Secondly, there is the usual question in LP of how many levels must be assumed. At least three levels have been suggested for English in Kiparsky (1982c) and up to four in Halle and Mohanan (1985). Related to this is the question of what determines the division of suffixes into particular levels and whether affixes uniquely belong to

[109] Cf. Inkelas (1993) for a proposal of a model of the morphology-phonology interface called Prosodic Lexical Phonology (PLP), that tries to counteract this problem. As discussed in chapter 1, phonological rules do not access morphological structure directly in PLP, but rather access phonological structure, referred to as p-structure, which is created from morphological concatenations. These p-structures may be misaligned with morphological structure and thus allow for phonological domains that are not consistent with morphological domains.

one stratum. In addition, we can also wonder whether particular morphological and phonological operations are restricted to one stratum. We have already seen that so far we would have to assume at least two levels to account for the multiple spirantisation facts. Yet another level will have to be assumed if we consider the separative suffixes that block spirantisation. Otherwise, under the present analysis, the incorrect causativised forms shown in (13) are predicted.

(13)	verb		sepr.	caus.intrans.sepr.	
a.	sel-a	'move'	sel-uk-a	sel-ush-a	'cause to knock over'
				*sesh-ush-a	
b.	lub-a	'be lost'	lub-uk-a	lub-ush-a	'set free/religious save'
				*luf-ush-a	

Assuming the separative to be on a third stratum may capture its blocking effects, but misses the generalisation that it is only suffixes with back vowels that block spirantisation. In addition, it is also necessary to work out some formalisation of the spirantisations triggered by the long causative suffix *-ish-* in examples (6d-f) above, while maintaining that the regular *-i-* of the language does not cause spirantisation. This presumably leads to a fourth stratum showing that the more morphological irregularity is expressed the higher the chance is of deriving a new level or stratum.

The basic LP assumption of ordered levels is also brought into question in GP, the framework assumed in this dissertation, which takes phonology to be a function that applies at a single level and in addition assumes that all derivations are subject to the minimalist hypothesis (Kaye 1995), which states that 'processes apply whenever the conditions that trigger them are satisfied'. The minimalist hypothesis implies that derivations are unaware of the history or future of any derivation in which they are involved. This implies that in the analysis sketched in (12), the disparity between the first and second application of phonology, with the causative -į- only absorbed in the second application, producing *pish-ish*, and not in the first, where *pish-į-* is produced, is not a possible option. Thus under GP assumptions, there is no position between a spirantised stem and a causative morpheme to infix the applicative so that it undergoes spirantisation, since spirantisation results in total absorption of the causative morpheme.

Hyman's second assumption of a spirantising -į- morpheme in Hyman's analysis implies an underlying seven-vowel system, since the surface high front vowel does not cause spirantisation as illustrated in the examples with the applicative. The surface five phonetic vowels can be derived by absolute neutralisation of the Proto-Bantu /į/ and /ų/ in all contexts. This is, however, contrary to the orthodox view of neutralisation (Kiparsky 1968) which restricts neutralisation only to specific contexts. Absolute neutralisation also raises learnability problems and leads to undesirably opaque phonological systems since the input representation is difficult to recover from the output. It is thus desirable to account for the spirantisation facts with the view that both the underlying and surface vowel systems consist of five vowels. Hyman also raises specific issues on Bemba morphology and phonology in support of his analysis. I review four of his arguments.

To account for the presence of /į/ and /ų/ in Bemba, Hyman argues that these vowels do not undergo height harmony as discussed in chapter (2). He cites the following examples.

(14)	verb		root+caus.		root+caus.+pass.	
a.	end-a	'walk'	ensh-į-a	'walk (transitive)'	ensh-į-w-a	'be walked'
b.	ónd-a	'be slim'	onsh-į-a	'to slim'	onsh-į-w-a	'be slimmed'

Thus, for Hyman, the causative /į/ fails to undergo vowel harmony in the final column of (14a-b) because it is prespecified as [+high] while the spreading feature in /e/ and /o/ is specified as [-high]. The vowel harmony feature only affects vowels that are unspecified, here /i/ and /u/. The first issue we can raise is to do with the forms of the *root+caus*. as containing the causative morpheme -*į*-. The causative in all such cases has been totally absorbed in Bemba and only the outputs [enʃa] and [onʃa] are possible. Thus the /į/ in the *root+caus.+pass.* forms, is not part of the causative but of the passive. Bemba is not unique in Bantu, in having two forms of the passive suffix -*iw*- and -*w*-. We naturally need to explain why the long passive fails to undergo vowel harmony, and we return to this point in chapter 5, but this is irrelevant to the causative morpheme /į/ in Bemba.

Secondly, Hyman argues that because the causative always precedes the applicative in Bemba, applicative forms of frozen causatives such as *posh-a* 'greet' (historically derived from *pola* 'be well after an ailment') that produce *posh-esh-a* 'greet for' are evidence for postulating interfixation of the applicative. Again this relies on the assumption of the unavailable form *posh-į-a*. Given this argumentation, we make the prediction that the opposite effect, namely a frozen applicative followed by a causative, is not a possible morphological operation. Contrary to this, we do find causative forms of frozen applicatives; *ingil-a* → *ingish-a* 'enter/cause', *tangil-a* → *tangish-a* 'go ahead of /cause'.[110]

A third point that Hyman raises is with respect to the area of application of spirantisation, where he claims that nasals do not undergo spirantisation and block the process from applying across them. Thus in (15) the form in the final column with spirantisation of the root-final consonant is ungrammatical according to Hyman (1995: 90). This is not the case: nasals are palatalised to /ɲ/ in the process of spirantisation and do allow spirantisation to apply across them. In (15a) two forms of a causativised reciprocal are possible with different scope readings, while in (15b) and (15c) only the form with spirantisation of the root-final consonant is possible.

[110]As far as I can see, these data do not bear on suffix order if we consider the frozen forms to be lexicalised, as can also be seen from their meaning; *posh-a* 'greet' and *ingil-a* 'enter'. Being lexical items, they can be affixed with any suffix. These examples will fall under the notion of derived root discussed in chapter 5.

(15)	verb	root+recip.	root+recip.+caus.	
a.	pál-a	pál-an-a	pál-any-a ~	pash-any-a
	‘resemble’	‘resemble e.o.’	‘A make B and C resemble e.o.’ ~ ‘A and B make e.o. resemble e.o.’	
b.	sel-a	(*sel-an-a)	*sel-any-a	sesh-any-a
	‘move’		‘make e.o. move about’	
c.	lub-a	lub-an-a	*lub-any-a	lufy-anya
	‘be lost’	‘not know e.o.’	‘cause to lose e.o.’	

An important observation that must be made about multiple spirantisation in the causative is that roots are divided with respect to whether they are spirantising or not. The blocking effect of any suffix can therefore only be illustrated if the verb root used is a spirantising one. Thus, in (15a-c) *pasha* ‘make look alike’, *sesha* ‘make move’ and *lufya* ‘lose’, are all licit forms. Thus Hyman’s use of verb forms like *punk-an-į-a*/**punsh-an-į-a* (‘bump into each other’) or *pet-an-į-a/*pesh-an-į-a* (‘be entangled’) as illustrating the blocking effect of the reciprocal, is not adequate because both the verbs *punk-a* ‘bump into’ and *pet-a* ‘fold/coil’ are non-spirantising (**punsh-a*, **pesh-a*).

Finally, Hyman claims that some verbs cannot take the causative *-į-* directly and require what he refers to as an ‘intermorph’ to separate the causative and the verb root which itself fails to undergo spirantisation because the ‘intermorph’ does not allow spirantisation across it. Consider the data in (16).

(16)	verb		root+intermorph+caus.	
a.	imb-a	‘sing’	imb-is-į-a	‘make sing’
b.	sek-a	‘laugh’	sek-es-į-a	‘make laugh’

We have already characterised forms such as these as containing the regular form of the causative suffix *-ish* (recall the data in (4)). There is thus no need to postulate an intermorph, which cannot be motivated semantically and whose role in the remainder of the language is doubtful. Notice also that Hyman’s analysis would be unable to account for spirantisation in the long causative.

Let us now look at an alternative approach offered in Optimality Theory.

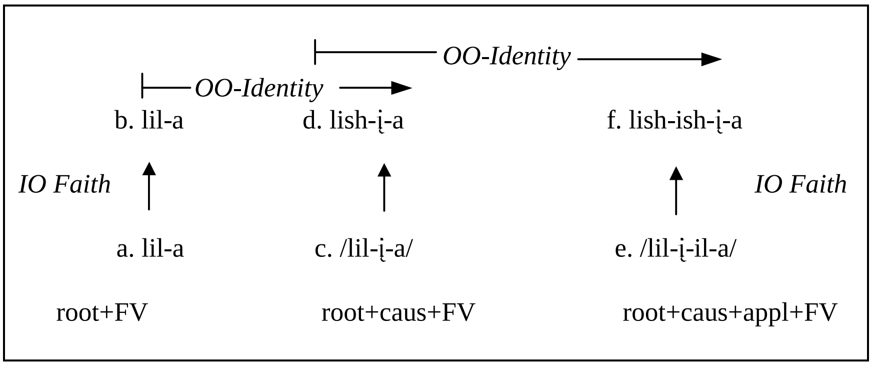
4.3.2 Benua’s Correspondence Theory approach

Within the framework of Optimality Theory (Prince and Smolensky 1993, McCarthy and Prince 1993b, 1995), Benua (1997) develops a trans-derivational correspondence theory dubbed Output-Output correspondence, where words are derived in a parallel grammar, without intermediate stages. Optimality Theory (OT) views the grammar as a hierarchy of universal well-formedness constraints. OT recognises one level of derivation that involves inputs and outputs. An output is a structure that minimally violates the language-particular constraint ranking. An input is an underlying form that is initially derived from surface forms by principles of the grammar during language acquisition. Constraint interaction is the central tool of operation in OT. Constraints set targets or goals for inputs and when these goals conflict, one goal takes precedence over another. This priority amongst competing goals is modeled as a ranked priority of constraints. Thus for a given input, a set of candidate outputs is generated and evaluated against a language specific constraint ranking. The candidate output that best satisfies the ranking, by violating the fewest, highest ranked constraints is selected as the optimal or actual surface form. Constraints fall into two main groups, markedness constraints and faithfulness constraints. Markedness constraints demand well-formedness in structure, while faithfulness constraints militate against deviation from lexical forms. All constraints in OT are restrictions on output representations. A fundamental premise of OT is that constraints are supplied by universal grammar, and that language-particular grammars result from different rankings of the universal output constraints. The set of possible inputs is also universal and any possible input structure fed into a language particular grammar gives rise to a well-formed output in that language. This is referred to as the *Richness of the Base*. Since inputs are unrestricted, several possible inputs may converge on the same output representation. Prince and Smolensky (1993) suggest that speakers resolve this indeterminacy in the acquisition of language by *Lexicon Optimization*, whereby learners choose the output that least violates high-ranking constraints, in the mapping to the actual output as the lexical representation.

Richness of the Base is important to Benua’s OO-correspondence theory, because it implies that misapplication of identity effects in paradigms can only be produced by constraints that compare two surface representations. Correspondence Theory, as stated by McCarthy and Prince (1995), holds that candidate sets are provided with correspondence relations between elements in related strings, i.e. according to Benua, between segments in a pair of words in a paradigm. Correspondence identity between two segments is enforced by ranked and violable constraints. Universally, faithfulness to root material takes precedence over faithfulness to affixal material: Root-Faith » Affix-Faith. OO-correspondence is an extension of correspondence relations between input-output and base-reduplicant pairs developed in McCarthy and Prince (1995). Benua argues that there is an OO-correspondence relation linking words across their individual input-output correspondence. Each output word is linked to an input by an IO-correspondence relation (IO-Faith), and the pair of words are related by OO-correspondence (OO-Identity). Each affix or morphological operation invokes an OO-correspondence relation; thus in multiply affixed words, as seen in the Bemba spirantisation, the increasing morphological complexity of the verb is reflected in the phonological paradigms that are constructed in a linear array as shown in (17) below. The identity relation triggered by the morphological derivation holds between the derived word and an output base. OO-correspondence relations are the phonological reflex of a morphological relation between two words. The grammar evaluates pairs of words that exist in a paradigm where each member of the paradigm is a fully formed actual word of the language. Under this view, the spirantisation cases in Bemba can be treated as the copying of an inflected base as illustrated in (17).

(17) Spirantisation as OO-correspondence

OO-IDENT (strident) » IO-FAITH (strident)



When OO-Identity constraints take precedence over markedness requirements or faithfulness to the underlying form, phonological processes over-apply. If, on the other hand, OO-Identity constraints are dominated by markedness, phonology applies as expected and the identity of paradigmatically related forms is reduced. The unit of evaluation in OO-correspondence is a paradigm where the paradigmatically related words are available to the phonology at the same time. Thus in (17) the OO-correspondence relation between (17b) and (17d) is evaluated separately from the correspondence relation between (17d) and (17f). The OO-correspondence relations depicted in (17) for Bemba are captured under the partial ranking given above the table, where OO-Identity (as well as markedness) dominates IO-Faith with respect to stridency between outputs. In multiple affixation such as this, the language particular constraint hierarchy is duplicated and the recursions of these duplicated hierarchies are ranked with respect to one another so that the base is evaluated against a higher ranked recursion than the derived word. This enforces a “bottom-up” character of word formation.

Summing up, (17) represents a linear array of a paradigm where the input (a) has an IO-correspondence relation with (b), and in the same spirit, input (c) has an IO-correspondence relation with (d). The output base (b) has an OO-correspondence relation with the derived output (d) that is evaluated under the ranking OO-Ident » IO-Faith. We assume that there are other constraints that play a role to ensure that base (b) does not force output (d) to lose its strident segment. In the next paradigm, (e) has an IO-correspondence relation with (f), and (f) has an OO-correspondence relation with (d). Here the dominance of OO-Ident makes underlying *lil-* (root of ‘cry’) in (e) undergo spirantisation, producing the multiply spirantised output (f), even though one instance of spirantisation is not phonologically conditioned. Benua assumes, like Hyman, that the applicative affix is infixed between the root and the causative, so (17e) only serves to show that an additional suffix is added.

Accepting Benua's analysis of spirantisation entails a commitment to the assumptions of OT and in particular of OO-correspondence. There are basic assumptions such as the universality of constraints, the limitless set of possible inputs, the generator GEN that, based on our view of the architecture of the grammar, we may question. More specifically, Hale, Kissock and Reiss (1997) have raised objections to the validity of OO-correspondence and are sceptical about introducing such a powerful tool into the phonology. Imposing a relation between outputs in a paradigm involves a 'looking back' mechanism, particularly for all over-application cases, even though Benua (p.c.) denies this. In over-application, the first member of a paradigm (17b) imposes its shape on the second member (17c). Conversely this means that (17c) fails to surface based on its input, but rather looks back to the previous output to influence its structure.

Apart from the fact that like Hyman, Benua needs to make reference to a causative morpheme as a concrete entity in order to obtain the derived environment for spirantisation, the correspondence theory approach also makes wrong predictions with respect to the data given in (13) concerning spirantisation in the separative. As seen in these data, the separative suffix *-uk-* never allows its verb root to undergo spirantisation even if it is a spirantising verb. Thus, *sel-uk-a* 'be knocked over' + causative → *sel-ush-a* (**sesh-ush-a*), despite the grammaticality of *sesh-a* 'cause to move'. Since the causative *-į-* starts out in a position adjacent to the root (*sel-į-uk-a*) in Benua's analysis, we would expect spirantisation of the root-final consonant. In the same vein Benua's analysis makes wrong predictions for languages like Runyankore and Kirundi that do not have over-application effects (cf. example (11a): koz-ile → kol̲-iz̲e * koz̲-iz̲e). OO-correspondence would predict the multiply spirantised form as optimal. Output-output correspondence is therefore too strong for these forms. Let us now consider a morphological approach as proposed in Downing (2001).

4.3.2 Downing's Morphological approach

Downing (2001) develops an analysis of spirantisation effects in Bantu with particular reference to Jita (E.25) in a morphological approach, arguing that the suffixes that trigger spirantisation are in a different morphological position than those that do not. Downing compares the agentive and the causative suffixes to the applicative and the perfective suffixes, where the former two trigger spirantisation and the latter two don't. Downing divides the Bantu verb structure (18a) into p(honological)-structure that correlates with m(orphological) structure, although it is not necessarily isomorphic to it. Downing's structure is given in (18b). Similar structures have been proposed in Hyman (1998) and Hyman and Inkelas (1997).

(18) a.

Inflected stem
(I-stem)

Morphological derivational stem (M-Dstem) — Inflectional final suffix (IFS)

Root — Derivational suffixes

b. [[[[(C)VC]$_{\text{PRoot}}$ (VCVCVC)] $_{\text{PDStem}}$ (G)V]$_{\text{PStem}}$] $_{\text{I-Stem}}$

From (18b) Downing defines a P-D(erivational) stem as consisting of the string from the initial segment of the M-Dstem to the final consonant of the I-stem in (18a). In this structure, the position of the spirantising suffixes is outside the P-Dstem. This gives the domain structures in (19) for the spirantising and the non-spirantising suffixes. I use the Bemba examples that are by now familiar. I also give one of the now lexicalised agentive nouns for illustration. In (19a) *umuβomfi* 'worker' is derived from the verb *βomb-a* 'work', the verb *lil-a* 'cry' is used in (19b) and (19c).

(19) spirantising suffixes

a. agentive -i [[[umu-βomf] $_{\text{MDStem}}$] $_{\text{PDStem}}$ -i] $_{\text{I-Stem}}$
b. causative -į- [[[lish] $_{\text{MDStem}}$ -i] $_{\text{PDStem}}$ -i-a] $_{\text{I-Stem}}$

non-spirantising suffixes

c. applicative -il- [[[lil-il] $_{\text{MDStem}}$] $_{\text{PDStem}}$ -a] $_{\text{I-Stem}}$
d. perfective -ile [[[lil] $_{\text{MDStem}}$ -il] $_{\text{PDStem}}$ -e] $_{\text{I-Stem}}$

According to (19a) and (19b) the spirantising agents are not part of the PDstem and this causes spirantisation as opposed to (19c) and (19d), where the high front vowels of the applicative and perfect are part of the PDstem. Downing defines spirantisation as marking an important prosodic edge, the PDstem. Although Downing evokes morphological structure as salient for the definition of PDstems, it seems to me that the choice is based on the phonological shape of the suffix, in line with the generalisation proposed in chapter 2, that verbal bases are consonant-final. Finally, the long causative *-ish*, which also triggers spirantisation in Bemba, would be placed within a PDstem. This is not in itself bad, but requires a new trigger of spirantisation to be established, under the present assumptions. Downing's analysis is interesting because it places the trigger of the phonological process outside the phonological domain. My analysis will make the opposite claim, namely that a phonological domain defines a unit of phonological activity and thus the spirantisation agent must be contained within it. I am however in total agreement with Downing's view that the PDstem (my phonological domain) does not include the final vowel. The difference between assuming the spirantisation trigger to be inside or outside of the phonological domain that it affects, is that in the former case, we expect only edge effects in which case multiple spirantisations will imply application of the causative trigger at each phonological domain boundary. In the latter view, where the causative trigger is contained within the phonological domain, we predict its effects to affect the whole domain, i.e. spread through the domain in the case of a spreading element (I). The extent of I-spread will thus define the phonological domain. We return to this presently.

Downing argues, in line with Hyman (1994), that causative doubling cannot be treated as a purely phonological rule of palatal harmony. According to Downing, a rightward spread rule would predict that any palatal glide should trigger palatal harmony. And conversely, leftward palatal harmony, which has the causative in its semantically motivated position, makes wrong predictions for the Jita data that she deals with, because the palatal glide fails to trigger palatal harmony in all sonorants to its left. Downing's argumentation relies on the fact that the causative is the glide /y/ in Jita. In this case we may want to posit a real causative doubling analysis. If we consider the trigger of spirantisation in the causative to be some feature (I) that associates to the verbal complex from either the left or the right, then we restrict palatal harmony to this feature alone. My proposal, given in section 4.4.3, will consist of leftward spread of the element (I). In Bemba this (I)-spread is only blocked in very specific environments when suffixes containing /u/ are present. Consonantal mutation in the causative is only possible if the element (I) is fully absorbed into the target segment. Lack of full absorption due to incompatibility of elemental compositions results in gliding as seen in the forms *luba* → *lufya* 'be lost/lose'.[111]

We have seen that while the Lexical Phonology, Output-Output correspondence and morphological approaches are possible analyses of the spirantisation process and no doubt shed light on the intricacies of the effects of the over-application of the causative, there are a number of improvements that can be made. There are three outstanding issues. The first concerns the phonological and phonetic status of the short causative, which cannot be the now lost /i̯/ of Proto-Bantu. The second concerns the characterisation of spirantisation in the long causative; how can this be related to the short causative? And the third concerns the blocking effect illustrated by the separative suffixes. In the following section, I propose an analysis that addresses these issues while trying to account for other Bantu languages such as Runyankore and Kirundi, where spirantisation is limited to the base-final consonant.

[111] Historically, spirantisation in Bemba was probably a purely morphological rule of causative doubling. My claim is that the present day data reflect that spirantisation has been reanalysed as a purely phonological rule that is triggered in causative forms. It is also for this reason that restricting the causative to beginning in its semantically motivated position, whatever that may be, is irrelevant to its expression in a multiply spirantised domain. Jita, where the causative -*y*- is a distinctive morpheme, may not yet be at this stage. In more recent work, Downing (2002) presents an analysis of causative doubling in Jita that treats the process as a Paradigm Uniformity effect.

4.4 Spirantisation in GP

I will claim that in Bemba the long causative suffix that consistently fails to spirantise the root-final consonant constitutes analytic morphology, where the root forms an internal phonological domain to which suffixes attach. The short causative, on the other hand, which triggers spirantisation of the stem-final consonant will be treated as constituting non-analytic morphology, which implies one phonological domain between the root and its suffixes. This idea is illustrated in (20) below, where the square brackets indicate phonological domains.

(20)	stem+caus	stem+ appl+caus	
a. long causative	[[le:mb] esh-]	[[le:mb] esh-esh-]	‘make write for’
b. short causative	[lish-]	[lish-ish-]	‘make cry for’

The illustration in (20) implies that for a hearer who perceives the input (20a), their understanding of this verbal base relies on their phonologically parsing the internal root and then the suffixes that follow, as opposed to (20b) where their parsing device only recognises one phonological chunk: hence no bracketing derivation. The remainder of this chapter will be dedicated to defending this view by giving motivations for these domain distinctions from an account of the spirantisation effects in Bemba.

The most important assumption in Bemba phonology for this purpose, also discussed in chapter 2, is the fact that all morphological and phonological domains must end in a consonant in order to make it possible for the obligatory final vowel /a/ to attach to this domain. Addition of the FV produces a pronounceable unit that is licit in the strict CV syllable structure of Bemba.[112] Since the FV is excluded from active phonology, processes are restricted to the root and its extensions to produce a consonant-final output. In the unmarked case I assume that the root forms an independent phonological domain. Thus, when the long causative *-ish-*, that has a -VC- shape, is added to the root, it does not result in a violation of the requirement for a base-final consonant, and it also allows the root to retain its integrity, resulting in the postulated domain structure in (20a). In addition, in morphologically complex stems of the long causative, the root retains its integrity because the autonomy of the root cannot be lost once it has been established. I return to this point below.

The short causative on the other hand, which marks all causative forms by spirantisation of the root-final consonant cannot be regarded as existing segmentally independently of the root since only its effects surface. The short suffix therefore forms a single domain with the root and we must assume from this that its structure is either (a) one that cannot be suffixed to the root or (b) one that would result in the violation of a consonant-final base if it were suffixed to the root. We return to this distinction presently. Crucial in the spirantisation effects of the short causative is

[112] I only use the term ‘syllable’ here in traditional reference to the type of segmental sequences allowed in languages. We have already seen in chapters 2 and 3 that the only relevant units in GP are Onset-Nuclear pairs since GP does not recognise syllables.

that in morphologically complex stems only one phonological domain is visible because the autonomy of the root cannot be recaptured once it is lost. We can therefore formulate the generalisation that as long as suffixation processes result in analytic morphology, the root retains its integrity but if suffixation is non-analytic, then the root is never autonomous. This explains why spirantisation cases of the long causative in morphologically complex stems never access the root-final consonant (cf. examples in (6d-f)). We can thus conclude that the shape of the suffix, which indicates the type of suffixation process selected, entails whether or not a root retains its autonomy in phonological processes, i.e. whether it is analytic or non-analytic.

I will present two possible analyses of the spirantisation effects in GP in order to motivate my preferred analysis. I have already expressed my scepticism of considering the short causative to be the Proto-Bantu /į/, as this vowel is no longer available in the language. From the spirantisation and particularly the palatalisation effects of the causative on nasals; /n, m/ become /ny, my/, respectively, I assume, in line with traditional literature that the short causative consists of a high front vowel, but contend that this vowel must be identical to the high front vowel in the present day five vowel system of the language.

4.4.1 The short causative as an H-licensor

In this section I develop a putative analysis of spirantisation involving H(ead)-licensing. Despite the appeal of this approach, I will reject it in favour of an analysis that models the causative *-i-* as a floating segment. Consider first, though, the h-licensing approach.

Any analysis that treats the short causative as the high front vowel of the language faces a representational problem with respect to the short causative in segmental structure. If it is regularly represented in a skeletal position dominated by a nucleus, then we have to assume that its effects are not triggered from this position since suffixes such as the applicative *-il-* do not trigger spirantisation. This gives scenario (b) described above, where the structure of the causative results in a violation of a consonant-final base. This is shown in (21a). Under this assumption the spirantising vowel delinks from its skeletal position, as shown in (21b) with an extended base, and attaches to the preceding onset that it licenses, thereby resulting in spirantisation of the segment dominated by the onset. In addition, we can postulate that the spirantising vowel in N_3 charges N_2 with spirantising ability so that the double and multiple spirantisation effects are accounted for. Formally, this can be represented by the notion of h(ead)-licensing in GP.[113] Following h-licensing, the causative *-i-* can be regarded as dominated by a headed position represented in (21b)

[113] H(ead)-licensing was initially used in GP to account for ATR harmony effects: ATR vowels are represented by headed phonological expressions (PE's) while their non-ATR counterparts are represented by unheaded PE's. The shift of non-ATR vowels to ATR in a domain when suffixation with an ATR vowel containing suffix occurs, is accounted for by h-licensing (Kaye 1982), whereby the previously unheaded segments become headed and hence ATR.

by a bold and underlined skeletal point (N_3).[114] N_3 h-licenses the nucleus in N_2 causing it to dominate a headed phonological expression, i.e. make the (I) element of the vowel of N_2 headed. Spirantisation will have to be considered as the spreading of a headed (I) element. The headed element now in N_2 thus spreads into the onset to its left (O_2) explaining the double spirantisation effect in (21b). This accounts for why the separative suffix *-uk-*, which lacks an (I) element to act as host of the h-licensing process, blocks spirantisation. The /a/ of the reciprocal suffix *-an-* would have to be treated as empty, following its distribution in word-final position and its lack of harmonisation in the mid-vowel harmony of Bemba. (Square brackets in the phonological structure are used to mark phonological domains).

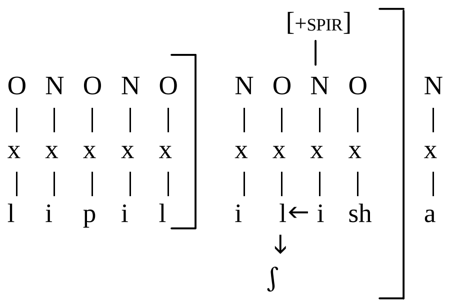
(21) a. lil-i- ROOT 'cry'+ caus. b. lil-il-a → lish-ish-a 'make cry for'

```
a.                                   b.   h-licensing
                                                                 
* O  N  O  N ]  N                    O1 N1 O2 N2 O3    N3 ]  N4
  |  |  |  |    |                    |  |  |  |  |     |     |
  x  x  x  x    x                    x  x  x  x  x     x     x
  |  |  |  |    |                    |  |  |  |        ‡     |
  l  i  l  i ]  a                    l  i  l ← i l     i  ]  a
                                           ↓     ↓
                                           ʃ     ʃ
```

An analysis of spirantisation as a consequence of h-licensing requires that we reconsider our representation of the high vowels of Bemba, which we have presently characterised as headed (cf. chapter 2). Otherwise, we would expect all front high vowels of the language to trigger spirantisation. We could instead assume that N_3 licenses N_2 for the additional process of spirantisation as per *Licensing Inheritance* (cf. discussion in chapter 3 on different licensing tasks), in which case we can assume there is a causative morpheme in the lexicon listed with the diacritic 'spirantisation' that is able to license other nuclei with this quality. However, the major problem of differentiating between a spirantising and a non-spirantising *-i-*, while maintaining a uniform representation of the high front vowel, remains. There is also the additional problem of trying to extend this analysis to the long causative where the only possible solution will be to assume that the *-i-* of the long causative *-ish-* also has the spirantising effect and is also listed in the lexicon with a diacritic to this effect. The process would then proceed as in (22) in the long causative.

[114] In Kula (1997) I argued for a version of h-licensing where the h-licensor is lexically specified by a headed position in the phonological representation. A segment that is dominated by a headed position is headed and can thus act as an h-licensor.

(22) lipil-il-ish-a → lipil-ish-ish-a ‘make pay for’



Perhaps the greatest drawback of this analysis is that it almost re-imports the seven vowel system by distinguishing between a headed (spirantising) versus a non-headed (non-spirantising) /i/. We are thus back to the assumption of two high front vowels in the language.

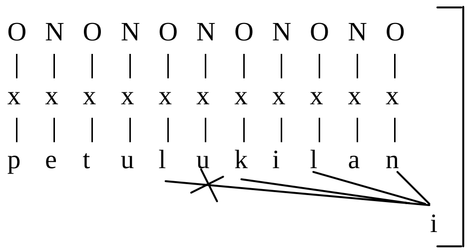
Let us look at an alternative analysis from scenario (a) where the short causative, owing to its structure, cannot be suffixed to the root.

4.4.2 The short causative as a floating segment

This alternative view involves considering the short causative as a floating segment that has no representation in constituent structure.[115] As a floating segment with no surface realisation, it relies on the root-final consonant to be realised. This accounts for why the causative forms a joint domain with the root and by so doing satisfies the requirement for obligatory consonant-final bases. The multiple spirantisation in morphologically complex stems can, under this view, be explained as illustrated in (23) where the floating /i/ spreads leftwards through the whole domain.

(23) short causative as floating *-i-*:

pet-uluk-il-an-a → pet-ulush-ish-any-a ‘make unfolded for each other’



I-spreading

[115] Cf. Rennison (1999) for a discussion of floating melodies in Koromfe, where a floating vocalic melody attaches to another vowel without any increase in length, thus *dɔ kʊ a pesu* → *dɔ kɔ pesu* ‘he kills a sheep’. The article /a/ is a floating melody here.

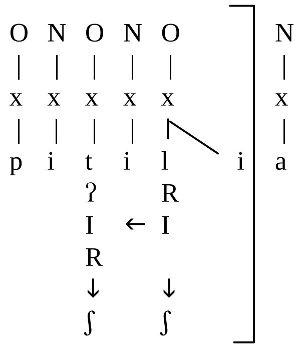
Since the floating suffix is not part of constituent structure it is surprising that the /u/ of the separative blocks its spread through the domain. If we can explain this as a restriction on /i/ crossing over /u/ because they reside on the same tier, as is assumed in standarg GP, then it is also surprising that the /i/ of the aplicative *-il-* does not block the floating /i/ from spirantising /k/. In addition to this irregularity, there is no obvious way of connecting the spirantisations caused by the floating /i/ to those of the long causative. Like in (22), we would have to assume that the vowel in *-ish-* triggers spirantisation, in which case we lose the distinction between spirantising and non-spirantising /i/ gained by assuming a floating segment. I therefore endorse the idea of a floating segment but argue that its effects are triggered in a different way to that expressed in (23). I turn to this presently.

4.4.3 The short causative in a non-analytic domain

The two GP analyses presented so far have two major attractions. In the latter analysis, the representation of the short causative as a floating segment allows only its effects to surface. And in the former analysis, a direct way of incorporating the opacity of /u/ in the separative suffix is possible. I retain both these ideas in some respect but shift the burden of spirantisation from the vowel to consonants.[116] The main reasoning behind analyses such as the one depicted in (21b), or those incorporating infixation, is the need for adjacency between the triggering vowel and the affected consonant. I take a somewhat reversed and not usually assumed position that, although the process is triggered by a vowel, it can be traced through the domain by consonantal interaction. Taking the short causative as represented by a floating /i/, which attaches to the root-final consonant in order to be realised and thereby spirantises this segment, further spirantisation proceeds from the spirantised segment by (I) spreading leftwards, as shown in (24a). This characterisation of spirantisation is easily extendable to the long causative since the phonological expression (PE) of [ʃ (h.I)] in Bemba, given in the consonantal chart in chapter 2 above, contains an (I) element that, as illustrated in (24b), spreads leftwards through the vowel to the preceding consonant. My claim is thus that the process involves a form of consonant harmony where spirantised consonants trigger spirantisation in consonants that occur in their domain.

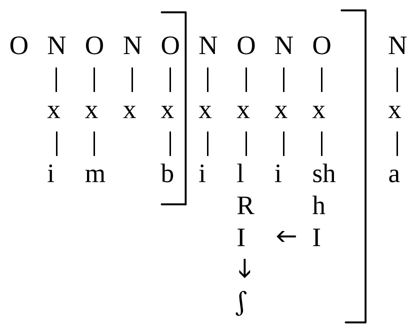
[116] A version of the analysis that follows was presented in Kula (2000a, b).

(24) a. short suffix: pit-a ‘pass’ → pish-a *and* pit-il-a → pish-ish-a



In simplex roots, the floating causative attaches to the root-final consonant in the same manner as shown for the applicative suffix in (24a). As already stated, the short causative forms a non-analytic domain with the verbal base or root and as such always results in spirantisation of the root-final consonant. The initial consonant in the verb never spirantises. This can be related to the strength required in the initial onset as seen in the phonotactics of Bemba where consonantal strength diminishes towards the right edge of the verbal complex (cf. Sharman 1963). Apart from a diachronic palatalisation process that changed all initial /k/ to /ts/ before {e, i}, we only see the hardening of /l d/ before a nasal prefix in initial position (see discussion in chapter 3, section 3.4.3). This follows from the head-initial phonological domain postulated for Bemba, i.e. the head nucleus in initial position is able to license any onset in its ON pair. Consider now the representation of spirantisation with the long causative in (24b).

(24) b. long suffix: imb-a ‘sing’ → /imb-ish-a/ and /imb-il-a/ → /imb-ish-ish-a/



(24b) shows a parallel process of spirantisation to (24a), with the long causative. In this case, the root-final consonant remains inaccessible throughout the derivation, due to the visible phonological bracket that demarcates the autonomy of the root in analytic morphology. We can thus uniformly account for spirantisation both with the short and the long causative as a consonant harmony process that spreads an (I) element leftwards from spirant consonants.[117] The direction of spreading here is in contrast to vowel harmony, which proceeds from left to right. We could pursue a left to right spreading analysis of spirantisation so as to ensure uniformity in spreading processes in Bemba, in which case a root-final consonant spirantises following consonants of the base. However, data with the blocking /u/ would be problematic and require de-spirantisation of the root-final consonant and skipping of another consonant before spirantisation applied. There is very little motivation for such processes.

The right to left consonant harmony process described here is not unique and can be seen in other Bantu languages such as Kinyarwanda (Kimenyi 1980), where a palatalisation process palatalises the fricatives /s z/ before syllables containing palatal fricative consonants. Consider (25) below.

(25) Kinyarwanda

a.	ku-baaz + iiš- →	ku-baž-iiš-a	'to carve with'
b.	gu-saas + iiš- →	gu-šaš-iiš-a	'to cause to make'

In (25), *-iiš-* represents a causative suffix that palatalises the root-final consonant /z/ in (25a). Contrary to Bemba spirantisation, palatalisation in Kinyarwanda also extends to the first consonant of the root by a proces of palatal harmony (25b). *Ku-* and *gu-* are infinitival prefixes that are subject to Dahl's Law.[118]

Outside of Bantu, Applegate (1972:15ff) discusses similar data to the multiple spirantisation process that involve sibilant harmony in Chumash an American-Indian language, where the third person subject prefix *s-* is changed to /š/ if it is attached to stems containing the sibilant /š/. Consider, *s+ ixut* → *sixut* 'it burns', but *s+ilikš* → *šilikš* 'it is soft'. Notice, however, that these processes as opposed to the Bemba case, are limited to sibilant coronals.

Coming now to the blocking effect of the separative suffixes, I assume that this effect follows from the vowel quality of the suffix. The vowels /i e a/ are transparent to the process while /o u/ are opaque. This distribution can be explained by the fact that, because /i/ and /e/ already contain an (I) element, they remain unaffected by (I) as representations with identical elements are barred in GP. With respect to /a o u/, as we have already seen in the discussion of vowel fusion in chapter 2, (I) is never the harmonising element - all fusions result from the rightward linking of (A). In addition, the vowel system of Bemba also shows that (I) and (U) never combine

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[117] As will be discussed in section 4.5 and already alluded to in section 4.1, languages that have undergone 7-to-5 vowel reduction exhibit total absorption of the causative *-i-* that results in strident fricatives that are not part of the reconstructed PB consonantal system. Given this co-relation between vowel reduction and the emergence of strident fricatives we can treat vowel reduction as following from the absorption of the causative *-į-* and that the resulting spirant fricatives contain this absorbed spirantising feature: hence the transfer from an originally vowel triggered process to a consonantal harmony.

[118] As stated in chapter 3, Dahl's Law is a voicing dissimilation process that voices the first consonant when two successive syllables begin in voiceless consonants.

because they must both be head in complex expressions.[119] Leftward (I)-spread thus leaves /a i e/ unaffected. I will take it from this that (I) is unable to spread across (U), resulting in the blocking of spirantisation. Again, such a blocking effect is standard in GP where (I) and (U) are treated as residing on the same tier.

We have seen how spirantisation can be accounted for as a form of I-harmony between consonants that is blocked by back vowels. The thrust of the analysis relies on a differentiation in phonological representation of the segment /i/, so that the constituent structure assumed dictates the phonological process that follows, or lack thereof. This means that only a floating (I), by virtue of its structure, can anchor onto another consonant, as this is the only means of realisation it has. The (I) in the long causative *-ish-* on the other hand, does not have an anchoring option available since it is part of a -VC- unit which, when suffixed to a root will result in the desired consonant-final base. The other option parallel to the floating (I) is of course an (I) with constituent structure. We will investigate this option in the discussion of imbrication in chapter 5 and see what the phonological consequences of such a representation are.

The multiple spirantisation seen in both the short and the long causative illustrate phonological interaction between the suffixes and hence supports no bracketing derivation. From a production point of view, the verb root is accessed from the lexicon and then in the case of the analytic long causative, the verb root retains its phonological domain thereby producing two domains in the final output, i.e. the root domain and the d(erivational)-suffix domain. In the case of the non-analytic short causative, the verb root loses its autonomy and produces one phonological domain that fuses the root and following suffixes, in the final output form. These phonological domain characterisations follow directly from the domain of I-spread.

Let us now see what a characterisation of spirantisation as triggered by a floating segment that docks onto a domain-final consonant, tells us about the distribution of spirantisation across Bantu.

4.5 Predictions for Bantu spirantisation distribution

The distribution of spirantisation across Bantu, particularly as described by Labroussi (1999), ranges from languages with partial to full spirantisation, as shown in (3) above. A closer investigation shows that seven-vowel languages, i.e. those that have not undergone reduction, generally have spirantisation which, crucial to the phonological representation point being made here, does not involve full absorption of the triggering vowel /ị/. Consider (26) below. [120]

[119] This is also true in the consonantal system and explains why labials, which contain (U), fail to undergo total absorption of (I) and thus produce /fy/.

[120] The Nyakyusa data and Safwa data are from Labroussi (1999), Kinga data are from Wolf (1905) and Schadeberg (1973b), Holoholo from Coupez (1955).

(26)

	causative -i̯-					
a.	sook-a	'come out'	→	soos-j-a	'take out'	(Nyakyusa)
b.	dzoŋg-a	'escape'	→	dzons-j-a/ dzoos-j-a	'make disappear'	(Nyakyusa)
c.	gul-a	'buy'	→	guz-j-a	'sell'	(Safwa)
d.	teeg-a	'get lost'	→	teez-j-a	'lose'	(Safwa)
e.	lil-a	'cry'	→	lis-j-a	'make s.o. cry'	(Holoholo)
	agentive -i					
f.	tendeeɾ-a	'to spy'	→	ʋntendees-i	'a spy'	(Nyakyusa)
g.	paap-a	'bear a child'	→	ʋmpaaf-i	'parent'	(Safwa)
h.	pond-a	'forge'	→	ʋmponz-i	'ironsmith'	(Kinga)

There is no spirantisation with *-ile*/*-iɾe* in Kinga (G.65), Safwa (M.25), Holoholo (D.28), and Nyakyusa (M.31). In (26a-e) the spirantisation triggering causative suffix *-i̯-* changes the root-final consonant to the spirant /s/ that has a remnant off-glide (/j/ here represents the glide /y/), while in (26f-h) the agentive suffix *-i* retains its shape. The important observation to be made here is that both the causative /i̯/ and agentive /i/ can be identified in the resulting form. Since these are seven-vowel languages, each of the seven vowels have constituent structure, meaning that they are represented in a nuclear position. The causative triggering *-i-* is therefore not a floating segment in these languages and for this reason fails to be totally absorbed despite triggering spirantisation. The structure assumed here must involve a doubly linked segment between the spirantising nucleus and the onset that undergoes spirantisation. Since there is no spirantisation with the perfect suffix *-ile* we can conclude that this presents the second /i/ vowel of the language. The differentiation between /i/ and /i̯/ in these languages is usually one of tense versus lax.

For five-vowel system languages, two different groups can be recognised: those with extensive or full spirantisation, and those with limited spirantisation, where only the causative acts as the trigger of spirantisation. In the first case, where full spirantisation occurs and the perfect *-ile*, causative *-i-* and agentive *-i-* all trigger spirantisation, we can give these a uniform representation in constituent structure and expect that these languages will generally not select absorption for the realisation of the causative. In the few cases where they do, we predict that this is not from an underlyingly floating segment. Consider the data in (27).[121]

[121] The Inamwanga data are from Busse (1940), Lungu data are from Kagaya (1987) and Nyiha data are from Labroussi (1999).

(27)

	causative -į-				
a.	ik-a	'come down'	is-j-a	'take down'	(Inamwanga)
b.	kal-a	'buy'	kaz-j-a	'sell'	(Inamwanga)
c.	oŋk-a	'suckle'	ons-j-a	'feed at the breast'	(Lungu)
d.	omb-a	'be wet'	omv-j-a	'wet something'	(Lungu)
e.	and-a	'start'	anz-j-a	'cause to start'	(Nyiha)
f.	izul-a	'be full'	izuz-j-a	'fill up'	(Nyiha)
	perfect -ile				
g.	pap-a	'carry on back'	apaf-ile	'has carried on back'	(Inamwanga)
h.	wol-a	'rot'	zjawoz-ile	'they rotted'	(Inamwanga)
i.	pit-a	'walk'	pis-ile	'has walked'	(Lungu)
j.	lol-a	'see'	loz-ile	'has seen'	(Lungu)
k.	mel-a	'grow'	βumez-ile	'it grew cl.14'	(Nyiha)
l.	zeŋg-a	'build'	twazenzenz-ile	'we built'	(Nyiha)
m.	seh-a	'laugh'	nases-ile	'I laughed'	(Nyiha)

Spirantisation in (27a-f) follows the pattern in (26), with the remnant of the triggering causative suffix still visible. The vowels of the causative and the perfect can in this case be considered identically represented.

The second group of five vowel system languages, with limited spirantisation, into which Bemba also falls, exhibit the opposite effects to those in (27). These languages have spirantisation with absorption of the causative /į/ but no spirantisation with the perfect suffix. I give an example from Ndali (M.21) (Vail 1972).

(28)

a.	pjat-a	'be sharp'	pjaʃ-a	'sharpen'
b.	βuuɾ-a	'say'	βuuʃ-a	'ask'
c.	it-ik-a	'answer back call'	it-iʃ-a	'call someone'
d.	oɣop-a	'fear'	oɣo-fj-a	'frighten'
e.	soβ-a	'be lost'	sofj-a	'lose something'

In Ndali, like in Bemba, we must consider the causative /į/ as differently structured from the /i/ in *-ile* and in particular to consist of a floating segment, which is structurally but not segmentally distinct from the /i/ in the language, since there are only 5 vowels. I tabulate these generalisations in (29). A tick indicates the presence of spirantisation and a cross its absence.

(29)

	-ile	-i	-į-	Absorption	Floating segment
7 vowel system Holoholo, Safwa, Nyakyusa	✗	✓	✓	*No*	*No*
5 vowel system Lungu, Nyiha, Inamwanga	✓	✓	✓	*No*	*No*
5 vowel system Ndali, Bemba	✗	✗	✓	*Yes*	*Yes*

In seven-vowel systems where two high front vowels can be distinguished on the surface, we expect to have no floating segment representation for the spirantising vowels and thus no total absorption. In five-vowel languages, where spirantisation is triggered in all contexts, we can consider the lone high front vowel of these languages to be the triggering agent represented in a nuclear position and thus not entailing total absorption. Finally, in five-vowel languages with spirantisation only triggered by the short causative, we predict that it has a different structure from the language's high front vowel that does not trigger spirantisation and must thus be represented as a floating segment that entails total absorption. Let us now consider the theoretical implications of the spirantisation process in Bemba.

4.6 Theoretical implications

4.6.1 Elemental representations

I have characterised spirantisation as a consonant harmony process that results from the spread of the element (I) leftwards within a phonological domain. Spirantisation is triggered by both lexical and derived spirants. Derived spirants result from the short causative, which is represented as a floating segment that triggers spirantisation of the onset to which it attaches. The lexical spirant /ʃ/ also triggers spirantisation in the same way. Spirantisation is a specific effect of the causative morpheme that cannot be generalised over the language. In GP, spirantisation entails a change in the elemental composition of the target segments and generally involves suppression of particular elements in a phonological expression (Harris 1997). Suppression is not equivalent to deletion but is rather the effect achieved by the lack of submission of an element to the acoustic cue that is directly interpreted as reduction in melodic complexity. This has the advantage of steering clear of the treatment of weakening as the random substitution of a set of feature specifications, as assumed in SPE, for example. However, due to the large number of segments undergoing spirantisation in the Bemba data discussed in the preceding sections, there are mismatches between the elemental representation of a lexical palatal spirant and palatal spirants derived from the spirantisation process. In (30) I give the phonological expressions that undergo spirantisation, i.e. the addition of (I), and the resulting representations. Angled brackets represent suppressed elements. The representation of lexical [ʃ] as given in chapter 2 is (h.I).

(30) stops: /t d k g/

a. t (ʔ.R) → (I.ʔ.R)	c. k (ʔ) → (I.ʔ)
b. d (ʔ.L.R) → (I.ʔ.R. «L»)	d. g (ʔ.L) → (I.ʔ.«L»)
fricative: /s/	liquid: /l/
e. s (R.h) → (I.R.h)	f. l (R) → (I.R)
labials: /p b/	
g. p (ʔ.U)→ (I.ʔ.U)	h. β (h.U.L) → (I.h.U.«L»)

In (30), we see the elemental representation of the segments that undergo spirantisation and the resulting PE's after the addition of the spirantising (I) element. In (30a-f), none of the derived segments yield an elemental composition that is identical to lexical /ʃ/, and yet they are all interpreted as /ʃ/. This apparent mismatch between phonological representation and phonetic output is a possible option in GP, since different PE's may identify identical acoustic cues. As Harris and Lindsey (1992: 105) point out, elemental patterns are not in themselves acoustic events but are rather to be understood as cognitive categories which are mappable onto patterns in the acoustic signal. For Bemba, then, we can identify the different PE's resulting from the spread of (I) as mapping onto an identical pattern in the acoustic signal, from which listeners and speakers decode the same sound segment, here /ʃ/. (The two ouputs of the labials also map onto an identical pattern for /fy/)[122] This follows, if we assume LC's to not only regulate the combinatorial possibilities of elements as a means of characterising language inventories, but that by defining all and only those sound segments available in a language, LC's define a static set of patterns in the acoustic signal available for a language to map its PE's onto.

In (30a-f) (I) spreads and assumes head position in the stricture sub-gesture. This implies that (ʔ) and (h) are relegated to dependent position. As dependent, (ʔ) loses its power to demand that the segment be a *stop*. Since the element (I) is head, the segment is interpreted as the only non-stop and non-nasal palatal consonant in the language, /ʃ/. The element (L) in these expressions is not head and is suppressed, therefore nasality and voicing cannot surface. I-spread in (30a-f) is incorporated

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[122] We would also probably have to assume a similar kind of acoustic mapping for Korean neutralization that maps {s t' tʰ tʃ' tʃ tʃʰ} onto [t], cf. Rhee 2002 for discussion. The three kinds of affricates are tense, lenis and aspirated, respectively.

directly into the target phonological expression by which it changes the internal configurations of elements. In the case of the labials in (30g) and (30h), however, (I) does not penetrate the configuration of elements because the combination of (I) and (U) is barred at all levels (derived and lexical) for both vowels and consonants. (I) is therefore linked as an adjunct to the stricture node of /p/ and /β/. For /p/ this diminishes the 'stop' properties of (ʔ) and for /β/ the element (L), which contributes voicing is suppressed. Compare the two representations of derived /ʃ/ and /fy/ in (31). I only give partial representations.

```
(31)  a.   /t/ → /sh/              b.   /p/ → /fy/
           x      x                     x      x
           |      |                     |      |\
           ʔ  →   I                     ʔ  →   ʔ   I
           |      |                     |      |
           R      ʔ                     U      |
                  R                            U
```

Thus while in (31a), the element (I) is incorporated into the elemental configuration of the target segment /t/, it is only adjoined in (31b) and results in an off-glide effect. Notice that this presents a different structure of a consonant-glide sequence from the light-diphthong structure assumed in chapter 2. This is justified because the doubly linked structure in (31b) entails consonantal interaction between the two segments that is not attested in other CG sequences. The prediction is therefore that there will be a restriction on the segments that can occur in a contour segment-like structure as depicted in (31b), for CG sequences. In fact, only labials that are then spirantised to /fy/ can occur in this configuration.

Let us now turn to a brief description of the domain structure that the process of spirantisation entails.

4.6.2 Domain structure

From the discussion of spirantisation so far, we can conclude that there are two possible phonological domain structures for the root and following extensions in Bemba: one that consists of a single domain containing the root and derivational suffixes, and another that consists of two domains with the root forming an internal domain. This is illustrated in (32).

(32) a. (root-affix$_1$-affix$_2$-affix$_3$)
b. ((root) affix$_1$-affix$_2$-affix$_3$)

The two-domain structure presents the unmarked case where the affixes are treated as forming a domain that is dependent on the root. This dependency relation in a two-domain structure is reflected in the spreading processes discussed. If the head of the verbal complex, i.e. the root, is not the trigger of a phonological process then it does not undergo it; hence spirantisation of the long causative never affects the root-final consonant. If, on the other hand, a single domain as in (32a) is assumed, phonological processes will affect the root-final consonant as well: this is illustrated by the short causative. We will now investigate a process of palatalisation and depalatalisation in another Bantu language and see whether any of the assumptions made so far make valid predictions for this language.

4.7 Nyamwezi palatalisation and depalatalisation

A challenging set of Kinyamwezi data is presented in Maganga and Schadeberg (1992), where palatalisation and depalatalisation go hand in hand and the latter process follows from the former. Palatalisation in Nyamwezi is triggered by the short causative and affects two groups of segments, alveolars and velars. Palatalisation with the short causative results in total absorption of the causative morpheme.[123]

Nyamwezi has a large consonantal system that is presented in (33) below. The elemental representations assigned to the consonants at this stage are based on the characteristics of the GP set of elements, given the number of contrasts exploited in Nyamwezi. After consideration of a number of phonological processes in the language, two of which will be discussed here, we are able to work out the licensing constraints of the language.[124] Given the PE's in (33), I give a tentative set of licensing constraints in (34). The leftmost element in each expression is head. Simplex expressions are headed.

[123]Kinyamwezi is one of the few seven vowel languages that has absorption of the causative and hence seemingly goes against the generalisation expressed in the table in (29) where we expect seven vowel languages to have no floating segments and hence no total absorption in spirantisation. As will be seen in sub-section 4.7.2 no floating segment is assumed and absorption does not involve an alteration of the elemental configuration of the target segment. In addition, there are also cases of partial absorption in Nyamwezi; nh → ɲhy̠.

[124] The licensing constraints for Nyamwezi that are given here are for expository purposes only and thus do not capture the consonantal inventory as given in (33), since other processes remain to be analysed. However, we can assume that the licensing constraints on which the palatalisation and depalatalisation processes rely, will have a role to play in the final set of LC's. As in earlier representations the leftmost element is the head of the phonological expression.

(33) Nyamwezi Consonantal Inventory

stops:	p (ʔ.H.U)	t (ʔ.H.R)		k (ʔ.H)
	b (ʔ.U)	d (ʔ.R)		g (ʔ)
fricatives:	f (h.U.H)	s (h.R.H)	ʃ (h.R.I)	h (h)
	β (U)			
	v (h.U.L)	z (h.R.L)		
affricates:			tʃ (ʔ.H.I)	
			j (ʔ.I)	
glides:			y (I)	(w (U))
liquid:		l (R)		
nasals:	m (L.U)	n (L.R)	ɲ (L.I)	ŋ (L)
	mb (ʔ.L.U)	nd (ʔ.L.R)	nj (ʔ.L.I)	ng (ʔ.L)
	mv (h.L.U)	nz (h.L.R)		
voiceless nasals:	mh (L.H.U)	nh (L.H.R)	ɲh (L.H.I)	ŋh (L.H)
		ntʃ (ʔ.L.H.I)		
	mf (h.H.L.U)	ns (h.H.L.R)	nʃ (h.L.R.I)	

(34) Nyamwezi Licensing Constraints

(i) ʔ must be head
(ii) h must be head
(iii) L is head in the absence of ʔ and h
(iv) U may not be co-operator with I or R
(v) I may not be co-operator with R
(vi) no head may license more than three operators

There is some co-relation in the representation of consonants in (33). Voicing in segments is treated as the unmarked case with no voice specification, while all voiceless segments contain (H). Prenasalised segments are considered to be basically stops or fricatives with the addition of nasality. The constraints in (34(i-iii)) define the major categories of segments, broadly; stops, fricatives and nasals. The constraints in (34(iv-v)) ensure that every segment only has one place of articulation, lack of place is interpreted as velarity. Finally, the constraint in (34(vi)) restricts the size of any expression. There are probably other constraints at work here but these serve to illustrate the point. Let us now consider palatalisation in the causative in Nyamwezi.

4.7.1 Data survey

As earlier stated, palatalisation in the causative affects alveolars (35) and velars (36).

(35)	a.	kʊlas-á	→	kʊlaʃ-á	'shoot'
	b.	kʊβon-á	→	kʊβoɲ-á	'see'
	c.	kʊgʊl-a	→	kʊgʊj-a	'buy'
	d.	kʊkaánz-a	→	kukaánj-a	'wash'
	e.	kwiibúúnh-a	→	kwiibúúɲhy-a	'swim'

The base-final alveolars /s n l nz nh/ are palatalised to /ʃ ɲ nj ɲhy/ as (35) shows. The examples in (36) below show the palatalisation of base-final velars where /k g ŋg ŋh / become /ts j nj ɲhy/, respectively.

(36)	a.	kʊβak-á	→	kʊβatʃ-á	'burn'
	b.	koog-a	→	kooj-a	'bathe'
	c.	kʊβʊʊŋg-a	→	kʊβʊʊnj-a	'put into'
	d.	kʊnuuŋh-a	→	kʊnuuɲhy-a	'stink'

As seen in the palatalisation outputs in (35) and (36), different target consonants can produce the same palatal consonant. Thus while we have /s/ → [ʃ], /n/ → [ɲ] and /k/→ [tʃ], we also have the following sets of consonants each resulting in an identical palatal; /l g/→ [j], /nz ŋg/ → [nj] and /nh ŋhy/ → [ɲhy]. Let us now consider the depalatalisation process that results when the perfect *-ile* (37) and the causative *-iish-* (38) are affixed to palatalised bases. The long causative only attaches to frozen causatives that are now considered lexicalised.

(37) depalatalisation with *-ile*

	a.	βiʃ-ile	→	βis-ije			'made hide'
	b.	βatʃ -ile	→	βak-ije			'lit'
	c.	βoɲ-ile	→	βon-ije			'made see'
	d.	gʊl-a	→	gʊj-a	→	gʊg-ije *gʊl-ije	'sold'
		og-á	→	oj-á	→	og-ije	'bathed'
	e.	kaánz-á	→	kaánj-á	→	kaang-ije *kanz-ije	'had washed'
		zeeŋg-a	→	zeenj-a	→	zeeng-ije	'has built'
	f.	ibúúnh-a	→	ibúúɲhy-a	→	ibuuŋh-ije *ibuunh-ije	'made swim'
		nuuŋh-a	→	nuuɲhy-a	→	nuuŋh-ije	'made smell'

In (37) we see that the base-final consonant undergoes depalatalisation, while the suffixal consonant is palatalised instead. In (37a-c) the depalatalisation process is straightforward: /ʃ tʃ ɲ/ revert back to /s k n/, respectively, seemingly tracing back the palatalisation process. However, the depalatalisation processes in (37d-f) show that things may not be quite so straightforward, and the idea of tracing back previous structure is not a viable option. In (37d-f) there are in each case, two competing forms to which the palatalised segment may depalatalise, but notably the depalatalisation process always goes in favour of the velar segments. I will assume without too much discussion that there is a requirement for palatalisation to be expressed at the right edge of the base, perhaps in line with Downing's (to appear) claim for Jita, to express the end of a phonological domain. We return to a possible analysis of these facts presently, but first consider the long causative that also causes depalatalisation in the manner just described, in (38).

(38) depalatalisation with causative *-iish*

a.	ij-a	→	ig-iiʃ-a	'while away the evening hours'
b.	βʊʊ́j-a	→	βʊʊg-iiʃ-a	'ask'
c.	laanj-a	→	laaŋg-iiʃ-a	'teach'

In (38a-c) the palatal root-final consonants undergo depalatalisation when the causative *-iish* is added. Consider now some cases where for both the perfect and the causative depalatalisation fails to apply.

(39) double causative

a.	kʊβʊʊtʃ-a	→	kʊβʊʊtʃ-iiʃ-a	*kʊβʊʊk-iiʃ-a	'to lift up'
	caus. + perf.				
b.	βʊʊtʃ-a	→	βʊʊtʃ-ije	*buuk-ije	'lift up'

The verb in (39) ((39a) includes the infinitive marker kʊ-) is a lexicalised causative derived from the verb *βʊʊk-a* 'to rise, to get up'. These data illustrate that lexical palatals, which are not the result of active palatalisation, do not depalatalise. Given this observation we have a distribution of data as schematised in (40) below.

(40)

	C_1 C_2 #	
✓	a. LEX.PAL-LEX.PAL	
✓	b. LEX.PAL-DERIV.PAL	
×	c. DERIV.PAL-LEX.PAL	→ Ø-LEX.PAL
×	d. DERIV.PAL-DERIV.PAL	→ Ø-DERIV.PAL

In (40), a tick indicates sequences that are allowed and a cross those that are barred. Thus (40a) shows that two lexical palatals are allowed since lexical palatals do not depalatalise (example (39a)). A lexical palatal followed by a derived palatal (40b) is also allowed (example (39b)), reinforcing the assumption that a palatal must be the final consonant in causative bases. (40c) shows that a derived palatal followed by a lexical one is disallowed: the derived palatal undergoes depalatalisation resulting in a final lexical palatal (examples in (38a-c)). And (40d) as expected, also reduces the sequence of derived palatals to a single final one (examples in (37)). But what are the phonological implications of depalatalisation, and in particular, how do we resolve the cases involving competing forms with respect to the output of depalatalisation? The next section presents an analysis within GP.

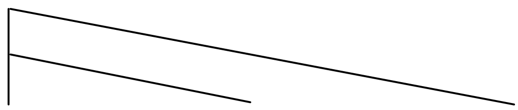
4.7.2 Determining the output in GP

I will treat palatalisation as the absorption of the causative /i/ in line with standard analyses and the causative /i/ as represented in a nuclear position. Crucial to the phonological representations here is the geometric structure of the elements. The Bemba data discussed so far have not given rise to any restrictions in elemental representation resulting from the fact that particular elements reside in the same sub-gesture. As already alluded to, elements with the same sub-gesture cannot combine with each other. In Bemba vowel harmony, discussed in chapter 2, we have seen how (I) and (U) cannot combine, because they are both in the stricture sub-gesture. This is formally represented in the two LC's that require both (I) and (U) to be head in vocalic representations.

We can distinguish at least three sub-gestures in a partial geometry of the consonants of Nyamwezi: the stricture sub-gesture with /ʔ/ and /h/ for stopness and frication, respectively, the phonation sub-gesture that houses voicelessness (H) and nasality (L), and the primary location sub-gesture that is host to (R) and (I) for coronality and palatality, respectively. Consider the partial geometry in (41).

(41) Nyamwezi partial element geometry

segment



stricture sub-gesture phonation sub-gesture primary location sub-gesture
ʔ h H L R I

Voiced is the unmarked option for voicing that is assumed if no voicing specification, (meaning no (H) element), is given. Velarity, as in Bemba, is expressed by the lack of a place element, and will be considered to be the default place feature of the language.[125] This partly explains the direction of depalatalisation

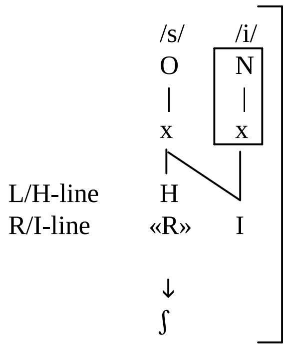
[125] Other evidence for assuming velar to be the unmarked consonantal feature for place in Nyamwezi, comes from the nominal prefix *mu-* which surfaces as a syllabic nasal before consonants and as a velar nasal before vowel-initial basses; -*βʊʊ́mbá* → *mɓʊʊ*mbi 'potter' but -*iβi* → *ŋwiiβí* 'thief' -*ezi* → *ŋweezí* 'moon' and -*ana* → *ŋwaaná* 'child'. According to Maganga and Schadeberg, this results from a constraint against /mw/ sequences. The interesting point here is that /mw/ is changed to /ŋw/ when it assumes onset position.

in the competing cases. The primary location sub-gesture will be crucial to the analysis of the palatalisation process.

The palatalisation process consists of adjunction of the (I) element of the causative to the elemental representation of the base-final consonant. I-adjunction is to be differentiated from spreading because it does not change the internal structure of the target segment but rather the element (I) is an adjunct of the target segment with whose elements it gets phonetically parsed, giving the effect of one segment. This structure results from the fact that in a seven-vowel system the spirantising vowel is represented in a nuclear position. Suffixing it to the end of the root violates the requirement for consonant-final bases. The vocalic unit thus adjoins to the preceding onset where it is either parsed as a simplex unit segment with the onset (s → sh) or parsed as secondary articulation on the onset (nh → ɲhy), depending on the restrictions on element combination expressed in the LC's. Recall that this is not the structure assumed for the Bemba short causative that penetrates the consonant it anchors onto and results in spreading or multiple linking of the element to give multiple spirantisation in bases. The Nyamwezi I-adjunction structures are given in (42) below for /s/ and /k/ palatalisation. In the following representations I use the term 'line' (meaning 'tier') to refer to the different sub-gestures. Only partial representations are given. Square brackets indicate the right edge of the base and boxed constituents undergo reduction.

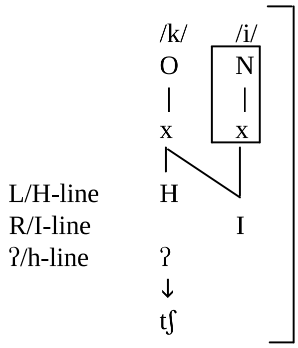
(42) a. kʊlas-á → kulaʃ-á 'shoot

s (h.R) *I-adjunction* → ʃ (h.R(I))



b. kʊβak-á → kʊβatʃ-á 'burn'

k (ʔ.H) *I-adjunction* → tʃ (ʔ.H.I)

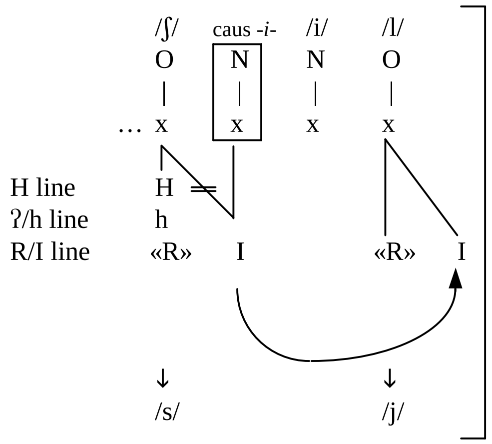


In the adjunction structures in (42) the nuclear constituent in which the causative suffix is represented is lost under reduction in order to avoid an OCP effect when the FV is added. This forces the costituentless /i/ to seek interpretation in the preceding onset by I-adjunction. In (42a), when (I) adjoins to /s/, the element (R) is suppressed because two elements on the same line are activated. There is no suppression in the palatalisation of /k/ in (42b) because there are no conflicting elements in the same sub-gesture. The same process applies in the palatalisation of the other segments, for which we will now consider the depalatalisation process.

For depalatalisation I will propose a type of element transfer that I will refer to as *element-hopping*.[126] In Kinyamwezi, element-hopping occurs when the perfect is attached to a palatalised base, resulting in adjacent nuclear positions that cannot be parsed in GP. The element of the causative base is thus forced to hop on to the base-final consonant where it adjoins. The resulting vacant nuclear position is either removed by reduction, or remains in the structure but gets no interpretation. What I hope to capture by the process of element-hopping is the absolute transfer of an element, from one position to another. This is to be differentiated from element spreading or multiple linking of an element where the element involved is rooted in the segment from which spreading or linking begins. Element-hopping will leave no trace of the hopped element. Consider the illustration of depalatalisation, (and palatalisation of the base-final consonant), in (43). Again I only give a partial representation.

(43) Depalatalisation as *element-hopping*

βiʃ-ile → bis-ije 'made hide': ʃ (H.h «R».I) *I-hopping* s (H.h.R) (and l → j)



(43) illustrates the hopping of element (I) from the derived palatal /ʃ/ to /l/ which then palatalises to [j]. This gives the sequence *derived palatal-derived palatal* → *Ø-derived palatal* in (40d). Notice that as long as only I-adjunction elements hop onto a following consonant, it follows from this analysis that depalatalisation will only affect derived palatals that have the I-adjunction structure. This gives the depalatalisation distribution of lexical versus derived palatals schematised in (40).

[126] This is reminiscent of syntactic *affix hopping* (cf. Lasnik 1990) which forces affixes to become syntactic dependents so as to avoid the 'stranded affix' constraint. Current models of syntax such as Marantz' (1997) Distributed Morphology do not assume affix hopping.

In the representation in (43) the captive (R) element is assumed to resume its activity i.e. be no longer suppressed, once the palatal (I) has hopped. The question is whether we want to portray phonology as possessing this characteristic of recapturing previous structures. In the cases involving the competing outputs to depalatalisation, we must assume that phonology fails to display this characteristic and hence results in velar outputs in all the competing cases. Consider the analysis of these forms (recaptured here in (44)), in (45). I use very simplified structure here, but assume the processes to proceed as in (42) and (43).

(44) Competing depalatalisation outputs of /j nj ɲhy/

	g		ng		ŋh
j		nj		ɲhy	
	l		nz		nh

(45) Irretrievable R-suppression leads to a velar depalatalisation output

	C2		C2		C2
a.	l (R) g (ʔ)	*I-adj.* →	j (I.«R») j (ʔ.I)	*I-hopping* →	g (Ø) g (ʔ)
b.	nz (L.R.h) ng (L.ʔ)	*I-adj.* →	nj (L.h.I.«R») nj (L.ʔ.I)	*I-hopping* →	ng (L.h) ng (L.ʔ)
c.	nh (L.H.R) ŋh (L.H)	*I-adj.* →	ɲhy (L.H.I «R») ɲhy (L.H.I)	*I-hopping* →	ŋh (L.H) ŋh (L.H)

(45) thus illustrates the palatalisation and depalatalisation process in the root-final consonant here labelled C2, where the initial consonant is C1 and the final one C3. The element of the causative suffix in (45a-c) I-adjoins to the target velar or alveolar segment in C2 at the right edge of the root. This results in palatalisation under suppression of (R) because it resides in the same sub-gesture as (I). This gives the palatalised forms in the second column of (45). In the presence of the perfect suffix *-ile* (I) hops from the palatalised segments in C2 to the base-final consonant (C3). Despite the hopping of (I) from the palatalised segment in C2 the suppressed (R) element remains suppressed forcing the segments in C2 to be interpreted with the unmarked velar place which is represented by the lack of a place element as shown in the third column of (45). Thus every input palatalised alveolar in C2 is depalatalised to its velar counterpart. This kind of change in place features within segments, which cannot be attributed to place assimilation, provides support for the validity of the process of suppression. In addition, there are mismatches between the representations of segments that get an identical phonetic interpretation, as also seen

in the outputs of spirantisation in Bemba. This reinforces the idea expressed earlier that the LC's of a language exhaustively define the acoustic cues available for cognitive units or sets of elements, to map onto, i.e. LC's define the *canvas* space available to a particular language. Thus, phonological processes in derivation can only create sound impressions that are already internal to the language.[127] Thus, in conflicting cases such as those shown in (44), different cognitive entities, i.e. different elemental representations converge to produce the same sound.

An alternative analysis can be derived from Maganga and Schadeberg's (1992) observation that, for the forms with conflicting choices for the depalatalisation output, Kinyamwezi treats the palatal consonants /j nj ɲhy/ as representing the velar-plus-palatal sequences /gy ngy ŋhy/ respectively. We can formalise this observation by assuming that velar is the unmarked consonantal feature inherently present in the alveolars involved in the competing cases of depalatalisation i.e. /l nz nh/, but is suppressed.[128] Absorption of palatal (I) would result in suppression resolution, thus yielding a velar output. Under such an analysis, we would have to give some elemental content to velarity, and the inability of the velar element and (I) to combine as resulting from their residing on the same tier, i.e. the same sub-gesture. Velar suppression resolution would thus determine the direction of depalatalisation and implies /l/, /nz/, /nh/ are suppressed /g/, /ng/, /ŋh/, respectively. An illustration of this alternative analysis is given in (46). Velar is here represented as (@).

(46) depalatalisation as velar suppression resolution

	suppressed velar		suppression resolution		velar output
	C2		C2		C2
a.	l (R «@»)	$\xrightarrow{I\text{-spread}}$	j (R.@.I)	$\xrightarrow{I\text{-hopping}}$	g (R.@)
b.	nz (L.R.h «@»)	→	nj (L.R.h.@.I)	→	ng (L.ʔ.@)
c.	nh (L.H.R «@»)	→	ɲhy (L. @.I)	→	ŋh (L.@)

The spread of (I) in (46), rather than adjunction, allows for an internal change to the configuration of the elements of the segment in C2 thereby resulting in suppression resolution of the suppressed velar place. I-hopping from palatalised C2 to the base-final consonant produces a velar segment in C2.

[127] Note that this excludes processes such as voicing, devoicing or nasalisation that define allophones of segments already present in a language.

[128] A stronger version of this would be to assume that velar is the unmarked consonantal feature in the language as a whole, and is therefore inherently present in all consonants. Under this view, segments like /p t f/ can be represented as also containing a suppressed velar that is never realised if we assume their internal configuration of elements is not altered, following adjunction. This entails secondary articulation giving /py ty fy/. Similarly, with suppressed velar, /s/ would also never alter its internal configuration given adjunction, and thereby never allow velar to surface.

As opposed to the Bemba spirantisation process, the palatalisation process in Nyamwezi is rightward spreading after the suffixation of the causative, which uniquely targets the root-final consonant. This behaviour of the causative in Nyamwezi supports the view of the root as forming a phonological domain that is an entity that can be the target of morphological operations. In addition, in morphologically complex verb forms, the mandatory expression of palatalisation at the right edge of the base follows from the assumptions of no bracketing derivation: there are no internal phonological domains within the d-suffix domain, i.e. [[Root] suffix$_1$-suffix$_2$]$_{\text{PAL}}$].

To summarise, we have accounted for the palatalisation process in Nyamwezi as the addition of an (I) element that can either be adjoined to, or spread into the representation of a base-final consonant. Depalatalisation on the other hand has been observed to only affect derived palatals and is accounted for in GP as element-hopping in order to retain the constraint on palatal final bases in predominantly causative forms. In addition, at least three properties of the phonology follow from the analysis proposed. Firstly, when particular combinations of elements, by which we define sound segments, are prohibited by militating licensing constraints, but by morphological derivation the illicit combinations are made, one of the elements in the illicit combination is barred from being mapped onto patterns in the acoustic signal. When an element undergoes such suppression, it is irretrievable in later derivations. Secondly, it is possible for different elemental combinations, because they are *not* acoustic events but rather cognitive categories, to be mapped onto identical patterns in the acoustic signal. This gives the difference in representation between lexical and derived palatals or indeed different representations of the same segment in the same language. And finally, lexical phonological entities, which are derived under the Licensing Constraints of a language, are not allowed to undergo restructuring that involves deletion of elements. Lexical segments will thus spread, rather than *hop* their elements.

We have seen how under particular assumptions of the phonology we can explain the mismatch effects in the representations of the result of phonological processes such as spirantisation in Bemba and palatalisation and depalatalisation in Nyamwezi. A remaining question in the spirantisation process is the level at which the proposed consonant harmony process applies. As shown in Shaw (1991) consonant harmonies are by nature long distance since they skip intervening vowels, but cf. Chiosáin and Padgett (2001) for a different opinion. In the consonantal I-harmony discussed in section 4.4.3, I have assumed transparency of /a i e/ and opacity of /o u/. In the next section, I discuss a process of nasal consonant harmony in Bemba that to the contrary spreads across all the five vowels of the language. How can we account for this and what does it tell us about the phonological structure of Bemba?

4.8 Nasal consonant harmony

Nasal consonant harmony (NCH henceforth) is found in a large number of Bantu languages such as Luba (L.31), Lamba (M.54), and Kikongo (H.16) (cf. Greenberg 1951). NCH generally refers to a process that changes the liquid /l/ or its allophones, depending on the language, to a nasal. In Bemba NCH affects all [l]-containing suffixes, namely the applicative, *-il-*, the perfect *-ile,* the transitive separative *-ul-*/*-ulul-*, the intransitive separative *-uluk-* and the completive suffix *-ilil-*. The triggers of the process are the nasals [m] and [n]. The velar and palatal nasals do not occur in root-final position so we do not have evidence to show that they trigger the process but expect that in the absence of this phonotactic restriction they would.[129] The result of NCH is always the coronal nasal. Consider the Bemba data in (47).

(47)	a.	tan-a	'refuse'	→	tan-in-a	'refuse for'	(appl.)
	b.	som-a	'plug'	→	som-onok-a	'become unpluged'	(intr.sep.)
	c.	kom-a	'lock'	→	kom-onon-a	'unlock'	(trns.sep.)
	d.	tum-a	'send'	→	tum-ine	'has sent'	(perf.)
	e.	kan-a	'deny'	→	kan-inin-a	'refuse totally'	(compl.)
	f.	land-a	'speak'	→	land-il-a	'speak for'	(appl.)
	g.	laŋg-a	'show'	→	laŋg-il-a	'show for'	(appl.)
	h.	somek-a	'plug'	→	som-ek-el-a	'plug for'	(appl.)

In (47a-e), we see the application of NCH triggered by either /n/ or /m/. (47c) and (47e) show that the process continues if there is an available following target. (47b) shows that other consonants (here /k/) do not undergo the process. (47f) and (47g) illustrate the non-application of NCH in roots ending in NC clusters. (47h) shows the requirement for 'adjacency' - the process is blocked by an intervening consonant (/k/). Thus in Bemba, NCH only affects consonants in sequence. Observe that here 'in sequence' means 'only separated by a vowel'. We cannot therefore treat the trigger and undergoer of NCH as being in an inter-onset government relation. As seen in chapter 3, inter-onset government results in the inaudibility of the intervening vowel; hence the empty nuclear position in the representation of NC clusters. The lack of nasalisation in NC clusters cannot be due to the blocking effect of non-lateral consonants as in example (47h), since there are languages such as Kikongo and Yaka where intervening consonants do not block NCH but NC clusters still do not trigger the process. The general idea expressed by an inter-onset government relation is that the nasal is a dependent of the following consonant and is thus hindered in its capabilities; it cannot act independently of the following stop.

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[129] We can have the palatal nasal in base-final position when it results from the causative as in *kaany-a* 'make stop' but nasal spread is obscured by spirantisation when an /l/ containing suffix such as the applicative *-il-* is added giving forms such as *kaan-ish-a* 'make stop for'. The exception to this is the perfect, which triggers imbrication, to be discussed in chapter 5, yielding *keeny-e* 'had made stop'. In addition, suffix-ordering requirements also make it impossible to test for NCH in other possible environments. For example, a causative base cannot be followed by a separative; **kany-ul-a*, **kany-uluk-a*. The same applies to the nasal-glide sequence *-my-* that results from the causative.

The prediction is thus that, as long as a language has an inter-onset government representation for NC clusters, then these sequences cannot trigger NCH.

An important question that we must also deal with is why NCH only targets liquids. In Kula and Marten (1998), this has been related to the phonological representation of the liquid, namely that it has a single element (R) and NCH only targets simplex expressions. In addition to this, I assume here that the simplex expressions targeted follow from the element geometry given in chapter 2. (L) in the phonation sub-gesture acts as head over the dependent primary location sub-gesture. According to LC (iii) for Bemba consonants; ‘Only L can license R U I’. We can thus foresee or have the possibility of (L) spreading into phonological expressions containing a place element, to result in a nasal of that place. Given that there are only three consonants that occur in suffixes, /l n k/ only /l/ is affected by NCH. /k/ consists of (ʔ) which cannot be licensed by (L), and /n/ is composed of more than one element and already contains (L). There is reason to believe that the NCH process also operated within roots so that Proto-Bantu **mel-a* ‘grow’ became *men-a* in Bemba (Greenberg 1951, Meeussen 1959). There are thus no verbal forms where a nasal precedes a liquid in the present language. That only (R U I) are subject to (L) spread is also in line with the fact that there are no verb forms where a nasal precedes /w (U), y (I)/ (cf. Sharman 1963). /w/ and /y/ must have also undergone NCH in Proto-Bantu.[130] The NCH process is, however, no longer operative in roots.

The ability of NCH to spread through vowels can be related to the fact that there are no nasal vowels in the language.[131] The impossibility of deriving nasalised vowels is also reflected in the LC’s of the vowel system of the language, given in chapter 2. The nasal element (L) must thus spread through the vowel and leave it unaffected.[132] From the aforesaid, nasal harmony appears as another instance of the spreading of element (L). It spreads from left to right, into simplex expressions. Note that NCH can be triggered by any nasal after the root and inclusive of the root, as long as the condition of a following consonant with a simplex PE belonging to

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[130] Hyman (1995b) also notes that voiced oral consonants were subject to nasal harmony in Proto-Bantu in Yaka. /d/, an allophonic variant of /l/, also undergoes NCH in Yaka. Hyman proposes that NCH in Yaka involves the multiple linking of voiced segments to the Soft Palate Node following Piggott’s (1992) feature geometry.

[131] There are various ideas on the representation and characterisation of consonant harmony (CH). McDonough and Myers (1991) suggest that in child language, CH is possible because child language has CV planar segregation. This is a possible solution because child language has a restricted inventory of syllable types and vowels within a morpheme are predictable. In this respect, child language structure is consistent with the restrictions spelled out in McCarthy (1989) for Semitic languages. A planar approach is not obviously helpful for agglutinative languages. Menn (1978) and Spencer (1996) argue that CH involves spreading of individual articulators, while Goad (1997) suggests that CH involves melody copy in a manner similar to reduplication.

[132] Chiosáin and Padgett (2001) argue for an approach that considers all harmony processes to be strictly local. Chiosáin and Padgett claim that there aren’t any transparent segments in spreading processes, and by articulatory means show that consonants in a domain of vowel harmony are co-articulated with the feature of vowel harmony in Turkish, for example. The question is whether we should consider such co-articulations as distinctive for phonology. Notice also that the NCH process fails to nasalise the intervening vowels.

the location sub-gesture is met. The reciprocal suffix *-an-* thus triggers the process, as (48) shows.[133]

(48)	a. kak-a	‘tie’	→	kak-an-in-a	‘become difficult (entangled) for’
	b. kum-a	‘be equal’	→	kum-an-in-a	‘be enough (numerically meet the requirement)’

The examples in (48) change the applicative *-il-* to *-in-* following the reciprocal. I assume that in (48b) the reciprocal is still the trigger given the locality requirements on NCH. We can thus represent NCH as the spread of the element (L), which in the geometry translates into having the phonation sub-gesture assume head position with the primary location sub-gesture as dependent. (49) illustrates the process. Only relevant elemental representations are given here.

(49) a. tum-il-a → tum-in-a ‘send for’ b. som-a→ som-ek-el-a ‘plug for’

```
a.                              b.
O  N  O  N  O  N                O  N  O  N  O  N  O  N
|  |  |  |  |  |                |  |  |  |  |  |  |  |
x  x  x  x  x  x                x  x  x  x  x  x  x  x
|  |  |  |  |  |                |  |  |  |  |  |  |  |
t  u  m  i  l  a                s  o  m  e  k  e  l  a
      U     R                         U           R
      L ──► L                         L ──╫?
            ↓
/t u  m  i  n  a/               /s  o  m  e  k  e  l  a/
```

(49a) shows the spread of (L) from the root-final consonant to cause nasalisation of the liquid in the following onset. (49b) shows the blocking effect of /k/. As shown with the completive suffix *-ilil-* in (47e), the NCH process is able to continue unhindered as long as there are following liquids. Although there are no examples of two independent nasalisable suffixes following each other, due to suffix-ordering constraints, it is clear that a preceding nasal would nasalise both suffixes. In addition, the fact that the reciprocal suffix nasalises following suffixes shows that the morphological domain boundary between the reciprocal and the suffix it nasalises is not visible to the phonology. This illustrates the phonological unity of the domain following the root and hence lends support to the claim being made here: none of the morphological boundaries of the d-suffix domain are available to phonology.

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[133] The old contactive suffix *-am-* behaves the same way although it is now frozen and no longer productive; *pal-am-a* ‘be near’ → *palam-in-a* ‘get closer to some location or person’. Although it is considered to be lexicalised, there are other processes that seem to point to its still being analysable for word-formation processes and thus not considered an integral part of the root.

4.9 Summary

In this chapter it has been demonstrated that phonology can maximally recognise two domains in the verbal complex, consisting of the root and derivational suffixes. Two domains can be seen in the spirantisation process triggered by the long causative where leftward spread of the harmonising (I) element fails to spirantise the root-final consonant. One domain can be seen in verbs that are spirantised by the short causative, represented as a floating segment that anchors onto the root-final consonant from which (I)-harmony proceeds leftwards to the end of the domain. In the former case, the root is phonologically recognised and parsing captures the root domain to construct the meaning of the whole. In the latter case, where only one domain is phonologically recognised, parsing treats these as simplex words. We can thus consider them as having their own lexical address and being accessed directly.

The output representations of spirantisation, reveal an interesting property of phonology, namely that different elemental combinations may map onto identical patterns in the acoustic signal. This is also convincingly demonstrated by the depalatalisation process in Nyamwezi where two different inputs to a palatalisation process produce the same palatal, which when depalatalised corresponds only to one of the inputs. In such cases, the analysis presented has avoided representing such processes as involving the delinking of structure or the random substitution of features, but rather as suppression. The different derived representations of the same segment within the same language has led to the conclusion that lexical entities may have different representations from derived ones. Processes such as Nyamwezi depalatalisation, which fail to affect lexical segments, confirm such a division and lead to the proposal made here, namely that derived segments can ‘hop’ their elements while lexical ones can only spread or multiply link them. The harmonising processes discussed in this chapter have been assumed to take place at a projection where both onsets and nuclei are available (P^0). In spirantisation we see the blocking effect of the back vowels. In nasal consonant harmony on the other hand, we see the transparency of all vowels that cannot be nasalised under the vocalic licensing constraints of Bemba.

5 Inflectional Suffixation

This chapter investigates inflectional derivation by suffixation. There are only two inflectional suffixes in Bemba. Inflectional affixes in Bantu generally tend to be prefixes rather than suffixes. We have already seen how in the prefix domain, concatenations of prefixes before the root form a single phonological domain that is dependent on the stem. This raises the question whether n the suffix domain, the other hand, the addition of an inflectional suffix to a predominantly derivational domain implies a phonological break consistent with the morphological one between the derivational and the inflectional suffixes. I will argue, following Downing (1997), that there is no such phonological domain boundary between derivational and inflectional suffixes. I give compelling evidence from the perfect, which undergoes a process of imbrication exactly under conditions where it risks failure of interpretation due to a rigidly defined phonological domain structure between the root and its suffixes. Imbrication will be shown to result from two shapes of the perfect suffix that distinguish regular and irregular suffixation. The other inflectional suffix is the subjunctive ending *-e*, which, because it is in the position of the FV, provides no insights into phonological domain organisation.

I begin by presenting a detailed survey of the data in the next section, followed by previous analyses to discontinuous affixation in section 5.2. Section 5.3 motivates the domain structure relevant for the analysis that is then presented for the different data sets relevant to imbrication. I conclude the chapter by giving the final phonological domain structure of the verbal complex in Bemba.

5.1 Data survey

The perfect verbal suffix in Bemba functions as a tense aspect marker denoting a terminated action. The function of the perfect suffix varies from language to language within the Bantu group. In Proto-Bantu (Mould 1972), it was mostly used to denote the terminative or perfect aspect. The peculiarity of the perfect suffix stems from the fact that apart from affixation to the end of the root or verbal base, it can also be inserted within a verbal base, particularly systematically before the base-final consonant. This process has been referred to in previous literature as formation of a modified base (Ashton et al. 1954, Givón 1970a, Mould 1973), Fusion (de Blois 1975), Ablaut (Kisseberth and Abasheik 1976), or Imbrication (Bastin 1983, Hyman 1995a). I adopt from Bastin (1983) the term *imbrication*. Imbrication can be viewed as resulting from irregular suffixation of the perfect as opposed to regular suffixation.[134] These two suffixation types are systematically divided between roots and bases, with suffixation to roots always being regular and

[134] As will be seen from the data formation of the perfect by imbrication is totally regular in as far as the process itself is concerned. My reference to it here and in any other following discussion as irregular is only to capture the fact that it does not involve suffixation to the end of a root or base.

suffixation to bases almost always by imbrication. This distribution of facts is not surprising, since we have just described the root as forming an autonomous unit that is not accessible to spirantisation in chapter 4. Let us first, however, consider the data a-theoretically.

5.1.1 Regular suffixation

The perfect suffix *-ile* is suffixed in a normal, i.e. regular fashion to all roots. This is expected for all roots that are consonant-final, because addition of a -VCV shaped suffix poses no threat to the strict CV syllable structure of the language. The final /e/ of the perfect takes the lexically specified position of the FV, as discussed in chapter 2, thereby satisfying the parameter setting on word-final empty nuclei. Given that we have defined the root as forming an autonomous unit in chapter 4, the only expected position for a following suffix to be affixed is after the root. The data in (1-4) show this expected regular suffixation of the prefect. The data are arranged according to the shape of the root, but all illustrate the same point; the suffix is attached to the end of the root. The perfect suffix *-ile* is subject to both vowel and nasal harmony, as the data show.

(1) ØVC-

a.	ak-a	‘light’	ak-ile	‘has lit’
b.	íb-a	‘steal’	íb-ile	‘has stolen’

(2) CVC- / CV:C-

a.	pet-a	‘fold’	pet-ele	‘has folded’
b.	túl-a	‘pierce’	túl-ile	‘has pierced’
c.	puut-a	‘blow’	puut-ile	‘has blown’
d.	paal-a	‘bless’	paal-ile	‘has blessed’
e.	noon-a	‘sharpen/whet’	noon-ene	‘has sharpened’

(3) CGV:C-

a.	fwiis-a	‘spit out’	fwiish-ile	‘has spat out’
b.	fyuuk-a	‘escape’	fyuuk-ile	‘has escaped’
c.	byool-a	‘belch’	byool-ele	‘has belched’
d.	fween-a	‘scratch’	fween-ene	‘has scratched’

(4) CV(CV)NC-

a.	cind-a	‘dance’	cind-ile	‘has danced’
b.	send-a	‘take’	send-ele	‘has taken’
c.	túntúmb-a	‘to carry a heavy load’	túntúmb-ile	‘has carried a load’
d.	βúlu:ŋg-a	‘mould into a round shape’	βúlu:ŋg-ile	‘has moulded’
e.	βéle:ŋg-a	‘read’	βéle:ŋg-ele	‘has read’

As already discussed, CVC- is the typical root shape in Bantu, with vowel length distinction and an initial empty onset as a variation on this root shape. The only roots longer than CVC- end in an NC cluster that is speculated to have its historical roots in a reciprocal suffix (either -*aŋgan*- or -*ang*-). These forms are now integrated into the language as roots that undergo regular suffixation as (4) shows.

5.1.2 Imbrication

Suffixation of the perfect to bases, i.e. to morphologically complex roots, results in imbrication. All data in (5) are taken from (1-4) above, but suffixed with the applicative to create an applicative base that is then suffixed with the perfect suffix -*ile*. These extended roots are now all seen to undergo imbrication.

(5)	verb	appl.	appl.+perf.		
a.	ak-a	ak-il-a	ak-iil-e	*ak-il-ile	'has lit for'
b.	pet-a	pet-el-a	pet-eel-e	*pet-el-ele	'has folded for'
c.	noon-a	noon-en-a	noon-een-e	*noon-en-ene	'has sharpened for'
d.	fyuuk-a	fyuuk-il-a	fyuuk-iil-e	*fyuuk-il-ile	'has escaped for/to'
e.	βúluŋg-a	βúlung-il-a	βúluŋg-iil-e	*βúuŋg-il-ile	'has moulded for'
f.	sek-a	sek-an-a(recip.)	sek-een-e	*sek-an-ine	'have laughed at e.o'

Given the perfectivised applicatives in the data in (5), we can describe imbrication as a process that, in the formation of the perfect, lengthens the final vowel of the base by adding the -*il*- of the perfect suffix, deletes the consonant /l/ of the perfect, and adds the FV /e/. The examples in (5) above illustrate that we cannot consider imbrication to be an inherent property of a particular set of verbs, since the non-imbricating verb forms in (1-4) undergo imbrication when they are extended. Example (5f) shows that the lengthening effect of the process results from the active participation of the vowel of the perfect, which in this case fuses with the vowel of the reciprocal to produce the long mid-vowel /e:/. I will refer to the position where vowel lengthening and fusion take place as the *imbrication site*. Example (5f), as well as the examples in (6), also illustrate that it is the consonant of the perfect that is deleted rather than that of the base.

Coming now to frozen bases whose roots have no independent meaning, we notice that imbrication applies in these verbs. If imbrication is based on bases rather than roots, then the fact that frozen bases undergo the process indicates that the suffixes in these bases are still accessible to phonological operations. In (6), I give a sample of the most predominantly imbricating bases. The frozen suffixes are underlined.[135]

[135] The historical status of the final -VC- in what I term frozen bases here is not known in some cases. However they all behave in an identical fashion to actual frozen suffixes and I will refer to them as such. Meeussen (1967) uses the term *expansions* for such bases.

(6) frozen suffixes

	stem		perfect	
	stem		perfect	
a.	íkat-a	'catch'	ík-éet-e	'has caught'
b.	kálip-a	'pain'	kál-íip-e	'has pained'
c.	a:ŋguk-a	'be easy'	a:ŋgw-íik-e	'has been easy'
d.	sukus-a	'throw'	sukw-íis-e	'has thrown'
e.	kú:ŋgub-a	'gather'	kú:ŋgw-íib-e	'has gathered'

There is one set of examples where it seems that imbrication does not delete the final consonant of the perfect. These involve frozen passives illustrated in (7a-d) with the frozen passive suffix (-*w*-) underlined, and the roots without an independent meaning. The same effect is observed in productive passive forms as example (7e), where the root has independent occurrence, i.e. with other suffixes or the FV, shows.

(7) frozen passive -*w*-

a.	filw-a	'be unable'	fil-il-w-e	'has been unable'
b.	te:ndw-a	'tire of'	te:nd-el-w-e	'has grown weary of'
c.	búlw-a	'be lacking'	búl-il-w-e	'has come to lack'
d.	témw-a	'love'	tém-en-w-e	'has loved'
e.	pet-w-a	'be folded'	pet-el-w-e	'has been folded'

Apart from these data in which we can identify a root and a suffix, even if neither is part of active morphology, there are verbal forms of the shape [CGV:C-], [CV:C-] and [CVCV:C-] as illustrated in the data in (8), (9) and (10), respectively, which look like roots, given that vowel length is only underlyingly distinctive in roots, but which nonetheless undergo imbrication. The final -VC of these verbs (-al, -at, -an) can be recognised as Proto-Bantu extensions but given that these suffixes now form part of the root vowel in (8) and (9), they pose a serious problem for the assumption that imbrication does not apply in roots. In addition, imbrication is also odd in these forms because of the long vowel in the imbrication site that would obscure the vowel lengthening effect of imbrication. Remember also that we have already seen roots with long vowels in (3) that take regular suffixation. Consider the data in (8-10).

(8) CGVC-

a.	byáal-a	'plant'	byéel-e	'has planted'
b.	fwáal-a	'dress'	fwéel-e	'has dressed'
c.	kwaat-a	'have'	kweet-e	'has had'
d.	shaal-a	'remain'	sheel-e	'has remained'

(9) CV:C-

a.	káan-a	'refuse'	kéen-e	'has refused'
b.	láal-a	'sleep'	léel-e	'has slept'

(10) CVCV:C-

a.	loŋgáan-a	'gather together'	loŋgéen-e	'has gathered'
b.	nyoŋgáan-a	'be twisted'	nyoŋgéen-e	'has twisted'
c.	lubáan-a	'be mixed up'	lub-éen-e	'has confused'

In examples (8-10), we must consider imbrication to involve vowel loss, as would be generally assumed if three vowels undergo fusion.[136] The sequence of three vowels referred to here is the long root vowel /aa/ and the vowel /i/ of the perfect suffix. Obviously a striking similarity in these examples is the fact that the long vowel involved in all cases is /a/. We return to an analysis of these data in section 5.3.5.

Finally, let us now consider the small class of vowel-final roots, which present a case where the root vowel may fuse with the initial vowel of the perfect suffix *-ile* (as well as any other following vowel-initial suffix), and thereby seemingly allow imbrication in roots.

5.1.3 CV- roots

As seen in earlier discussion, roots have predominantly been of CVC shape. The only vowel-final roots in Bemba are short roots that consist of a CV unit. This is a general cross-Bantu tendency. The only exception to this, in Bemba, is a single verb root of the shape ØVCV- (example (11p)). There are about fifteen such CV- verb roots in Bemba, cited in (11) below. CV- verb roots also do not vary much in number and meaning across Bantu. The stem of CV- roots, i.e. after addition of the FV, is also CV shaped. This raises the question of whether the root should be considered as only consisting of the consonant in the CV output stem. However, apart from the verb forms in (11a-d), it is clear that CV stems involve two positions in the root from which gliding follows when the FV is added. In (11a-d), we must assume vowel loss or shortening in the final output form that is shown in square brackets. Long vowels are never final in Bemba.[137] Consider the CV roots and their perfect forms in (11).

[136] Fusion between a long vowel and a short vowel were totally disallowed in the fusion processes discussed in chapter 2: a-ka-laa-iba → a-ka-laa-iba 'he will be (develop the habit of) stealing' and not the ungrammatical *a-ka-leeba. (See example (51) in section 2.5 for morphological glosses). This disparity will be shown to follow from phonological domain organisation in morphologically complex verbs.

[137] The verb *be* in (11c) does not form a perfect form with *-ile* and there is no suppletive form. The perfect of *be* is expressed by a combination of different tense signs. In (11k), the reconstructed root for *drink* is **nó-* (cf. Meeussen 1967). This would account for the variant *nween-e* in the perfect form, while *nwiin-e* could be considered a result of analogy to CV- roots containing /u/ since there are no roots with mid-vowels.

(11)

	CV-verb			perfect	
a.	cá-a	[c′-a]	‘dawn’	céel-e	‘has dawned’
b.	pá-a	[p′-a]	‘give’	péel-e	‘has given’
c.	bá-a	[b′-a]	‘be’	____	
d.	ʃá-a	[ʃ′-a]	‘leave’	ʃíil-e	‘has left’
e.	lí-a	[ly′-a]	‘eat’	líil-e	‘has eaten’
f.	pí-a	[py′-a]	‘burn’	píil-e	‘has burnt’
g.	ni-a	[ny-a]	‘defecate’	nyeel-e	‘has defecated’
h.	i-a	[y-a]	‘go’	iil-e	‘has gone’
i.	tú-a	[tw′-a]	‘pound’	twíil-e	‘has pounded’
j.	sú-a	[sw′-a]	‘pluck’	swíil-e	‘has plucked’
k.	nú-a	[nw′-a]	‘drink’	nwiin-e/nwéen-e	‘has drunk’
l.	lu-a	[lw-a]	‘fight’	lwiil-e	‘has fought’
m.	pú-a	[pw′-a]	‘finish’	pwíil-e	‘has finished’
n.	fú-a	[fw′-a]	‘die’	fwíil-e	‘has died’
o.	u-a	[w-a]	‘fall’	wíil-e	‘has fallen’
	ØVNCV-				
p.	úmfu-a	[úmfw-a]	‘hear’	úmfw-íile	‘has heard’

Although perfect forms in (11) seemingly appear to have undergone imbrication, they actually involve regular suffixation as a close examination reveals. Consider (11j) for example, where the vowel of the root *sú-* glides to /w/ when the perfect is added; *sú-ile* → *sw-íile* ‘has plucked’. This is followed by compensatory lengthening of the vowel of the suffix to give the perfect output *swíile* ‘has plucked’. Thus, the vowel length in the data in (11) is not a result of imbrication, but rather a result of fusion between the root vowel and the suffix vowel (11a-h) or a result of compensatory lengthening after gliding of the root vowel (11i-p).[138] In any case, if imbrication is a process that affects a vowel before a base-final consonant, then we do not expect it to occur with vowel-final roots (or bases for that matter, if they were available). We thus treat all the forms in (11) as undergoing regular suffixation that may result in vowel fusion or gliding and compensatory lengthening.

From the data given so far, it is clear that imbrication always affects verbal bases, i.e. extended roots.[139] However, the situation is slightly more complicated with extended CV- roots, where imbrication never applies with a single suffix unless it is the reciprocal *-an-*. Imbrication in extended CV- roots only systematically applies in multiply suffixed verbs. Consider the data in (12), illustrating this distribution.

[138] Recall that gliding here involves a heavy diphthong structure as discussed in chapter 2. The effect results from two adjacent nuclei, i.e. the CV- root vowel and the initial vowel of the perfect suffix.
[139] See Kula (2001) for a survey of Proto-Bantu suffixes confirming this intuition.

(12) no imbrication with single /i/ initial suffixes

	root	root+appl.	ext.root+ perf.		
a.	pí-	píil-	píil-ile	*píil-e	‘have burnt for’
b.	fú-	fwíil-	fwíil-ile	*fwíil-e	‘have died for’

imbrication with more than one /i/ initial suffix

	root	root+caus.+appl.	ext.root+ perf.		
c.	lí-	líish-ish-	líish-iish-e	*líish-ish-ile	‘made eat for’
d.	pí-	píish-ish-	píish-iish-e	*píish-ish-ile	‘gave e.o. for’

imbrication with a single /a/ initial suffix

	root	root+recip.	ext.root+ perf.		
e.	lí-	lí-an-	lyéen-e	*lyaan-ine	‘have eaten e.o.’
f.	tú-	tú-an	twéen-e	*twaan-in-e	‘have pounded’

In (12a) and (12b) no imbrication applies to CV- roots extended with only the applicative. The same roots undergo imbrication when more than one suffix is added ((12c) and (12d)). (12e) and (12f) show the reciprocal as the only suffix allowing imbrication in a non-multiply affixed CV- root. This distribution can be attributed to a blocking effect that serves to avoid homophony when /i/ initial suffixes are added to CV roots: imbrication should not lead to already existing words. In (12a), for example, formation of the perfect by imbrication would produce an output that is identical to the perfect of the simplex root *pí-*. This is the starred form in (12a). The lack of imbrication in (12a) acts as a blocking effect on the homophony that would result between the perfect of the simplex root and the perfect of the extended root. Hence the perfect of the applicativised base *píil-a* ‘burn for’ is *píil-ile* ‘has burnt for’, with regular suffixation.[140] In multiply suffixed forms (12c) and (12d), on the other, there is no risk of homophoy and imbrication applies regularly. Examples (12e) and (12f), which undergo imbrication after a single suffix, support the assumption of opacity triggered blocking effects: the perfect of *lí-* (root of ‘eat’) in (12e) is *líil-e* ‘has eaten’, while the perfect of its reciprocal is *lyéen-e* ‘have eaten each other’, i.e. two distinct forms.

We will have to find a way of incorporating the data in (12a) and (12b), under a view of mandatory imbrication in bases. Needless to say, the claim that imbrication only ever affects bases, is still valid. We can thus sum up the characteristics of imbrication as follows:

- imbrication is a property of bases that involves at least three processes;

[140] Two phonologically identical forms for the perfect of *pí-* and the perfect of the applicative of *pí-*, i.e. *píil-e*, are also barred because they can ambiguously occur in the same environment and cannot as such always be contextually differentiated. Consider, for example, the sentence $a_{\text{SM.}}$ *píil-e*$_{\text{v.pst.}}$ *umunankwe*$_{\text{N.}}$ that under interpretation of *píil-e* as the perfect of the root *pi-*, can be interpreted as ‘he burnt (himself) for his friend’ and under the putative interpretation of *píil-e* as perfect of an applicative as ‘he has burnt himself for his friend’.

(a) vowel fusion and/or gliding, triggered by the perfect suffix vowel /i/ when it comes into contact with the vowel preceding the base-final consonant;
(b) loss of segmental content within the perfect suffix, the suffix consonant /l/, and
(c) a discontinuous realisation of the perfect suffix, since the initial /i/ and the final /e/ of the suffix are separated by the root-final consonant in imbricated forms.

- imbrication cannot be characterised as being based on some inherent property of particular verbs since non-imbricating verbs yield to the process once they are extended.
- the imbrication site is consistently before the base-final consonant.

Let us consider some proposals that have been offered to account for phenomena akin to imbrication.

5.2 Previous proposals for discontinuous affixation

The most striking characteristic of imbrication is the fact that a suffix is not attached to the end of the base on which it is dependent. Any kind of infixation process raises questions for a phonology that considers segments to be in a linear order defined by fixed positions that have a relation with each other. An obvious question in this line of research is whether such infixation processes target prosodic units. In this section, we will consider two possible analyses on altering the order of segments in a string.

5.2.1 McCarthy's Templatic approach: Cupeño reduplication

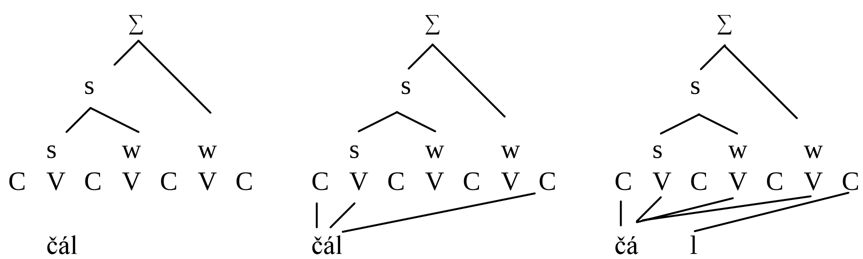
McCarthy (1984) discusses the templatic nature of Cupeño, an Uto-Aztecan language spoken in Southern California and described by Hill (1966). Cupeño exhibits a similar process to imbrication in certain types of reduplication of the verbal mood *habilitative*, which roughly translates as *'can do x'*. Reduplication in these forms involves partial reduplication of the verb stem consisting of a pair of segments - a glottal stop and the last vowel of the stem. This pair of segments is, like in imbrication, inserted or reduplicated before the stem-final consonant. Consider the habilitative forms of the verbs in (13) below. Reduplicated material is underlined and accents on vowels mark stress.

	verbs		habilitative	
(13)	verbs		habilitative	
a.	čál	'husk'	čáʔaʔal	'can husk'
	hel^{y}ép	'hiccup'	hel^{y}éʔeʔep	'can hiccup'
b.	čáspel	'mend'	čáspeʔel	'can mend'
	ʔísax^w	'sing men's songs'	ísaʔax^w	'can sing men's songs'
c.	píneʔwex	'sing enemy songs'	píneʔwex	'can sing enemy songs'
	xáleyew	'fall'	xáleyew	'can fall'

McCarthy argues that the Cupeño data in (13) provide strong support for a foot based morphological template of the habilitative, if we consider the output of the habilitative rule to be a sequence of a stressed syllable followed by two unstressed syllables. The last vowel in the stem is copied once (13b) or twice (13a) following a stressed syllable, or not at all (13c), depending on the extent to which the requirement for two syllables after the stressed syllable has been met. The sequences of vowels resulting from this reduplication process are separated by a glottal stop, a mechanism that is utilised elsewhere in the language when vowel-final roots are suffixed with vowel-initial suffixes. Under McCarthy's analysis, we can assume a left headed habilitative template consisting of a strong position followed by two weak positions in which the stressed vowel is associated with the strong position in the template. Additionally, a stipulation is necessary to the effect that the final consonant of the stem is associated with the final C position of the template. This final association rule only affects non-syllabic segments so that vowels in vowel-final stems, which do not form the habilitative, are not subjected to this final association rule.[141] Consider the derivation of the habilitative of *čál* 'husk' in (14) below, adapted from McCarthy (1984: 314).

(14) čál 'husk' → čáʔaʔal 'can husk'

a. habilitative template — b. left headed template & final -C association — c. rightward vowel spread



(14a) gives the template of the habilitative consisting of a metrically strong position followed by two weak positions. In (14b), the stressed vowel of the root attaches to the strong position of the template and the final consonant of the verb to the final C slot of the template. The only source of material to fill the remaining empty positions in the template is the stem vowel that spreads into the weak vocalic positions, after which glottal stops are inserted to avoid sequences of vowels or to fill the C slots of the CV tier. In longer verbs such as *čáspel* 'mend' (13b), the first CV after the strong position in the template is already filled leaving only one weak

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[141] I considerably simplify McCarthy's analysis here. The analysis anchors on a differentiation of disyllabic from tri-syllabic feet. The Cupeño case discussed here involves dactylic feet, represented by Σ in (14), which are left dominant and dominate three syllables. The dactylic foot ends the word and allows verb roots with non-final stress to form habilitatives. For further discussion cf. McCarthy (1984).

position to be filled. Note that it is the final vowel in the verb stem, and not the stressed vowel, which fills the remaining weak position. In this way, we are able to account for why only one -Vʔ- sequence appears in the examples in (13b). The data in (13c), which already have two syllables after the stressed syllable, completely fill up the habilitative template and hence cannot form a habilitative that is distinct from the root. This accounts for the varying shapes of the habilitative in verb forms of different sizes in Cupeño.

For the Bemba process of imbrication, a templatic analysis would involve introducing an underspecified -VC- template for the perfect suffix, represented on a different tier from the verbal base. This would allow the base-final consonant to attach to the C slot of the suffix -VC- template, thereby leaving only a V slot for the *-ile* suffix that is then filled by /i/.[142] I give an illustration in (15).

(15)

C V_1 C V_2 C	-FV	CV tier
k á l i p	-a	verbal base tier
- V_3 C -		template tier
i l	e	

káliip-e 'has been painful'

Thus in (15), the base-final consonant /p/ attaches to the C slot of the -VC- template, and the initial vowel of the perfect suffix /i/ attaches to the V slot. The consonant /l/ of the suffix remains unsyllabified and is stray erased. Production of the perfect form means collapsing the tiers, resulting in the vowel sequence V_2-V_3 in the imbrication site. This templatic approach requires derivational (frozen *-ip-*) and inflectional (*-ile*) suffixes to be represented on different tiers and thereby predicts them to be phonologically distinct. There is little motivation for such a distinction. A distinction between derivational and inflectional affixes is crucial for the analysis because the final association rule cannot be phonologically conditioned by an underspecified -VC- shape since no other -VC- shaped suffixes condition imbrication.[143] In addition, under such an analysis, we would be at pains to explain why roots do not condition imbrication (cf. examples in 1-4): the final consonant of roots could equally well undergo the final association rule. There is thus little motivation for a templatic approach to imbrication.[144] Let us now consider a prosodic analysis as proposed in Hyman 1995.

[142] This can be viewed along the lines of the three dimensional autosegmental phonology account of Hausa plurals in Halle and Vergnaud (1980), and McCarthy (1979, 1982).
[143] I deal with some problematic data in section 5.3.8 where imbrication seems to be triggered by any suffix. These cases will, however, be treated as resulting from phonotactic constraints between suffixes.
[144] This is not to undermine McCarthy's analysis, which is perfectly fine for Cupeño and easily extendable to templatic languages.

5.2.2 Hyman's Prosodic Analysis

Hyman (1995a) gives a prosodic account of the Bemba data given above by evoking the notions of extrametricality under circumscription (McCarthy and Prince 1986, Hammond 1991) and a minimality condition on imbrication that ensures that only bases longer than a syllable are subject to the process. The minimality condition is given as follows:

(16) Minimality Condition:
$\Sigma > \sigma$: a stem must be longer than one syllable

The most straightforward interpretation of the minimality condition in (16) suggests that the only permissible stems or words in Bemba are bi-syllabic or longer words. This implies that processes like imbrication must adhere to this condition and only produce outputs that are consistent with the minimality condition. Consider then the process of imbrication in (17) with illustrations in (18), as proposed by Hyman (1995a: 11).

(17)
a. at the right edge of a verb base circumscribe (i.e. mark as invisible) the final C subject to the minimality condition (cf. 18a)
b. suffix perfect *-il-* onto the remaining base (cf. 18b)
c. add the inflectional final morpheme *-e* (in 18B, this brings /t / back into syllabification) (cf. 18c)
d. syllabify followed by stray erasure where necessary (cf.18d)

(18)		A	B	C
		cít-	sákat-	úmfu-
	a.	___	sáka‹t›	___
	b.	cít-il-	sáka-il‹t›	úmfu-il-
	c.	cít-il-e	sáka-il t-e	úmfu-il-e
		σ σ σ	σ σ σ	σ σ σ
	d.	c i t- i l -e	s a k a- i l t- e	u m f u -i l- e
	e.	cít-il-e	sák-éet-e	úmfw-iil-e

The aim of Hyman's analysis is to propose a uniform suffixation process for the perfect that is applicable to all verb forms. Such uniformity is desirable because it does not involve a special rule intended only for imbrication. We only need to assume that the trigger of circumscription is the perfect suffix and that imbrication applies depending on whether circumscription applies, which itself is dependent on the size of the stem. Thus, for the CVC- root in (18A), the final consonant of *cit-* is not circumscribed as this would lead to a remainder of /ci/, which is not longer than a syllable. The lack of circumscription means that the perfect suffix attaches to the end of the root to give *cit-ile* ‘has done’.[145] In (18B), the final consonant of *sakat-* is circumscribed at the right edge, leaving /saka/ which is longer than a syllable. The perfect suffix is then attached, followed by addition of the final vowel /e/, which brings the circumscribed consonant back into syllabification. The loss of segmental material in the perfect suffix follows directly from this analysis; there is no room in the phonological representation to accommodate the suffixal /l/ once the circumscribed final consonant is brought back into syllabification, it is therefore, stray erased. Finally, in (18C), with a vowel-final root, circumscription fails to apply due to the lack of a final consonant, and hence no imbrication takes place.

From the foregoing, then, we conclude that the aim of the minimality condition in circumscription is to ensure that the *remainder* after circumscription is larger than one syllable.[146] This interpretation is not without problems, as it edges on the rather vague definition of the prosodic unit that is subject to imbrication. Ideally, the minimality condition should apply as a general rule defining minimal stems in the language. The remainder after circumscription would - in this sense - be a sub-case of stem. However, in view of the CV-stems discussed earlier, the minimality condition cannot be regarded as a global rule, but is rather specific to imbrication. In addition, although under Hyman’s analysis, vowel-final roots, such as (18C), are subject to the same operations as consonant-final ones, it is not clear in what sense the statement in (17a) holds for a vowel-final root. (17a) is in itself a commitment to the proposition that there will always be a final -C and therefore makes no predictions for verb forms like (18C). More empirically, given the definition of the minimality condition, all roots that are longer than CVC-, i.e. all -NC final roots, which do not undergo imbrication, are problematic for the condition since it predicts that circumscription should apply in these cases. In *bele‹ŋg›-* ‘read’, *bulu‹ŋg›-* ‘mould’, the remainder after circumscription *is* larger than a syllable, but imbrication never applies in these cases. We may, however, be able to counteract these problems by a re-statement of the minimality condition.

The proposed final consonant circumscription in Hyman’s analysis is equivalent to McCarthy’s notion of final association discussed in section 5.2.1, and plays the role of ensuring that the imbrication site remains before the base-final consonant. Note also that, as in the Cupeño case, a final vowel is not subject to circumscription. This assumption is relevant to the question of whether we consider glides that are underlying vocalic entities as circumscribable or not (cf. the data in (7)). For glide

[145] Hyman’s analysis assumes the perfect suffix to consist of two distinct parts: *-il-* and *-e*. This follows from the rules (17b) and (17c), and is reflected in the perfect formation of the CVC- root in (18A): *cít-* first undergoes *-il-* suffixation (18A-b) and then *-e* suffixation (18A-c). There is a long-standing debate in Bantu linguistics on the validity of this division. We will not concern ourselves with this here but suffice it to say the final /e/ of *-ile* occupies the position of the FV in perfect forms.

[146] In McCarthy and Prince’s (1986) formulation, prosodic circumscription picks out a prosodic constituent at one end of a word (typically a foot) as the target of a morphological operation. Hammond (1991) terms this positive circumscription and identifies negative circumscription as the case where the morphological operation is applied not to the circumscribed unit but to the remainder after circumscription. Hyman’s formulation thus presents a type of negative circumscription.

final roots, Hyman evokes morphemic circumscription, which targets morphemes such as the passive *-w-*, thereby allowing vowels to be circumscribed. Morphemic circumscription only affects the causative /i/ and the passive /u/.[147] This explains the unexpected imbrication in the examples in (7). Note, however, that this type of circumscription is clearly not subject to the minimality condition because when the passive *-w-* is circumscribed in for example (7a), *fil‹w›-*, the remainder after circumscription is *not* greater than a syllable. According to the analysis sketched in (18B), the suffix consonant /l/ is stray erased when the circumscribed segment is brought back into syllabification: there is no room in the phonological representation to accommodate it according to Hyman's analysis. This, however, fails to happen in *fil‹w›*, where the output form is *fil-il̲-w-e* 'has been unable', rather than the predicted ungrammatical **fili:we*. It might therefore be more insightful to relate the lack of syllabification of the suffixal /l/ in **sakee-l-te* (18B) to phonotactic constraints rather than to *lack of space* in the phonological representation. A final complication in the passive forms is the imbrication of productive passives. Consider the examples in (19) below.[148]

(19)	root	root+pass.		root+pass.+perf.	
a.	pet-a	pet-w-a	'be folded'	pet-el-w-e	'has been folded'
	appl.base	appl.base+pass.		appl.base+pass.+perf.	
b.	pet-el-a	pet-el-w-a	'be folded for'	pet-eel-w-e	*pet-el-el-w-e
					'has been folded for'

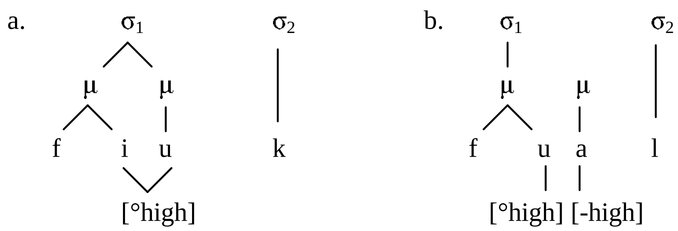
The interesting data here are in (19b) where the perfect form of a passivised applicative (3rd column), results in imbrication before the applicative. In the prosodic analysis, this must involve double circumscription of first the passive morpheme and then the preceding consonant, i.e. *pet-e‹l›-‹w›-*. This is unexpected, particularly given that final NC clusters are excluded from circumscription on the grounds that only simplex consonants are circumscribable. Circumscription of only the final passive suffix in (19b) would produce an ungrammatical output form: *pet-el-‹w›-* + *-il-* → **pet-el*$_{appl.}$*-el*$_{perf.}$ *-w-e*, as shown in (19b) or **pet-el-ee-w-e*, with loss of the suffixal /l/.

A final investigation of the prosodic analysis involves the CGV:C- bases in (8), which undergo imbrication but would violate the minimality condition if circumscription took place. For these cases, Hyman employs a constraint that bars a sequence of vowels to be in the same syllable if the second is pre-specified for

[147] According to Hyman (1994) the causative /i/ appears before the FV in causativised stems as discussed in chapter 4. Remember also that my investigations have led me to conclude that the presence of the causative is only indirectly manifested in the mutated base-final consonant. This is achieved by representing the causative as structure free and hence docking onto the consonant that precedes it (cf. discussion chapter 4). The causative suffix therefore poses no complications for my analysis.

[148] A passive base that is applicativised also produces the form in the second column of (19b), i.e. *pet-w-a* 'be folded' → *pet-el-w-a* 'be folded for'. This suggests that the passive is subject to imbrication with other suffixes as well. I return to these data in section 5.3.6.

height. The analysis here treats /i/ and /u/ as underspecified for height, represented as [°high] and /a/ as pre-specified for height, represented as [-high] in (20). Consider now the syllabification of *fyuuk-a* 'escape' (3b) versus *fwaal-a* 'dress/wear' (8b), in (20) below. Illustrations are adapted from Hyman (1995a: 21).

(20)


In (20a) the two vowels unspecified for height are syllabified in the same syllable σ_1, while in (20b) the pre-specified vowel /a/ fails to be syllabified in σ_1. Circumscription of /k/ in (20a) fails to apply because the remainder after circumscription will be exactly one syllable, as opposed to (20b) where the remainder after circumscription of the final consonant /l/, will be a syllable and a mora. The generalisation captured by this analysis is that if /a/ is the second vowel in a sequence of two vowels then imbrication applies because the mora of this pre-specified vowel fails to be attached to the preceding syllable. It is doubtful that the syllabification pattern of a long vowel in one mora (20b) has any role to play in the language in general.

There are other remnant issues such as the data in (10) where *-aan-* final roots undergo imbrication, as well as the fact that -NC final roots never undergo imbrication despite meeting the requirements of the minimality condition. These issues are dealt with in Hyman's analysis by assuming that NC clusters are never circumscribed, hence no imbrication, and that all *-aan-* sequences have an underlying consonant between the two vowels, thereby allowing circumscription without violation of the minimality condition. The epenthetic consonant is deleted at the end of the derivation. The final version of Hyman's proposal for imbrication can be summed up as in (21).

(21) Prosodic analysis of imbrication involves:

- prosodic circumscription of the base-final C
- morphemic circumscription of the causative and passive morphemes; morphemic circumscription precedes prosodic circumscription
- a minimality condition that defines the conditions for circumscription
- a constraint that bars a vowel pre-specified for height to be syllabified in the same syllable as an underspecified vowel, under the assumption of pre-specified and underspecified vocalic features
- NC sequences must not be circumscribed

- verbs ending in -aaC- (cf. (10)), are underlyingly -aGaC-, imbricating to -aGeeC-, then simplifying to -eeC-, where G represents an epenthetic consonant[149]

Thus the final version of circumscription reads:

> at the right edge of a verb base ending in a single V plus single C, circumscribe the final C subject to the minimality condition (a final C will be circumscribed only if the final vowel is short). If the final C is a morpheme circumscribe it under morphemic circumscription followed by circumscription of the preceding C under prosodic circumscription.

Hyman's analysis in (21) though insightful would benefit from a reduction in the stipulations made for the process of imbrication. There are at least two questions relevant for the characterisation of the process. Firstly, why does the language take an option that leads to loss of segmental content, and secondly, why does the imbrication site lie at the right edge of the word? An additional question, also raised in the prosodic analysis just discussed, is whether the unit to which the perfect suffix attaches in imbrication constitutes a morphologically valid unit. I pursue these questions in the following sections, leading to my proposal in section 5.2.1.

5.3 Defining the domain of imbrication

As seen from the data surveyed in section 5.1, imbrication never targets roots. This supports the characterisation of the root as autonomous in the unmarked case in the process of spirantisation discussed in chapter 4. The only possible counter examples to this are CGV:C- roots that alternate between non-imbricating (22) and imbricating (23). Consider the following data reproduced from (3) and (8), respectively.

(22) non-imbricating CGV:C- roots

a.	fwiis-a	'spit out'	fwiish-ile	'has spat out'
b.	fyuuk-a	'escape'	fyuuk-ile	'has escaped'
c.	byool-a	'belch'	byool-ele	'has belched'
d.	fween-a	'scratch'	fween-ene	'has scratched'

149 It is necessary to postulate an epenthetic consonant here because imbrication is not able to apply in the prosodic account if the imbrication site contains a long vowel. Without this restriction, circumscription could apply normally to the final consonant and a long vowel fuse with the /i/ of the perfect to yield a long vowel, resulting in the loss of a mora.

(23) imbricating CGV:C- roots

a.	byáal-a	'plant'	byéel-e	'has planted'
b.	fwáal-a	'dress'	fwéel-e	'has dressed'
c.	kwaat-a	'have'	kweet-e	'has had'
d.	shaal-a	'remain'	sheel-e	'has remained'

I will claim that this distribution can be accounted for by considering (22) to be roots and (23) to be bases of CV- roots. I delay discussion to section 5.3.3. The effect of considering roots to be autonomous units for the process of imbrication is that roots form a closed domain that is immune to the process. Thus, from the distribution of imbrication between roots and bases (extended roots), we can define the domain of imbrication as in (24):

(24) In the schema:
[[[Root] D(erivational)-suffixes] I(nflectional)-suffixes],
imbrication only takes place if the domain of D-suffixes is non-null.

What (24) defines is the strict application of imbrication to bases and never to roots. When there are no derivational suffixes present, regular suffixation to the end of the root is predicted. In the next section I discuss evidence for a condition like (24) in Bemba.

5.3.1 Imbrication and phonological domains

In this section, I derive imbrication effects from a mismatch between phonological and morphological domains. We have already defined the root as forming its own phonological domain and that following derivational suffixes also form only one domain that is dependent on the root. Thus, the claim is that; after all derivational suffixes a phonological domain is marked. Let's consider the illustration in (25) to see what happens when inflectional suffixes are added.

(25) a.	Morphology	:	root]$_1$ Ø	I-suffixes]$_2$
b.	Morphology	:	root]$_1$ D-suffixes]$_2$	I-suffixes]$_3$
c.	Phonology	:	root]$_1$ Ø	I-suffixes]$_2$
d.	Phonology	:	root]$_1$ D-suffixes]$_2$	I-suffixes]*$_3$

In (25a) and (25c), where no derivational suffixes are present, both phonology and morphology recognise the same boundaries: two morphological domains consistent with two phonological domains. (The dotted brackets after the root only serve to indicate the position of D-suffixes). In (25b), where derivational and inflectional suffixes are present, morphology recognises the three boundaries in the verb form (including the boundaries between the derivational suffixes) and creates three morphological domains. However, for the same verbal complexity in (25d), phonology still only recognises two domains. This means that the inflectional suffix remains outside the parsable area. In other words, the inflectional perfect suffix will always run the risk of not being realised if derivational suffixes are present. The claim is therefore that while there is an unlimited number of morphological domains possible, at least as long as derivational suffixes can be combined, there is a limit on phonological domains in morphologically complex verbs. Between the root and its suffixes only two phonological domains are parsable i.e. $[_2[_1$ root$]_1$ suffixes$]_2$.[150] For this reason, for purposes of interpretability, the perfect suffix shifts to the preceding phonological domain. This shift amounts to imbrication. This brings us to an important characterisation of how phonological domain boundaries are marked.

As stated earlier, phonological operations in the verb optimally aim to produce consonant-final bases, to which the FV is added. Let us consider a concrete example in (26), where the square brackets mark phonological domains. The brackets in bold in (26c) show the only licit phonological domain boundaries in a verb containing both derivational and inflectional suffixes.

(26)	root	a.	D-suffixes	b.	I-suffixes	c.	D + I-suffixes
	lemb-		[[lemb]-el-an]-a		[[lemb]-el]-e		*[**[[**lemb**]**-el**]**el]-e
	‘write’		‘write for each other’		‘has written’		‘has written for’

In (26a), the final consonant of the final derivational suffix serves as the base-final consonant of that phonological domain.[151] Similarly, the /l/ of the perfect *-ile* in (26b) acts as the base-final consonant of the second phonological domain. Domain-final consonants act as a parsing cue for phonological domain-finality and thus cannot be displaced from their position. We have already postulated, following assumptions in Downing (2000), that the domain to the right of the root defines the derivational domain of the verb stem as opposed to the left edged inflectional domain. I take this to mean that whenever derivational suffixes are present in a verbal base it will be one of these suffixes (the final one) that will mark the end of the derivational base, i.e. the final consonant of the final derivational suffix will mark the phonological domain boundary. Thus, if there are no derivational suffixes present in the verb, the morphological bracketing with respect to D-suffixes is invisible in the phonology. If, on the other hand, derivational suffixes are present, then the morphological bracketing becomes visible to the phonology and any other following brackets cannot be visible.[152] This implies that, under the assumption that a root and following suffixes only contain two phonological domains, one of the root

[150] The numeric value here is not part of the proposal per se, but merely follows from the definition of phonological domains under no bracketing derivation that is supported here by the behaviour of the inflectional perfect suffix. Discussion follows presently.

[151] As stated earlier, phonological domains are defined as representing phonologically active domains and not as representing domains that consist of meaningful units.

[152] Phonological brackets are being used here, as elsewhere in this dissertation, for explanatory purposes only and are not to be understood as phonological entities. To the phonological parser, in for example the imbrication process under discussion here, the domain boundary is marked by the final consonant of the final derivational suffix. In fact, imbrication lends support to this position.

and one of the root with its dependent suffixes, the structure in (26c), with three phonological domains (under the assumption that the inflectional suffix creates a new phonological domain boundary), must be resolved. Let’s consider the three possibilities for this resolution in (27). The bold -VC- in the illustrations represents the final derivational suffix.

(27) a. $[[\text{root}]\ \text{-}\mathbf{V}\text{-V}_{\text{infl.}}\ \text{-}\mathbf{C}]_{\text{D-suffixes}}$ b. $[[\text{root}]\ \text{-}\mathbf{VC}\text{-il}_{\text{infl.}}\ ]_{\text{D-suffixes}}$
c. $[[\text{root}]\ \text{-}\mathbf{V}\text{-il}_{\text{infl.}}\ \text{-}\mathbf{C}]_{\text{D-suffixes}}$

The representation in (27a) incorporates only the vowel of the perfect suffix into the derivational domain and thereby retains the shape of the right edge of the phonological domain marked by the final consonant of the final derivational suffix. Vowel fusion and lengthening will result from the adjacency of the two vowels. In (27b) the perfect suffix is incorporated in its entirety, following the final derivational suffix. This violates the requirement that the derivational domain should be marked by the final derivational suffix. (27b) can also be viewed as merely parsing the final morphological domain boundary (made by the perfect), as the phonological domain boundary. Finally, in (27c), the perfect is also totally parsed into the position preceding the final derivational -C-. This is in line with the prosodic analysis of Hyman in section 5.2.2 and would involve loss of the consonant of the perfect suffix. In GP, unlike in the prosodic account, this option involves the additional cost of loss of constituent structure because the suffix consonant of the perfect and it’s onset would be lost. As long as we keep the final derivational suffix in final position, then the choice is between (27a) and (27c). For economy reasons, I will opt for (27a), which only parses the vowel of the perfect suffix, thereby avoiding the repair strategy of deleting the consonant of the suffix.[153] Economy also explains why the imbrication site remains before the base-final consonant even if more than one derivational suffix is involved; more effort is required to skip derivational suffixes in order to move the perfect /i/ further away from the right edge. Parsing only the vowel /i/ of the perfect forces two different shapes of the perfect suffix.[154] I give their constituent structure representation in (28).

```
(28)   a.  N  O          b.  O  N
           |  |                 |
           x  x                 x
           |  |                 |
           i  l                 i
```

[153] In a constraint based approach such as Optimality Theory this can be viewed as unmarkedness ranked over faithfulness.

[154] The two suffix shapes proposed here are not independent of each other; rather, the idea is that suffix shape (28b) is a truncated form of (28a) that only arises when D-suffixes are present. What is crucial, however, is that the truncated form of the perfect, consisting of the vowel /i/, has constituent structure. A parallel is drawn here with the causative suffix that is represented as structure free and entering the preceding domain by docking on to the base-final consonant resulting in spirantisation (cf. chapter 4). We predict the two structures to trigger different effects

Given the representation of the truncated form of the perfect in (28b), i.e. represented in constituent structure, its incorporation into the preceding domain can only be into the position before the base-final consonant and not after it, otherwise a sequence of two vowels after addition of the FV would result. Such an output would render the truncation of the perfect purposeless since fusion of the two vowels would produce a glide that remains outside the phonological domain. Truncation must therefore be viewed as an effort towards incorporating the perfect into the preceding phonological domain.

Let us retrace the argument so far. I have argued that within morphological structure, phonology can only access two phonological domains. The root forms the first phonological domain. The second phonological domain, marked by the final consonant of the final derivational suffix, consists of the root and following derivational suffixes. If the inflectional perfect suffix is present in a following unparsed domain, it shifts into the preceding phonological domain by inserting the /i/ of the perfect *-ile* into the position before the base-final consonant. This results in the process we term imbrication. We can thus characterise the conditions for imbrication as in (29).

(29) conditions on imbrication:

- verb roots create phonological domains
- a maximum of two phonological domains between the root and its suffixes is allowed
- phonological domain boundaries cannot be adjusted

Let us now consider how this characterisation of imbrication explains the process in the environments that it occurs in. I consider, in the following sections, how the process of imbrication interacts with frozen bases, multiply extended roots, extended CV roots, the passive, reduplication and the separative suffix *-ul-*.

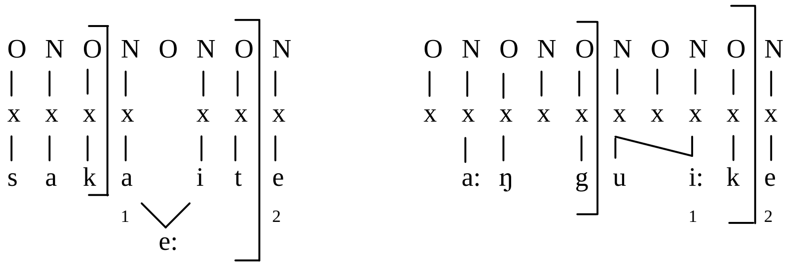
5.3.2 Imbrication in bases

In the foregoing, I have argued that imbrication never affects roots. This gives an easy and straightforward explanation to all the data in (1-4) that undergo regular suffixation. Thus the application of imbrication is not conditioned by the size of the stem, but rather on whether a root or a base is involved. It thus follows that for the NC- final long roots in (4) such as *βúlu:ŋga* 'mould', *βéle:ŋga* 'read', no imbrication applies. This explains why they are never subject to the process of circumscription, postulated in the prosodic account.

Let us now consider how the perfect forms are created, starting with CVCVC-bases that consist of either frozen suffixes or productive suffixes (data in (5) and (6)). Identifying the final -VC- of the bases in (5)-(6) as suffixes (*-at-* and *-uk-* in (30)), imbrication proceeds as illustrated in (30). In (30a) and (30b), the extensions are penetrated by the truncated perfect suffix in a bid to be parsed within the final phonological domain defined by the derivational suffix. The perfect suffix would otherwise fall outside the two domains indicated by square brackets. (In the following representations I omit the structure of long vowels where it is not directly relevant to the derivation).

(30) CVCVC- ØVCVC-

a. sák-at-a → sák-éet-e b. a:ŋg-úk-a → a:ŋgw-íik-e



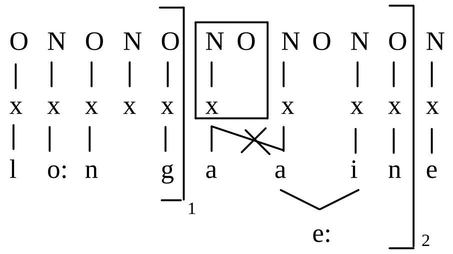
In (30a) imbrication results in vowel fusion across two nuclear positions, subsumed under fusion of the elements of /i/ and /a/ under rightward A-linking as seen in chapter 2, to produce /e:/, which is long because it fills two skeletal positions. In (30b) fusion of the elements (I) and (U) is barred following the phonotactics of Bemba, here defined by both the vocalic licensing constraints and the process constraint on vowel fusion.[155] This means /u/ is pronounced as a glide represented in a structure akin to a heavy diphthong, where the initial vowel has glide pronunciation and the second has vocalic interpretation stretched over the two positions as shown in (30b). This gives the two outputs of imbrication in this base type: one that involves total fusion (30a), and one that involves partial fusion (30b).

The next base shape that contains a frozen suffix that is still morphologically recognisable involves bases ending in *-aan*, given in the data in (10). This is an unusual suffix shape because vowel length is not underlyingly distinctive in suffixes. This can be considered to be derived from a reduplicated reciprocal *-anan-* which lost the intervocalic nasal, or from the reconstructed reciprocal **-aŋgan-*, which is still manifest in some Bantu languages (Yao P.21, Nyoro E.11). Needless to say that the roots this suffix attaches to all have an independent meaning showing that it is not yet totally fossilised.[156] Imbrication in these cases involves loss of the (NO) sequence following the root, under reduction, as shown in (31). Reduction in this case is a necessary outcome because a vowel stretched over three skeletal positions is illicit in Bemba.

[155] The relevant licensing constraint here is *I and U must be head*. Under fusion, one of these elements would have to lose its head status.

[156] Thus for example, *longaana* 'gather together' is derived from *longa* 'pack of items', with an extension of the meaning to animate entities. The root can also be used with other suffixes such as the separative to give *long-olol-a* 'unpack' (transitive) or *long-olok-a* 'be unpacked' (intransitive). Relevant examples are given in (10).

(31) CVCV:C-
lo:ŋg-áan-a → lo:ŋg-éen-e ‘have gathered’



If imbrication did not target bases, we would expect it to be avoided in cases like (31) because there is a long vowel in the imbrication site, which results in loss of the boxed NO sequence preceding the imbrication site. This is a consequence of the fact that vowel lengthening is a by-product of imbrication. It is for this reason that in the prosodic account, Hyman (1995a) postulates an epenthetic consonant between the two vowels in the base, which is deleted at the end of the derivation. We can, however, deduce from (31) that vowel length does not block imbrication but rather that the process is dependent on the status of base or not.[157]

5.3.3 Imbrication with extended CV- roots

As observed in sub-section 5.1.3, extended CV- roots, only systematically imbricate when they are multiply affixed (data in (12)). Imbrication in CV- roots extended with a single suffix only applies if the suffix contains /a/ (examples in (8) and (9)).

When CV- roots are suffixed with any (-VC-) suffix, there is vowel fusion between the root and the suffixal vowel. In many cases, this fusion has led to frozen bases where the CV- root involved is no longer identifiable in the sense that it no longer has independent use. This situation is also enhanced in fusions that involve suffixes that are no longer productive. Consider the data in (32), where the bases have independent use, i.e. are semantically non-compositional. Given in brackets are the possible CV- root and -VC- suffix.[158] Data of this type are given in (3) and (8-9).

(32)	CGV:C-			perfect	
a.	byáal-a	(bi-al)	‘plant’	byéel-e	‘has planted’
b.	fyuuk-a	(fi-uk)	‘escape’	fyuuk-ile	‘has escaped’
c.	fwiik-a	(fu-ik)	‘dress’	fwiik-ile	‘has dressed’
d.	βeek-a	(βa-ik)	‘shine’	βeek-ele	‘has shone’
e.	loot-a	(lo-ut)	‘dream’	loot-ele	‘has dreamt’
f.	luul-a	(lu-ul)	‘praise’	luul-ile	‘has praised’
g.	liil-a	(li-il)	‘enjoy’	liil-ile	‘has enjoyed’
h.	kaan-a	(ka-an)	‘refuse’	keen-e	‘has refused’

[157] There is a condition on imbrication affecting long vowels that is explored in sub-section 5.3.3.
[158] Insightful etymologies of CV- roots can be found in Greenberg (1974).

In the vowel fusions in (32a-c), as well as all data that produce CGV:C- bases, the vowel of the CV- root involved is produced as a glide and therefore surrenders its contribution to the root vowel in the output form. In (32d-h), on the other hand, the CV- root vowel remains a part of the root vowel of the output form because it undergoes total fusion with the vowel of the suffix. Both partial and total fusion, obscure the original quality of the input CV-root, i.e. produce a *new* root vowel. Given this change in the root vowel, it seems reasonable grounds on which to assume that there is no phonological boundary after CV- roots. My proposal is thus that a *derived root* as opposed to a *natural root*, is created in these cases. For CV-roots, this non-trivially implies that the first phonological domain in extended forms is after the first derivational suffix, thus $[\text{CV-VC-}]_1$ rather than $^*[[\text{CV}]_1\text{-VC-}]_2$. This would mean that, not only does the final consonant of a derivational suffix mark a phonological domain but also that all word-internal phonological domains must be consonant-final. For this reason, CV roots and following vowel-initial suffixes form derived roots. This means that we treat the data in (32) as consisting of derived roots. Notice, however, the imbrication in the derived roots (32a) and (32h) which is in contrast to the behaviour of natural roots.

The main motivation for treating roots as forming autonomous units is that roots always maintain the quality of their vowel hence they also act as the trigger of the rightward vowel harmony discussed in chapter 2. Indeed, the definition of root itself anchors on the presence of a root vowel that bears lexical tone and is also the head of the domain from which all licensing within the domain emanates. Thus, any phonological process that threatens to obliterate the colour of a root vowel is barred, resulting in a closed phonological domain for the root. This position is strictly maintained in natural roots. However, in derived roots, which are basically (frozen) bases promoted to root status, a phonological operation may occur in the root as long as the identity, here the elemental character, of the root vowel remains visible. Given that any of the five vowels of the language may occur in any root position, let us consider what the set of possible derived roots from CV roots are, in (33). I do not use concrete examples.

(33)

Root	-uC- suffix	-iC- suffix	-aC- suffix
a. Ca-	Cu:C-	Ce:C-	Ca:C-
b. Ci-	Cyu:C-	Ci:C-	Cya:C-
c. Cu-	Cu:C-	Cwi:C-	Cwa:C-
d. Ce-	Cyo:C-	Ce:C-	Cya:C-
e. Co-	Co:C-	Cwe:C-	Cwa:C-

We can divide the possible derived roots into three groups; those that are CV:C-shaped (Ca:C-, Ce:C-, Ci:C-, Co:C-, Cu:C), those that contain the glide /w/ (Cwa:C-, Cwe:C-, Cwi:C-) and those that contain the glide /y/ (Cya:c-, Cyo:C-, Cyu:C-). Thus, maximally five different root vowels in derived roots can be identified. For each of these vowels, application of imbrication, unlike in natural roots, is a possibility under the condition that the resulting vowel after imbrication does not totally displace the vowel of the derived root. In other words, the elemental content of the derived root vowel must be a proper subset of the output long vowel after imbrication. This means that imbrication is barred in the derived roots of the shape Cu:C- and Co:C- where imbrication would yield Cwi:C- and Cwe:C-, respectively. In these cases, the root vowels /u:/ and /o:/ (i.e. their elemental make-up) are totally replaced. The imbrication outputs of the derived roots Ce:C- and Ci:C- also violate of the requirement to retain the identity of the root vowel, because the long vowels /e:/ and /i:/ do not form proper subsets of the long vowels produced after imbrication, i.e. Ce:C- and Ci:C-, respectively. I will term the condition on imbrication into a long vowel site as a *containment* requirement.

(34) Containment: for imbrication to apply in a long vowel site, the elemental content of the target long vowel must be contained in the output long vowel.

The containment requirement ensures that the input vocalic structure of the derived root is independently recognisable in the resulting long vowel after the incorporation of the perfect vowel /i/.[159] Consider the illustration of containment in (35).

(35) a. Ce:C- → Ce:C- b. Ci:C- → Ci:C- c. Ca:C- → Ce:C-

a.		b.		c.	
N O N →	N O N	N O N →	N O N	N O N →	N O N
A	A	I	I	A	A
I	I				I

Under the definition of containment in (34), (35a) fails to produce an output long vowel where the input elements (A.I) can be identified independently of the perfect element (I). Imbrication thus fails to take place in this case. This explains why complex verb forms such as *ceel-a* 'dawn for' (derived from *ca-il$_{appl}$-a*), have regular suffixation in the perfect: *ceel-ele* 'has dawned for', rather than the imbricated output (**ceel-e*). In essence, the notion of containment accounts for the blocking effect that I have already alluded to in the discussion of CV- roots in section 5.1.3. (35b), under the same reasoning, also fails to undergo imbrication. (35c), on the other hand, allows imbrication because the input root vowel consisting of the element (A), is contained in the output vowel, consisting of the element combination (A.I). What we capture by this, as in the prosodic analysis by the assumption of different height specifications, is that only a long vowel /a:/ ever undergoes imbrication. Thus, in derived roots, imbrication is possible only if the

[159] The fact that there isn't a containment requirement in CV- natural roots, i.e. *bi-al-a* → *byaal-a* 'plant', with total replacement of the CV- root vowel /i/, follows from the phonological domain structure assumed. As already discussed, CV- roots do not form independent phonological domains - they are vowel-final. The first phonological domain that forms an 'autonomous' unit is the derived root [CV-VC]. Thus the entity *phonological domain* has supremacy over the entity *root* and preservation requirements are held at the phonological domain level.

output vowel after imbrication satisfies containment. This is a formalisation of the opacity effect noticed in these verbs in section 5.1.3.

As seen in (36), complex verbs involving non-imbricating derived roots (CV- root + -uC- or -iC- suffix, cf. (32b-g)), or imbricating derived roots (CV- root + -aC- suffix, cf. (32a) and (23h)), are parsed within two phonological domains.

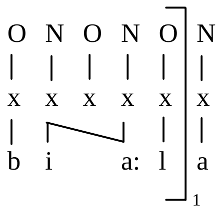
(36)	root			derived root	perfect	
a.	tu-	[tu-an-]	→	$[\text{twa:n-}]_1$	$[\text{twe:n-}]_1\text{-e}$	‘have pounded e.o.’
b.	tu-	[tu-il-]	→	$[\text{twi:l- }]_1$	$[\text{twi:l-}]_1\text{-il-e}]_2$	‘has pounded for’
c.	tu-	[tu-il-an-]	→	$[\text{twi:l}]_1\text{ an-}]_2$	$[\text{twi:l-}]_1\text{een-e}]_2$	‘have pounded for e.o.’

(36a) and (36b) show the formation of a derived root by the fusion of the CV- root vowel and the vowel of a derivational suffix, here the reciprocal and the applicative, respectively. This yields the derived roots shown in the 2nd column of (36). In (36a) imbrication applies to the derived root, giving a perfect form that consists of one phonological domain. In (36b) by comparison, the derived root does not undergo imbrication under containment, resulting in the total parsing of the perfect in the empty D-suffix domain, thereby utilizing the second phonological domain. (36c) is a multiply extended CV- root. As in (36a) and (36b) a derived root is formed by the CV root vowel and the vowel of the following suffix. Imbrication then applies in a standard manner, i.e. not in the derived root, but in the non-null D-suffix domain.

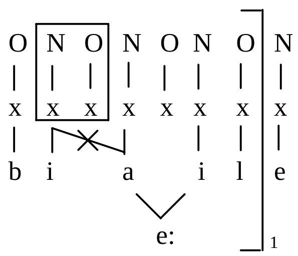
Consider now the derivation of the perfect in derived roots in (37). (37a) contains the *dead* suffix *-al-*. The inability of /i/ and /a/ to fuse in this sequence, following discussions in chapter 2, causes /i/ to have glide interpretation while /a/ compensatorily lengthens to give the derived root: *byaal-* (root of the verb ‘to plant’). On the introduction of the perfect in (37b) the NO sequence enclosed in a box is lost by reduction.

(37) C(G)CV-

a. bí-al-a → by-áal-a



b. by-áal-a → by-éel-e



In the discussion of imbrication in extended CV- roots we have introduced the notion of derived root that results from the fusion of a CV- root and a following -VC- suffix in order to create a consonant-final internal phonological domain. Within a derived root, imbrication is only possible if it faithfully reproduces the root vowel without any containment violations. In coming sections, we will see how the notion of formation of a derived root and the idea of fusion in vowel-final roots, take on a more general nature in phonological derivations in the language.

5.3.4 Imbrication and the passive

The final set of data that needs some elaboration involves the passive (cf. 7a-d). This includes both frozen and still active morphological bases of the passive. The passive, as noted by Meeussen (1959), always appears final in a base, i.e. in the position immediately preceding the stem-final vowel. This tendency has generally been attributed to the length of the passive with the view that shorter suffixes tend to come at the end of a base. Hyman (1995a), as discussed earlier, uses a condition that recognises morphemes within phonology as circumscribable to induce this behaviour of the passive.

There are two significant factors in imbrication with the passive. Firstly, the passive is the only suffix that allows the perfect suffix to be totally parsed whenever the passive is the only derivational suffix present (38a). Secondly, it appears as though all suffixes that are clearly non-imbricating, do ‘imbricate’ with respect to the passive (38b), (38d) and (38e).[160] Both these factors are attested across Bantu. Consider the data in (38).

(38)	root				
a.	tol-a	‘pick’	tol-w-a	tol-el-w-e	(pass.+perf.)
b.	pu:t-a	‘blow’	pu:t-il-a (appl)	pu:t-il-w-a	(appl.+pass.)
c.	pu:t-il-w-a (appl.+pass.)		pu:t-iil-w-e	*put-il$_{\text{appl.}}$ -il$_{\text{perf.}}$ -w-e (appl.+pass.+perf.)	

Zulu (Meinhof 1932):

	root		passive	applicative	appl.+pass.
d.	thum-a	‘send’	thuny-w-a	thum-el-a	thuny-el-w-a
e.	ɓoph-a	‘bind’	ɓosh-w-a	ɓoph-el-a	ɓosh-el-w-a

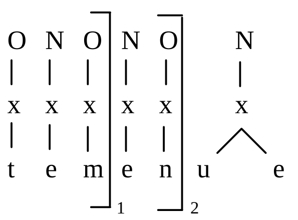
In (38a), as in the cases with the frozen passives in (7), the perfect of a passive produces the perfect before the passive. (38b), (38d) and (38e) show how the same process applies when the passive is combined with other suffixes such as the applicative. We have already seen that the applicative suffix does not instantiate imbrication at all, following its interaction with the causative for example, where *sek-esh-esh-a*,‘make laugh for’ is an applicativised causative; the applicative *-il-* attaches to the end of the base and undergoes spirantisation. These examples thus lead us to conclude that the passive needs some special treatment for the language as

[160] Imbrication is being loosely used here to refer to the infixation of *-il-* before the passive. As seen so far, there is no evidence for infixation processes in Bemba other than that involving the perfect.

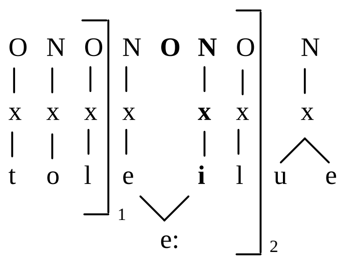
a whole. Formation of the perfect in (38c), which involves a multiply suffixed passive base, yields interesting results that shed light on the nature of the passive. In (38c) the imbricated output of an applicativised passive does not give us a form with the perfect reproduced in totality, but rather the truncated form of the perfect is used. The question is, what phonological representation will help us to capture these facts faithfully and at the same time restrict imbrication to bases, as has been the case in all the data discussed so far? It is clear from the parallel behaviour of the passive, using both the full and the truncated form of the perfect, that whenever the passive is the only derivational suffix in the base, the perfect treats the base as if it were a root. Conversely, when other derivational suffixes are present, normal imbrication occurs. Notice from the perfect of the applicative in (38c), that the passive glide is not treated as the base-final consonant. Thus the solution lies in not regarding the passive -*w*- as syllabified in an onset. I thus take the passive to have no independent constituent structure and to therefore be incorporated into the structure of the FV. This is in line with the structure of glides as light diphthongs that has been assumed for Bemba. One of the repercussions of this syllabification is that the distribution of the passive is consistent with that of the FV, meaning that all bases that are only extended with the passive are phonologically parsed as roots. Consequently, the final derivational suffix before the passive will be the marker of the second and final phonological domain of the base. Thus, under these conditions, all suffixes that interact with the passive must precede it because it only becomes visible with the FV.[161] The frozen perfect forms of the passive (as well as all root+pass. sequences), are in this way treated in an identical fashion to roots with regular suffixation (39a), and multiply suffixed passive bases in the same manner as all imbricating bases that take the truncated form of the perfect. Illustrations are given in (39).

(39) CVC(CV)G- bases

a. tém-w-a → tém-en-w-e
‘has loved’



b. tol-el-w-a → tol-eel-w-e
‘has been picked for’



[161] This position of the passive also explains why its long variant -*iw*-, which is now hardly productive, does not trigger vowel harmony as seen in forms such as *ensh-iw-a* ‘be driven’. However, I have also elicited data that show that it may be undergoing reanalysis so that *lek-ew-a* ‘be stopped/be divorced’ is acceptable by some speakers. Other Bantu languages, such as Swahili, where the long passive is still in use, show that it has already been reanalysed as falling in the D-suffix domain and as such regularly undergoes vowel harmony.

For frozen passives such as (39a), regular suffixation illustrates that roots can still be recognised even when they have lost independent use. In (39b) we see that the base-final derivational suffix is the applicative, in which case imbrication applies normally. Under this view of the passive as contained within the structure of the FV, two phonological domains between the root and its suffixes are maintained. Consider now the more puzzling data in (40), where the frozen passive in combination with the reciprocal does not take final position.

(40)	frozen passive	frozen pass.+recip.		frozen pass.+recip.+ perf.	
	tendw-a	tendw-an-a	*tend-an-w-a	tendw-een-e	*tend-eenw-e
	'tire of'	'tire of e.o.'		'have tired of e.o.'	
	temw-a	temw-an-a	*tem-an-w-a	temw-een-e	*tem-eenw-e
	'love'	'love e.o.'		'have loved e.o.'	

In the data in (40), the frozen passive *-w-* fails to be the final derivational suffix in both the reciprocalised and the perfectivised reciprocal forms. Under the assumption that the passive is represented in the structure of the FV, we predict the ungrammatical outputs in (40). Why are the outputs in (40) possible? Consider that the combination of the passive and the reciprocal suffixes is restricted to frozen passives. This means that any passivised verb form cannot be affixed with a reciprocal.[162] Given this distribution, we must consider the formation of frozen passives as resulting from the gradual movement of the passive suffix from its position in the FV to the position of the domain-final onset. This move also entails the lack of independent use of what we must consider to be the original root of the frozen passives; *tem-w-a* 'love' **tem-a*, *tend-w-a* 'tire of' **tend-a*, *fil-w-a* 'fail' **fil-a*. The frozen passives, as we have already pointed out, are semantically non-compositional and can thus have reciprocal forms as long as the transitivity of the verb form is appropriate. Despite this non-compositional semantics, the applicative, causative and perfect still treat the passive as represented in the structure of the FV, but the reciprocal does not, and therefore we must consider the fossilisation of the passive as a reflection of two possible scenarios. Either, within the course of historical development, we can simultaneously recognise frozen passives to be at two different stages of fossilisation and as such have two different lexical representations at some stage, or the fossilisation of the passive develops separately with respect to each suffix. I do not go into justification of either of these positions, but suffice it to say that for the forms in (40) we must consider the frozen passive to be within the root as secondary articulation on the domain-final consonant.

Let us now move on to an examination of the assumption that the root forms an autonomous phonological domain for perfect forms of reduplicated stems, and see how this position makes the variability manifested in these stems easily predictable.

[162] See Mchombo and Hyman (1992) and Hyman (2002) for a discussion on suffix order in Bantu.

5.3.5 Imbrication and reduplication

As already stated in chapter 3, Bemba exhibits both partial and total reduplication. Partial reduplication is not productive and verbs with partial reduplication are considered to be lexicalised. Total reduplication, on the other hand, is productive and just about any verb can be reduplicated to denote repetitiveness, intensity, or carelessness in the performance of the action of the verb. Partial reduplication is created by prefixing a copy of the initial CV of a root or stem to that stem. We have characterised this copied initial CV as represented in two ON pairs in chapter 3. Total reduplication of stems longer than CV involves doubling of the stem while in CV stems it involves tripling. The perfect forms of reduplicated stems for both partial and total reduplication appear at first sight to be indeterminate and have often been put down to speaker variation. The question is whether this variation can be predicted? On the basis of the analysis of imbrication presented, I claim it can be. Consider the partially reduplicated stems and their perfect forms in (41).

(41)	partial reduplication		perfect	
	a. paa-paat-a	'plead'	paapeet-e	'has pleaded'
	b. too-toosh-a	'whisper'	tootweesh-e	'has whispered'
	c. se-sem-a	'prophesy'	seseem-e	'has prophesied'
	d. shí-shik-a	'burn'	shishiik-e	'has burnt'
	e. pu-puk-a	'fly'	pupwiik-e	'has flown'
	f. pam-pamin-a	'hammer'	pampamiin-e	'has hammered'
	g. sún-sunt-a	'trot along'	sunswiint-e	'has trotted'
	h. pim-piŋg-a	'carry'	pimpiŋg-ile	'has carried'

In (41) perfect formation predominantly involves imbrication although the majority of -NC final partial reduplicative stems pattern with (41h) and have regular suffixation. We can consider imbrication in partial reduplication to result from the selection of the initial CVC- as root, i.e. by creation of a derived root. Identifying some part of the stem as root allows imbrication to apply.[163] Regular suffixation, on the other hand, results from analysing the resulting reduplicative stem as the new root. The competing structures are thus [stem] → [[red.+ C of stem]$_{\text{derived root}}$ remainder of stem] and [stem] → [red.+ stem]$_{\text{derived root}}$. In the former case, imbrication must apply to avoid an additional phonological domain (41a-g), and in the latter case the perfect *-ile* is attached to the end of the derived root (41h). Under this view, the root becomes more of an abstract rather than an actual entity in line with the derived root created by CV roots in sub-section 5.3.3.[164] We can thus

[163] What I refer to here as *stem* is what is referred to in most OT literature (McCarthy and Prince 1993) as the *base* of the reduplication process. I do not use *base* just to avoid confusion with its use in this dissertation, following Bantu tradition, to refer to an extended root. *Red.* in what follows refers to the reduplicant, i.e. the part of the stem that is reduplicated, and *reduplicative stem* to the output after reduplication.

[164] Yao (Ngunga 2000), which as we will see in section 5.4 forms the perfect in the same way as Bemba, i.e. regular with roots and by imbrication with bases, also supports the hypothesis of an abstract CVC- for

formulate a condition to which our parsing device is sensitive such as, ‘in any case where the root is blurred, create a derived root by selecting as root the initial CVC- or by scanning the stem to identify the first derivational suffix, in which case the root will fall before this suffix.’ We can speculate that perhaps the preponderance of imbrication in partial reduplicative stems is due to the fact that the option where a derived root is created, in a condition like the one just stated, is considered to be more economical with respect to the parsing device, which in this case merely scans for the initial CVC- as opposed to scanning for the first D-suffix. Let us now look at total reduplication, where there seems to be even more variation.

(42) total reduplication

a.	shit-a.shit-a	‘buy a lot’	shit-ile.shit-ile ‘has bought a lot’
b.	suk-a.suk-a	‘fidgety’	sukasuk-ile ‘has become fidgety’
c.	lyályaat-a	‘eat a lot’	lyáalyéet-e ‘has eaten a lot’
d.	lubaan-a.lubaan-a	‘unrecognisable’	lubéen-e.lubéen-e ‘has become unrecognisable’
e.	fwaat-a.fwaat-a	‘trample about’	fwa:t-a.fwéet-e/fwéet-e-fwéet-e ‘has trampled about’

In total reduplication, the reduplicative stem consists of independent stems that may both imbricate (42d) and (42e) or both be regularly suffixed (42a), or only one of the stems may imbricate (42c) and (42e). Two scenarios, as in partial reduplication, are perceivable in these data. Either the reduplicative stem is regarded as having no internal phonological domains i.e. consisting of a derived root, or as recognising an internal domain that may be a derived or a natural root. This broad difference can be captured by non-analytic versus analytic morphology, as presented in chapter 2. However, in reduplication, a further dimension is added to these two scenarios: the two stems involved may either be morphologically simplex (i.e. roots, equivalent to the stems *black* and *board* in English *blackboard*) or morphologically complex (i.e. bases). If the two stems involved, labelled here as A and B, are roots, as in (42a) and (42b), the prefect form (42a) results if the roots are treated as consisting of two domains and (42b) results if the roots are viewed as a unit. Consider the illustration in (43).

(43) A and B as roots

a. [[A][B]] → [**[**Root] = 0]$_{\text{D-suffixes}}$**]**$_{\mathbf{A}}$ **[**Root] = 0]$_{\text{D-suffixes}}$**]**$_{\mathbf{B}}$]
(42a. shit-ile.shit-ile)

b. [A B] → **[**[Root] = 0]$_{\text{D-suffixes}}$]$_{\mathbf{A}}$ [Root] = 0]$_{\text{D-suffixes}}$]$_{\mathbf{B}}$**]**
(42b. suka.suk-ile)

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perfects of partially reduplicated stems; *pa-pala* → *papeele* ‘flutter wings’, *do-doma* → *dodweeme* ‘hesitate’, *ŋu-ŋuna* → *ŋuŋwiine* ‘scrape out with teeth’.

In (43a), the roots are treated independently, thus two natural roots are parsed while in (43b) the two roots are parsed as one derived root. This latter pattern can also be seen in (42c) where two roots are parsed as one and a suffix -*at*- (now unproductive) is added to the derived root. Imbrication applies normally as in all extended roots.

Moving on to bases in total reduplication, if A and B are morphologically complex roots as in (42d) and (42e), then given the two possibilities of having either one or two phonological domains between A and B, the following are the possibilities.

(44) A and B as bases

a. [[A][B]] → [**[**[Root] ≠ 0]$_{\text{D-suffixes}}$**]$_{\mathbf{A}}$** **[**[Root] ≠ 0]$_{\text{D-suffixes}}$**]$_{\mathbf{B}}$**]
(42d. lubéen-e.lubéen-e)

b. [A B] → **[**[Root] ≠ 0]$_{\text{D-suffixes}}$]$_{\mathbf{A}}$ [Root**]** ≠ 0]$_{\text{D-suffixes}}$]$_{\mathbf{B}}$]
(42e. fwaat-e.fwéet-e)

For the forms in (44), imbrication will always apply because they are bases, but we may differentiate reduplicative stems that imbricate both stems, following the phonological domain structure in (44a), and those that only imbricate once at the end of the base (44b), in which case the two stems are parsed as a derived root up to the second root. (44a) thus presents two independent phonological domains within the reduplicative stem, but which themselves contain two phonological domains each, because they are bases, and therefore result in imbrication applying separately to each base. As seen from (42e), both options may be possible within the same reduplicative stem. Presumably, different speakers opt for either of these forms. Note that the prediction is that we never expect imbrication only in the initial stem of a totally reduplicated base, because if it is accessed, then a phonological domain has been parsed, reflecting the structure in (44a). This prediction is borne out, as none of the data in (42) can alternate with imbricated forms of the shape, **fweete.fwaata*, **lyee.lyaata* or **lubeene.lubaana*.

We have seen that in both partial and total reduplication, as long as a root is identifiable, natural or derived, it is in no case imbricated into. Although we may want to argue that the output of reduplication must always be a new stem in its own right, it is clear that we have to allow for the possibility of decomposition in phonological processing. In the next section I present a final set of problematic data involving imbrication and the separative suffix.

5.3.6 Imbrication with the separative

The separative transitive suffix -*ul*- or its long version -*ulul*-, gives an interesting spin on imbrication because it seems that all suffixes imbricate with respect to the separative. This endangers the analysis that imbrication results from a shift of the inflectional perfect suffix into the derivational domain, to avert lack of interpretation. Consider the following data in which most of the verb forms are lexicalised.

(45)

	-ul- separative	-ul-il- sepr.+appl.	-ul-ish- sepr.+caus.	ul-il-e sepr.+perf.	
a.	pút-ul-a	pútwiil-a	putwiish-a	pútwiil-e	'cut'
b.	lép-ul-a	lépwiil-a	lépwiish-a	lépwiil-e	'tear'
c.	kak-ulul-a	kakulwiil-a	kakulwiish-a	kakulwiil-e	'untie'
d.	kont-ol-a	kontweel-a	kontweesh-a	kontweel-e	'break'
e.	shíp-ul-a	shípwiil-a	shípwiish-a	shípwiil-e	'doze off'
f.	pút-uk-a	pút-uk-il-a	pútwiish-a	pútwiike	'cut'
g.	kak-uluk-a	kak-uluk-il-a	kakulwiish-a	kakulwiike	'untie'

In (45a-e) we see that the outputs of the separative, with both the applicative (second column) and the causative (third column), are the same as that of the separative and the perfect (fourth column). The only suffix that seems to escape this suffixation pattern with the separative is the reciprocal -an- (*pút-ul-a* → *pút- ul-an-a*). I will interpret these data as not involving imbrication at all, but rather as resulting from a ban on the suffix order **-ul-il-* that forces the separative to lose its suffixal consonant; /u(l)-il/. The nature of the consonants involved in this sequence does not seem to play a role since the consonant may also be /ʃ/.[165] It is also not a ban on the sequence of vowels since the same sequence is allowed in *-uk-il-* (45f).

/l/ deletion is a widespread process in Bantu that has varying productivity in different languages. In Swahili, for example, Proto-Bantu *l has been deleted in many intervocalic environments. In Kirundi, a final /l/ is deleted in the formation of the perfect (cf. section 5.4). We can thus treat /l/ deletion in Bemba as restricted to the separative in the environment where an /i/ containing suffix follows.

Deletion of the consonant of the separative results in fusion of the vowel of the separative and the vowel of any following vowel-initial suffix, whether this is the perfect or not. In the separative data in (45) phonological domain formation is therefore consistent with the assumptions made in this chapter. Consider the domain structure in (46).

(46) $[[\text{kak}]_{\text{1Root}}\ \text{ulul}]_{\text{2D-suffixes}}$ + caus. -ish → $[[\text{kak}]_{\text{1Root}}\ \text{ulul-ish}]_{\text{2D-suffixes}}$ -a

$\downarrow$

Ø

$[[\text{kak}]_{\text{1Root}}\ \text{ulwiish}]_{\text{2D-suffixes}}$ -a

/kakulwiisha/

As seen in (46), two phonological domains are retained. Consider now the following data involving perfected forms of applicativised and causativised separatives, given in the second and third columns of the data in (45), respectively.

[165] The only other productive suffix containing /i/ and a consonant other than /l/ is the stative *-ik-*, but unfortunately separatives do not form statives with this suffix. We will therefore have to be content with regarding the causative *-ish-*, whose /ʃ/ may be argued to underlyingly be /l/, as illustrating that the quality of the following consonant does not play a role.

(47)

	-ul-il-	-ul-il-il-e	-ul-ish-	-ul-ish-il-e	
	sep.+appl.	sep.+appl.+perf.	sep.+caus.	sep.+caus.+perf.	
a.	pútwiil-a	pútwiil-ile	putwiish-a	putwiish-ile	'cut'
b.	lépwiil-a	lépwiil-ile	lépwiish-a	lépwiish-ile	'tear'
c.	kakulwiil-a	kakulwiil-ile	kakulwiish-a	kakulwiish-ile	'untie'

For the perfective forms in the second and fourth columns, imbrication does not apply because the imbrication site contains a long vowel and imbrication would result in a containment violation. The perfect suffix in these cases thus remains outside the phonological domain.[166] This is equivalent to extrametricality in metrical terms. The phonological domain structure of the perfect forms in (47), taking the perfectivised separative-applicative in (47c) as example, is thus the following:

(48) $[\text{kak}]_{1\text{Root}}$ $\text{ulwiil}]_{2\text{D-suffixes}}$ ‹ile›

The representation of *-ile* in angled brackets reflects extrametricality, which follows from the avoidance of the long vowel in the imbrication site. This outcome lends support to the notion of containment and implies that for these forms the perfect fails to be within the phonologically active area. Let us now consider the implications this analysis makes for other Bantu languages.

5.4 Formation of the perfect in other Bantu languages.

The two suffix shapes given in (28) tally with the attested shapes of the perfect suffix found in other Bantu languages that range from languages that never have imbrication to those that only have imbrication, or at least only use the truncated form of the suffix, in the formation of the perfect. Let us consider a few cases.

In Kwanyama (R.21) and Ndonga (R.22) only regular suffixation of the perfect is possible. Thus we can consider these languages as only having the regular shape of the suffix giving the perfect forms in (49) for both roots (49a) and (49b) and bases (49c-e). Consider the Ndonga data in (49) from Fivaz (1986). Derivational suffixes are underlined.

(49)

	root/base	perfect		
a.	ti-	'say'	ti-ile	'has said'
b.	lánd-	'buy'	lánd-ile	'has bought'
c.	land<u>ul</u>-	'follow'	land<u>ul</u>-ile	'has followed'
d.	tond<u>ok</u>-	'run'	tond<u>ok</u>-ele	'has run'
e.	fát<u>ulul</u>-	'explain'	fát<u>ulul</u>-ile	'has explained'

[166] Notice though that there is the possibility of treating the frozen separatives in (45a-e), (47a) and (47b) as forming a single phonological domain, given that they have opaque roots that have no independent function. Under this view, deletion of the consonant of the separative would result in a derived root that would form the first phonological domain and the added perfect suffix would form the second phonological domain; $[\text{pútwiil}]_{1\text{Derived root}}$ + perf. -ile → $[\text{pútwiil}]_{1\text{Derived root}}$ $\text{-ile}]_{2\text{D-suffixes}}$ 'has cut for'.

Thus in (49), where only regular suffixation holds, the underlined derivational suffixes do not trigger imbrication.

Moving on to Yao (Ngunga 1998), we observe that Yao patterns with Bemba in having imbrication in bases and regular suffixation with roots. Consider the data in (50), with the non-imbricating roots in (50a-c), and the imbricating bases in (50d-g). The base-final derivational suffixes in (50d-g) are underlined. Like in Bemba, some of these suffixes have lost productive use. Yao thus utilises the two suffix shapes proposed for Bemba.

	base		perfect	
(50)	base		perfect	
a.	di-	'eat'	di-ile	'has eaten'
b.	vin-	'dance'	vin-ile	'has danced'
c.	piind-	'bend'	piind-ile	'has bent'
d.	pél<u>ét</u>-	'go through'	pél-éet-e	'has gone through'
e.	wút<u>úk</u>-	'run'	wútw-íik-e	'has run'
f.	tóp<u>ól</u>-	'chase away'	tópw-éel-e	'has chased away'
g.	tík<u>am</u>-	'be half full'	tík-éem-e	'has been half full'

The Yao data can thus be accounted for in an identical manner to Bemba; imbrication applies whenever the D-suffix domain in non-null.

Let us now have a look at a case where imbrication offers the only possibility for the formation of the perfect. In Kirundi (D.62, Mould 1972), the intervocalic /l/ of the perfect suffix has been totally lost. This means that only the truncated form of the suffix is used with both bases and roots. [167] In (51), the perfect /i/ in base-final position glides to /y/. Notice that the base-final /l/ in (51e) and (51f) that is part of a derivational suffix is also lost in the formation of the perfect. There is also a spirantisation process that changes /b/ → /v/, and /d/ → /z/ before perfect /i/ as (51c) and (51d) show, respectively.

(51)	root/base		perfect	
a.	ba	'be'	baay-e	'has been'
b.	li-	'eat'	liiy-e	'has eaten'
c.	laab-	'look'	laavy-e	'has looked'
d.	gend-	'go'	genz-e	'has gone'
e.	ugul<u>ul</u>-	'open'	uguluy-e	'has opened'
f.	sib<u>ilil</u>-	'repeat'	subiliy-e	'has repeated'

The form in (51d) where spirantisation involves absorption of the perfect /i/, suggests that the truncated perfect loses its constituent structure in the derivation.

Finally, in Runyankore (E.13, Morris and Kirwan 1957, Mould 1972), it seems that the two suffix shapes exist side by side and their selection is determined

[167] Luganda (E.15, Mould 1972) patterns with Kirundi in only utilising the truncated form of the perfect suffix which in addition also results in spirantisation; *som-a* → *somye* 'read', *bb-a* → *bbye* 'steal', *yig-a* → *yiz-e* 'learn', *yigg-a* → *yizz*-e 'hunt', and *tuuk-a* → *tuus-e* 'arrive'.

phonologically rather than by the distinction of base versus root. Only bases and roots that end in any of the segments /l z n̥/ or the passive *-bw-* are subject to imbrication. (52a-c) show the non-imbricating roots or bases and (52d-g) the imbricating ones.

(52)	root/base		perfect	
a.	gu-	'be full'	gw-ile	'has become full'
b.	gamb-	'say'	gamb-ile	'has said'
c.	shutam-	'squat'	shutam-ile	'has squatted'
d.	teel-	'hit'	te-il-e	'has hit'
e.	eshoŋgol-	'sing'	eshoŋgo-i-l-e	'has sung'
f.	shemezibw-	'be pleased'	shemezi-i-bw-e	'has been pleased'
g.	tyootyooz-	'interrogate'	tyootyo-i-z-e	'has interrogated'

There is no vowel fusion in Runyankore, as the data in (52) show. The Runyankore case is interesting because it shows that the two suffix shapes exist independently of the reasoning based on the definition of domain structure given for Bemba. We can therefore see that within the Bantu group of languages there are languages like Kirundi and Ndonga which utilise only one of the suffix shapes in (24), and yet others like Runyankore, Yao and Bemba which utilise both options.[168]

5.5 Summary

In this chapter, evidence has been provided for the process of imbrication, which has been described as solely affecting bases in Bemba. It has been argued in line with chapter 4 that between the root and the following suffixes it is only possible to have two phonological domains out of the three broad morphological domains; the root domain, the D-suffix domain and the I-suffix domain. As in spirantisation, the verb root is inaccessible for the operations of imbrication and marks the first phonological domain. The second domain is marked by derivational suffixes or the inflectional perfect if D-suffixes are unavailable. Since phonological domain boundaries are not adjustable, the presence of D-suffixes implies imbrication for the perfect. Imbrication has been characterised as the condition under which the regular perfect suffix truncates in order to be interpreted in the preceding D-suffix domain. Imbrication is a sufficient process to mark the perfect because the content of the truncated perfect /i/ (the element I) is identifiable under vowel lengthening or fusion in the imbrication site. The two suffix shapes proposed have also been shown to take

[168] We can speculate that the two suffix shapes derive from language change under the view that the perfect suffix is moving on a reduction continuum from *-ile* to *-e* to perhaps being totally lost, particularly given the formation of the perfect in Kirundi and Luganda that involves a process akin to spirantisation in the causative, treated in chapter 4 as involving a floating segment. The different languages discussed can be viewed as each being at different stages of this process. In fact, some Southern Bantu languages (Doke 1954) only have a final *-e* to express the perfect. More research needs to be done in pursuit of this view, which first of all must involve establishing that there was no imbrication in Proto-Bantu. Cf. Voeltz (1980) for a reconstruction of the perfect as deriving from the verb *gid- 'finish'.

on a more general characteristic in other Bantu languages, with languages like Kirundi and Luganda only utilising the truncated form of the suffix. The two suffix shapes serve to preserve consonant-final domains. As has been demonstrated by extended CV- roots that create derived roots, phonological domains must be consonant-final. Given that many of the suffixes involved have lost productive use in the language, and also conversely, that many of the roots have lost independent use, the notion of root can be regarded as a more abstract entity that refers to the initial CVC- of a stem.

Considering the interaction of the D-suffix domain in the present chapter as well as in chapter 4, we can now fully characterise the phonological domain structure of the verb in Bemba. This elaborates on the discussion of possible phonological domains in morphology, presented in chapter 3. I present in (53), the phonological domains relevant to Bemba in morphology. Square brackets indicate phonological domains.

(53) Phonological domains in Bemba verbal morphology

Type of morphology		example
Analytic morphology		
a. [[Root] affix^n]	-	suffixation processes, imbrication
b. [[stem]$_\alpha$[stem]$_\alpha$]	-	total reduplication
c. [[affix^n [stem]]	-	prefixation processes, partial reduplication
Non-analytic morphology		
d. [Root, affix^n]	-	short causative spirantisation
Concatenation of prefixes and suffixes		
e. [affix^n [[Root]$_1$ affix^n]$_2$]$_3$		

From (53), we conclude that in the verbal derivation of Bemba, maximally three phonological domains are parsable in a fully extended verb (53e). In analytic morphology the root or the stem is the head of the phonological domain structure ((53a) and (53c)). In all cases of affixation it is possible to have more that one affix. These units thus provide the criterion by which listeners decode inputs of complex verb forms for lexical access. Since parsing targets phonological domains, it follows that multiple affix combinations will be accessed in parallel in the phonology, hence No bracketing derivation.

In the following final chapter, I provide some speculations on the nature of such a phonological parser.

6 Implications and Conclusion

In this chapter I give a summary of the preceding chapters and present the proposals that have been made and the conclusions that have been reached and their implications for a theory of the morphology-phonology interface. I investigate what implications the proposed domain structure has for the structure of the lexicon and morphological processing. I offer some speculations on the structure of a phonological parser following the phonological processes attested in preceding chapters and the assumptions of GP. I also briefly explore areas of future research that arise from this thesis. Within Government Phonology the role of Licensing Constraints in defining the acoustic cues that are available for language inventories and within Bantu some speulatons and questions that must be raised in a theory of suffix-ordering.

6.1 Proposals and conclusions

In this thesis, I have argued for the position that the only phonologically relevant information in morphologically complex verbs in Bemba are phonological domains that identify the dependent structure between the root and its affixes. The root has been treated as the head of the phonological domain structure with the prefix and suffix domain as dependent structures. Two conclusions follow from this proposal: the root will be the trigger rather than the undergoer of phonological processes and affixation processes will involve no bracketing derivation because no phonological domains are recognised between affixes.

In chapter 2, I have argued that phonological domains in Bantu consist of onset final domains that are in a *licensing-at-a-distance* relation with the deviant Bantu FV, which allows the phonological domain to be interpretable. It is therefore the root and its suffixes that are the target of phonological processes. I have also investigated the notion of process constraints with respect to their influence on the choice of Licensing Constraints that are selected in a language in order to regulate the combination of elements, which define the inventory of segments. By the discussion of the Swahili and Herero vocalic inventories we have seen how it may be favourable in Bantu languages to capture the difference between inventories by reflecting possible parametric variation in phonological processes in Process Constraints while maintaining identical Licensing Constraints. The discussion of the vocalic processes of fusion and compensatory lengthening have revealed that complex expressions undergo elemental decomposition and thereby allow elements within the same nuclear constituent to get independent interpretation. This has led to the representation of glide-vowel sequences in structures akin to either light or heavy diphthongs. Finally, a geometric reprsentation of elements that defines the head and dependent relations of elements within phonological representations has been proposed.

In chapter 3, I have defined inter-onset government as the configuration that characterises NC clusters and under which the phonological processes triggered in NC clusters can be accounted for. This representation implies a sequence rather than a unit segment analysis. The three broad possible structures for NC clusters - ONO, coda-onset and complex segment - have been compared and contrasted. It emerges from this comparison that the ONO structure by far accounts better for the phenomena related to NC cluster formation. The processes of assimilation, consonant hardening, consonant epenthesis, Meinhof's Law and reduplication have been discussed. All these processes fall out of the ONO structure and also follow from the assumption of the root as a phonological domain on which the prefix domain is dependent. Within NC clusters assimilation has proceeded from the root to the nasal prefix under a government relation that defines the stop as head and the nasal as governee. Consonant epenthesis has been shown to follow from the need to have a realised governing head and consonant hardening from the need of the governing head to be stronger than the governee. The need for the retention of the structure of the root has been evidenced by NC cluster simplification in Meinhof's Law, which under licensing saturation aims to retain lexical contrasts in the root. This is in line with the containment requirement demanded on the root vowel in derived roots. All processes in a phonological domain have been regarded as sanctioned by licensing, which derives from the head of the domain. The notion of licensing inheritance has been adopted for this purpose.

In chapter 4, the process of spirantisation has been discussed and analysed as a consonant harmony process that spreads the element (I) from the right edge of the word towards the root. The spread of (I) is triggered by the causative suffix that I have represented as having two forms: a floating segment, which docks on the domain-final consonant and consists of non-analytic morphology, and a stable constituently rich causative, from which (I) spread proceeds at P^0 from onset to onset and consists of analytic morphology. The floating segment analysis explains the absorption that is seen in the target of spirantisation, as opposed to a non-floating causative that results only in partial absorption or gliding. This distribution is illustrated by an investigation of spirantisation in a variety of Bantu languages. An important issue also raised in the process of spirantisation is that different elemental combinations may produce the same segment by mapping onto identical cues in the speech signal. The process of spirantisation involves the incorporation of the element (I) into the elemental configuration of the target segments resulting in suppression, under which particular elements fail to be submitted to the speech signal. This characterisation of reduction in complexity is in contrast to the actual loss of structure by delinking. Absorption of element (I) has been contrasted with I-adjunction in the palatalisation process of Nyamwezi. The depalatalisation process that takes place in Nyamwezi has revealed that I-adjunction structures may undergo a process of element-hopping by which an element is transferred from one constituent to another with no traces. The depalatalisation process of Nyamwezi has also shown that suppressed elements remain irretrievable for later derivations. I have also considered the process of nasal harmony, which, conversely to the hardening process in chapter 2, shows that the spread of (L) under *no switching* results in nasal consonant harmony. NCH is subject to the same adjacency constraints as vowel harmony. The processes discussed in this chapter - multiple spirantisation in the suffix domain, depalatalisation transferred as palatalisation onto a following suffix, and NCH - have supported the view that all the suffixes following the verb root form one phonological domain.

Finally, in chapter 5 I have shown how the definition of D-suffix domain in chapter 4 demands an invariant domain boundary marker, namely the final consonant of the final derivational suffix. This has led to the process of imbrication, which requires the recognition of a truncated form of the perfective suffix. The representation of the truncated perfect suffix as represented in constituent structure has led to its infixation into the position before the base-final consonant, a position in which it does not risk losing its structure and also retains the requirement of a consonant-final base. The division of regular suffixation versus imbrication in the formation of the perfect has been related to the difference between base and root and has served to further illustrate the autonomy of the root. The discussion of the perfect forms of CV-roots and reduplicated forms has led to the proposal of an abstract or derived root that retains the typical CVC- root structure of the verb in Bantu. These investigations have led to the ultimate conclusion that verbs of varying morphological complexity receive a uniform interpretation in phonology in structure that maximally consists of three phonological domains.

For the debate on the interaction of phonology and morphology this thesis argues for limited visibity of morphology in phonology that is restricted to analytic and non-analytic domains. The assumption of no phonological domain boundaries consistent with morphological boundaries at every level of derivation has led to non-incremental but parallel derivation or no bracketing derivation. This proposal raises two questions for future research. In Government Phonology the kind of phonological processing that this derivation entails, and in Bantu languages the kinds of assumptions that must be made for a theory of suffix-ordering. I look at these in the following two sections.

6.2 The lexicon, lexical access and morphological processing

The Addressing Hypothesis in GP states that phonology helps the hearer to find the relevant lexical entries that a given utterance is made up of. GP does not subscribe to the view that the lexicon must be redundancy free in the sense that related words in a paradigm must be derived from each other, or one from the other. Thus the English pairs of words *opaque~opacity*, *sane~sanity* or *keep~kept* are considered to be lexically stored. In essence, regular (verbal) morphology as opposed to irregular (verbal) morphology is not considered to be stored. This means that in the paradigm *walk*, *walks*, *walked* only *walk* is lexically stored. This follows from the assumption that the latter forms consist of analytic domains, as discussed in chapters 4 and 5. The difference is that analytic domains, as opposed to non-analytic domains, consist of more than one phonological domain. Words that are considered to be stored in the lexicon consist of one domain. In this way, morphological forms that are non-analytic are treated on a par with morphologically simplex words, and are thus regarded not to be derived by phonological processes, just like morphologically simplex words (there is thus no postulation of a process of *tri-syllabic laxing* for pairs like *opaque~opacity*). Since the only aspect of morphological structure that is visible to phonology is a domain, identifying the domains in a word helps us to identify the word in the lexicon, lending support to the Addressing Hypothesis. Kaye (1995, 1996) emphasises that morphologically rich words that form non-analytic domains are lexically stored, but does not elaborate on the fact that phonology also plays a role in lexical access in morphologically complex words, which consist of analytic domains.

In (analytic) morphologically complex words, the head of the domain structure, on which the surrounding prefixes and suffixes are dependent, is lexically accessible. The lexical accessibility of the head of a morphologically complex verb explains the significance of the domain structure assumed, but also crucially explains the dependence relation between the root (head) and the affixes (dependents). For Bemba, this means that lexical entries of verbs are roots, given the specified domain-final licensing parameter discussed in chapter 2. This also sheds light on why there can only be two phonological domains between the verb root and following suffixes. As long as a morphologically complex verb form is identified as analytic, i.e. as consisting of an internal domain that addresses the lexical verb, identifying any other following morphological boundaries as phonologically visible does not make the verbal form more analytic than if only one following domain was identified. The phonology is therefore not engaged in any numerical computation, but only identifies the domain that captures the lexical entry and another domain following that. The need to access the lexically stored entity in a verbal complex follows from the role of phonology as an aid to processing. If we are able to identify the lexical verb being referred to, we reduce our search space and can already infer that we are searching for dependent units on a particular verb, which given some theory on suffix-ordering, should be rendered easier than the multiply suffixed verb forms may suggest. A more radical interpretation of assuming no bracketing derivation would imply considering complexes of suffixes (as well as their individual forms) to be stored in the lexicon, so that they are accessible in parallel. Such an assumption would lead us to reconsider our position on whether the suffixation processes discussed in chapters 4 and 5 are part of diachronic rather than synchronic phonology.

Let us now turn to a brief look at suffix-ordering.

6.3 Suffix-ordering

In the discussion of the processes affecting suffixes in the derivational domain, it was alluded to at several points that some processes may be influenced or blocked by suffix order. In addition given no bracketing derivation it is even more crucial to determine what the order of the affixes that are derived in parralell is and furthermore how they come to be in this order? Current analyses of these questions fall into three broad types; syntactic analyses claim that the order of derivational suffixes reflects the order of syntactic derivational steps from some assumed underlying level of representation (e.g. Baker 1985), while semantic analyses explain suffix-ordering with recourse to a notion of relevance to the (underived) predicate’s lexical semantics - the more relevant a derivational affix is for modifying the verb’s meaning, the closer it will be to the verb root (e.g. Bybee 1985). Finally, morpho-phonological analyses explain suffix-ordering either with recourse to the interaction of ordered strata of phonological and morphological representation (Kiparsky 1982b), or by postulating a morphological template where affixes are inserted in specific slots which are not directly motivated by either syntactic or semantic considerations, and where variation across Bantu languages is captured by ranking of constraints on the association of a given morpheme with a particular slot (Hyman 2002). While all these analyses capture some generalisations over the distribution of Bantu derivational suffixes, none of them provides an exhaustive explanation for the empirical facts. Let us have a brief survey of thesyntactic approach to suffix-ordering as presented in Baker (1985).

Baker (1985) explores a syntactic solution to suffix-ordering and claims that the order of affixes reflects the order of syntactic operations, a generalisation that he captures in the ‘Mirror Principle’. One prediction of this approach, as in fact also of semantic approaches, is an invariant and transparent order of suffixes for a particular semantic interpretation (especially if the order of syntactic operations is taken to be ultimately semantically motivated). The most well-known empirical evidence for this view are effects of compositionality on the ordering of suffixes as in the following Chichewa (N.31) examples (Hyman and Mchombo 1992), where the different surface orders of causative and reciprocal suffixes result in different scope readings:

(1) a. reciprocal + causative

[X cause [Y & Z tie Y & Z]]

Verb	recip.	caus.
[[[mang]	an]	its] -a

‘cause to tie each other’

b. causative + reciprocal

[[X & Y cause [X & Y] tie Z]

Verb	caus.	recip.
[[[mang]	its]	an] -a

‘cause each other to tie’

In (1a) the verb first takes a reciprocal suffix, so that the (plural) agent (Y&Z) becomes the patient of the verb. The following causative suffix then introduces an ‘external’ causer (X). In contrast, in (1b), the verb is causativised first, and a causative subject is introduced (X&Y). It is this ‘higher’ subject which becomes the reciprocal object when the reciprocal suffix is added. The result is two different interpretations that transparently mirror the order of the suffixes. There is, however, a problem with these data. While (1a) has only the reading described above, (1b) can in fact also have the reading of (1a). In other words, (1b) has both a compositional and a non-compositional reading. The meaning of (1a) on the other hand, is invariant and allows only for the compositional reading. Hyman (2002) refers to this disparity as *asymmetric compositionality*, i.e. one suffix order (1a) is necessarily compositional whilst the other (1b) is not.

There is further counter-evidence to the Mirror principle. In many Bantu languages, different orders of suffixes within the same language may be seen for the same semantic interpretation, while, on the other hand, the same order may result in different interpretations. For example in Bemba, the suffix order applicative+reciprocal gives rise to two readings, for example with a predicate *tie*, 'tie for each other' and 'tie each other for'. Thus while compositionality plays osme role in determining suffix order morphophonological as wel as other aspects of grammar also need to be investigated with respect to suffix order. Let us consider two cases already presented in chapter 5, where phonology may play a role in determining suffix order.

Under the assumption of a consonant final base as the optimal phonological domain structure, we can preduct the suffix order between the separative suffix *-ul-*, which has the property of consonant elision, with any other following suffix. Given the condition on consonant-final bases the transitive separative suffix precedes any following suffix because in this way consonant final bases are maintained. Consider the interaction of the applicative and the separative in (2).

(2)		root		sep.trans.		sep.- appl.	
	a.	cing-a	'cover'	cing-ul-a	'uncover'	cing-u-il-a	→ cingwiila
	b.	som-a	'plug into'	som-on-a	'unplug'	som-o-il-a	→ somweena

In (2), the separative *-ul-* (2a) and its harmonic variant *-on-* (2b), become /l/ and /o/, respectively, when the applicative is introduced. The possibility of having the applicative precede the transitive-separative is not semantically impossible given the applicative verbal base *cing-il-a* 'cover for', from which a separative can be derived to give the bracketing [un [cover for]]. This is reminiscent of bracketing paradoxes seen in English in morphologically complex forms such as *ungrammaticality* that may be subject to different bracketing, i.e. morphological packaging and processing. In the Bemba case in (2), morpho-phonological processing accounts for the preferred bracketing.

Consider another case of the passive *-w-*, which has traditionally been described as always coming final in Bantu derivational suffixes (Meeussen 1967). The passive in Bemba has two competing shapes referred to as the short (*-w-*) and the long passive (*-iw-*). Regarding the passive as always final in bases has led to analyses that consider all other suffixes as infixed in passive bases. Consider the examples in (3) where the passive interacts with the applicative (3a) and the causative (3b).

(3)	verb	pass.		appl./caus.-pass.	
a.	tol-a	tol-w-a	'be picked up'	tol-el$_{appl}$ -w-a	'be picked up for'
b.	sek-a	sek-w-a	'be laghed at'	sek-esh$_{caus}$ -iw-a	'be made to laugh'

In the foregoing we have already characterised this systematic behaviour of the passive as representing the syllabification of the passive *-w-* in the phonological representation of the mandatory final vowel (FV). The FV itself has been characterised as falling outside the phonological domain structure of the verbal base with the sole purpose of making the verbal base an interpretable unit. Representing the passive as within the structure of the FV implies that it will always be final in any sequence of derivational suffixes. This representation is supported by data such as (3b) where the long passive *-iw-* being outside the phonological domain structure, fails to undergo the regular vowel height harmony of Bemba. Thus the phonological domain representations of (3a) and (3b), that explains the suffix-ordering of the passive and other suffixes, is [[tol] $_{Root}$ -el$_{appl}$.]‹-w-a› and [[sek] $_{Root}$ -esh$_{caus}$.]‹-iw-a› respectively (the square brackets represent phonological domain boundaries, while the angled brackets represent extrametricality).

Apart from these cases it would be interesting to compute all the possible suffix orders given the set derivational suffixes and see whether the attested cases can be shown to follow directly from a theory of suffix order.

As a final excursion I consider some ideas on a phonological parser in GP, over which we can raise the questions; what considerations are necessary for phonology to aid us in processing input strings from the speech signal untill we eventually map this signal onto an entity in the lexicon? What kinds of information does a hearer rely on in order to correctly parse a phonological string into its constituent words?

6.4 Speculations on a phonological parser

As earlier discussed, the central role of phonology in GP is to aid speech processing (the Parsing Hypothesis), and to provide a lexical addressing system (the Addressing Hypothesis) (Kaye 1989). Ploch (1999) adds to these purposes of phonology the Acquisition Hypothesis, i.e. the idea that phonology helps the acquirer decide on the correct set of generative constraints (LC's). Given that in GP it is assumed that constituent structure is part and parcel of the lexical representation, parsing any input string must involve accessing constituent structure.[169] We must, in fact, consider constituent structure to be accessed prior to lexical access. But is it necessary to consider syllable structure as playing a role in parsing? To answer this question, we must consider possible hypotheses on how the hearer transforms the acoustic input into a lexical representation. Williams (1994), citing Frazier (1987), presents the following four advantages that are gained from including phonological structuring in the input signal.

(4) Including syllable structure information in the input speech signal aids us in:

(i) identifying likely hypotheses about the lexical segmentation of the string
(ii) facilitating the classification of the string

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[169] The lexicon does not have to be perceived as actually possessing constituent structure in precisely the way that we have described it, but would rather be assumed to have a coded version of it.

(iii) increasing the informativeness of partial information about the segment identity
(iv) maintaining global consistency of locally possible analyses

Thus by incorporating syllable structure in parsing, hearers can reduce the number of hypotheses on where the word boundaries in connected speech fall, since word onsets usually coincide with syllable onsets. Similarly, we can use information about stress to estimate the number of word boundaries. In English, for example, since words only have one main stress, two main stresses will indicate the presence of two word boundaries and even if this indication is not accurate, the search space of word boundaries is immediately reduced. The basis of points (ii) and (iii) is that a system that phonologically structures speech input can exploit both universal and language specific phonotactic constraints. This allows for the examination of a segment with reference to its neighbours, as opposed to the ambiguity of trying to identify a segment in isolation. If we, for example, detect a fricative followed by a high front vowel in Bemba and the fricative is ambiguous between {s, ʃ} we can exclude the former by the Bemba phonotactic constraint **si*. On a purely linear representation where the phonological environment is unavailable, such a mechanism could not be employed. Similarly and perhaps more drastic, in languages that have consonant clusters but also allow for vowel syncope, reference to syllabic structure would help to identify bogus clusters and thereby delimit the search space, since the consonants in such clusters will not both be treated as candidates for a word boundary.

In addition to the importance of constituent structure in parsing, the following considerations also have to be made in postulating a parsing model for phonology:

- allophonic variation or ‘lexical form blurring’ due to phonological processes that can alter the lexical form of a word by producing a quite distinct surface phonetic form of particular segments within the word such as the Bemba /t d k g l s / → [ʃ].

- the problem of detecting word boundaries, since any of the symbols identified could be the beginning of a new word, and thus each start a new word hypothesis, which increases the search space with each symbol that is parsed.

- segmental variation as occuring under well-defined phonological conditions and in specific contexts, and which if identified can reveal information about the constituent structure of the word and hence help the hearer identify word boundaries.

- a context dependent grammar to account for the contextual variants of segments, otherwise allophonic variation must be undone before accessing the lexicon, if the lexicon is regarded as only consisting of distinctive, non-redundant information.

Finally GP, which recognises no level of phonetic representation, seems to be a good starting point for this line of research because elements are directly interpretable in themselves and parsing does not require the retrieval of a segmental string before phonological processing can begin. This implies that sub-segmental structure is recoverable from the signal, while anything resembling a segmental or phonetic representation is only built once the relevant linguistic representation has been reconstructed. Segmentation thus does not precede parsing but is rather the result of it.

Appendix I

List of Bantu languages cited according to Bantu zone

A
Ewondo (A.72a)

D
Holoholo (D.28)
Kinyarwanda (D.61)
Kirundi (D.62)

E
Nyoro (E.11)
Runyankore (E.13)
Luganda (E.15)
Runyambo (E.21)
Jita (E.25)
Gusi (E.42)
Kikuyu (E.51)
Nwimbi (E.53)
Tharaka (E.54)

F
Sukuma (F.21)
Kinyamwezi (F.22)
Nilamba (F.31)

G
Swahili (G.42)
Kihehe (G.62)
Kinga (G.65)

H
Kikongo (H.16)
Yaka (H.31)

K
Chokwe (K.11)
Siluyana (K.31)
Subiya (K.42)

L
Luba (L.31)
Lunda (L.52)

M
Lungu (M.14)
Ndali (M.21)
Inamwanga (M.22)
Nyiha (M.23)
Safwa (M.25)
Nyakyusa (M.31)
Bemba (M.42)
Lamba (M.54)
Ila (M.63)
Tonga (M.64)

N
Nyanja (N.31a)

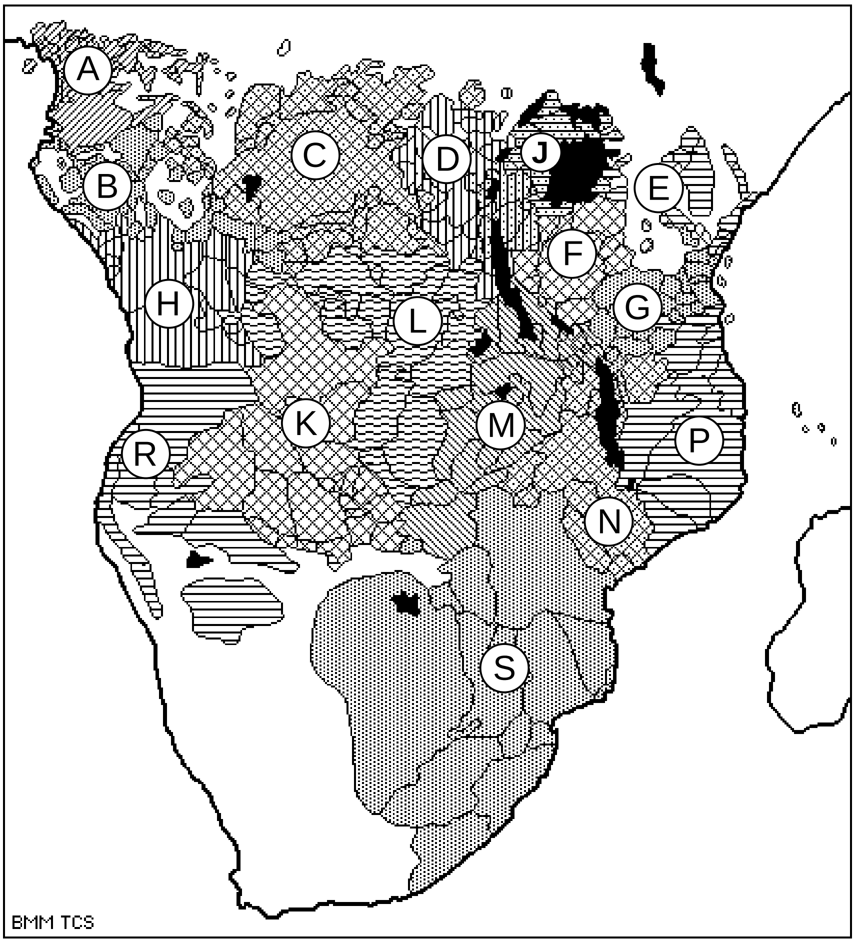
P
Yao (P.21)

R
Umbundu (R.11)
Kwanyama (R.21)
Ndonga (R.22)
Herero (R.31)

S
Shona (S.10)
Venda (S.21)
Zulu (S.42)

Appendix II

Bantu language zones



Source: Schadeberg (in press)

Bantu MapMaker programme: Lowe and Schadeberg (1997)

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Summary

This thesis argues for the position that morphological and phonological domains are not isomorphic. The proposal is that phonology does not have any access to internal morphological boundaries in morphologically complex verbs in Bantu languages. This is achieved by the further proposal that morphemes such as suffixes and prefixes, do not undergo cyclic affixation but are rather accessed in parallel in morphologically complex verbs. Evidence for this position is provided by morphologically conditioned phonological processes in the verb in Bemba.

The thesis also elaborates on the nature of phonological segments, their constituent structure and the licensing principles that hold between them, within the framework of Government Phonology. It is argued that there is a close knit between the processes operative in a language and the licensing constraints that are chosen to define the segmental inventory of the language. A contrast is drawn between segments that are represented in constituent structure and those that are considered as floating, with the effect that only the latter result in total absorption into a neighbouring segment. All phonological processes in a phonological domain are treated as subject to licensing by a nuclear head. A different definition of phonological domain that excludes the domain final nucleus is assumed. This is achieved by defining phonological domains on grounds of phonological activity, and regarding the word in Bantu as subject to lexical domain final licensing, which allows a domain final nuclear position to be lexically specified. This allows morphological and phonological operations to apply to onset final bases.

In prefixation, which consists of most of the inflectional morphology of Bemba, prefixes undergo vowel fusion and coalescence. This is an indication of the invisibility of morphological boundaries to phonology. In addition, prefixation with the first singular subject marker *n-* produces effects of hardening of the initial consonant of the verb stem, assimilation of the nasal prefix to the following consonant of the verb stem, and consonant insertion when the stem is vowel initial. The nasal and following consonant of the verb stem are thus characterised as being in a governing relation where the nasal is governee and hence susceptible to assimilation. The inter-onset government relation that is contracted takes place on an onset projection because the intervening empty nucleus fails to project to the nuclear projection. Meinhof's Law in NC clusters illustrates the notion of licensing saturation, where simplification of a hardened NC cluster takes place because the governing head fails to be licensed for hardening.

In suffixation, phonological interaction with derivational and inflectional suffixes is discussed. In the derivational domain, spirantisation triggered by a causative suffix is seen to affect all the consonants in the derivational suffix domain. The spirantisation process is formalised as the spread of an (I) element from the right edge of the word. Spreading here is from onset to onset at P^0. The spirantisation process, which results in changes in the elemental configuration of the segments affected, also illustrates the notion of suppression, where particular elements fail to be submitted to the speech signal for interpretation. An important outcome of the

process of spirantisation, as well as the palatalisation process of Nyamwezi discussed in chapter 4 is that different elemental combinations can result in the production of the same sound. Further activity of the suffix domain is seen in the nasal consonant harmony process that affects all liquids within the D-suffix domain and the vowel harmony process that lowers high vowels in the D-suffix domain. The latter two processes, as opposed to spirantisation, involve rightward spread of elements.

In suffixation processes with the perfect inflectional suffix *-ile*, a process called imbrication takes place, where the perfect suffix fails to be suffixed after other derivational suffixes. This is shown to follow from the assumption that the final consonant of the final derivational suffix is the phonological domain marker. Thus, interpretation of the perfect suffix relies on its location in the D-suffix domain. This results in a truncated form of the perfect that is infixed into the position before the base final consonant of the D-suffix domain. This allows the perfect suffix to be interpreted within the phonological domain and thus to be part of phonological processes – imbrication results in vowel lengthening and gliding. Failure of the perfect to be incorporated into the D-suffix domain due to opacity effects leads to extraprosodicity, where the perfect remains outside the phonological domain. This activity of the perfect suffix shows that only two phonological domains are parsable in the Bantu word. This outcome is in line with the head-dependent relations assumed in Government Phonology and is seen to operate here at a higher level with the verb root as the head and the D-suffix domain as its dependent. This explains why phonological process that are triggered by the head (vowel harmony and nasal consonant harmony) affect the whole suffix domain, while processes triggered in the D-suffix domain (spirantisation and imbrication) fail to affect the head.

From a wider perspective, this thesis differs from previous proposals on the phonology-morphology interface by not assuming levels or cycles in phonological rule application. This implies that there is no notion of bracket erasure for word internal morphological domains. In addition, the word is not the base of morphological or phonological operations.

Samenvatting (Summary in Dutch)

Deze dissertatie verdedigt het idee dat morfologische en fonologische domeinen niet isomorf zijn. Het voorstel is dat de fonologie geen toegang heeft tot interne morfologische grenzen in samengestelde werkwoorden in Bantu talen. Dit wordt ondersteund door het verdere voorstel dat morfemen zoals suffixen en prefixen geen cyclische affigering ondergaan maar daarentegen parallel aangesproken worden in morfologisch complexe verba. Er is ondersteuning voor deze stelling in de vorm van morfologisch geconditioneerde fonologische processen in werkwoorden in het Bemba.

Dit proefschrift gaat tevens in op de representatie van fonologische segmenten, hun interne structuur en de fiatteringsprincipes die er tussen segmenten gelden, binnen het kader van de *Government Phonology*. Er is gesteld dat er een nauwe relatie is tussen de processen die zich voordoen in een taal en de fiatteringscondities die gekozen zijn om het segmentele inventaris van de taal te definiëren. Er is een onderscheid gemaakt tussen segmenten die in de constituentstructuur zijn opgenomen en segmenten die dat niet zijn, waarbij alleen de laatste resulteren in algehele absorptie in naastliggende segmenten. Alle fonologische processen in een fonologisch domein worden geacht gefiatteerd te worden door een nucleair hoofd. Een nieuwe definitie van domein is voorgesteld welke de laatste nucleus van het domein uitsluit. Dit werd uitgedrukt door fonologische domeinen te definiëren op grond van fonologische activiteit, en door het woord in Bantu te onderwerpen aan lexicale woord-finale fiattering, welke bepaalt dat een domein-finale nucleus-positie lexicaal gespecificeerd mag zijn. Op deze wijze mogen morfologische en fonologische operaties uitgevoerd worden op onset-finale basen.

Het leeuwendeel van de inflectionele morfologie van het Bemba bestaat uit prefigering. Prefixen ondergaan vocaalfusie en versmelting. Dit is een aanwijzing dat de morfologische grenzen onzichtbaar zijn voor de fonologie. Daarbij komt dat het prefix *n-*, welke de eerste persoon subjectsvorm markeert, de initiële consonant van de werkwoordstam verhardt, alsmede assimilatie van het nasaalprefix aan de volgende consonant van de stam, en consonant insertie wanneer de stam met een klinker begint. De nasaal en de eerste consonant van de werkwoordstam vormen dus een *government* relatie waarin de nasaal gedomineerd wordt en dus onderhevig aan assimilatie. De relatie van *inter-onset government* vindt plaats op het niveau van de nucleaire projectie, omdat de tussenliggende lege nucleus niet op het de nucleaire niveau geprojecteerd kan worden. De Wet van Meinhof, waarin simplificatie van een nasaal-consonantverbinding plaatsvindt omdat het hoofd niet gefiatteerd kan worden, is een illustratie van het satureren van fiattering.

Met betrekking tot suffigering wordt de fonologische interactie tussen derivationele en inflectionele suffixen besproken. In het derivationele domein, betreft de spirantiseringsregel veroorzaakt door het causatiefmorfeem alle consonanten in het derivationele suffixdomein. Het spirantiseringsproces is geformaliseerd als het spreiden van een element (I) vanaf de rechterkant van het woord. Spreiding vindt hier plaats van onset tot onset op het niveau van P^0. Het spirantiseringsproces, dat

resulteert n veranderingen in de elementsamenstellingen van de betrokken segmenten, illustreert ook de notie van suppressie, waarbij bepaalde elementen niet verwezen worden voor fonetische interpretatie. Een belangrijk resultaat van de bespreking van spirantisering, alsmede van het palatalisatieproces in Nyamwezi dat in hoofdstuk 4 besproken wordt, is dat verschillende elementcombinaties in de productie van dezelfde klank kunnen resulteren. Het suffixdomein is verder nog actief in het proces van nasaalharmonie, dat alle liquidae in het suffixdomein ondergaan, en vokaalharmonie, dat in hetzelfde domein hoge klinkers verlaagt. Deze laatste twee processen maken, in tegenstelling tot spirantisering, gebruik van rechtswaardige spreiding van elementen.

In suffigeringsprocessen met het perfectieve inflectionele suffix *–ile* vindt een proces van zgn. imbricatie plaats, waarin het perfectieve suffix niet aangehecht kan worden na andere derivationele suffixen. Dit volgde uit de aanname dat de finale consonant van het laatste derivationele suffix het fonologische domein markeert. Interpretatie van het perfectieve suffix hangt dus af van de locatie in het derivationele suffix domein. Dit resulteert in een getrunceerde vorm van het perfectum als infix op de positie voor de finale consonant van dit domein. Dit laat interpretatie toe van het suffix binnen het fonologische domein en dus fonologische activiteit: imbricatie leidt tot klinkerverlenging en semivocalisering. Wanneer het perfectum niet in het D-domein kan worden geïncorporeerd vanwege opaciteitseffecten, leidt dit tot extraprosodiciteit, en blijft het suffix buiten het fonologische domein. Dit gedrag laat zien dat er slechts twee fonologische domeinen parseerbaar zijn binnen het woord in Bantu. Dit resultaat volgt het idee van government relaties in de Government Phonology en vindt hier plaats op een hoger niveau met de verbale stam als hoofd en het D-suffix domein als afhankelijke. Dit verklaart waarom fonologische processen die getriggerd worden door hoofden (zoals vocaal- en nasaalharmonie) het hele suffixdomein beslaan, terwijl processen in het D-suffixdomein (spirantisering en imbricatie) het hoofd niet beïnvloeden.

Vanuit een breder oogpunt verschilt deze dissertatie van eerdere voorstellen betreffende de relatie tussen fonologie en morfologie door het niet aannemen van niveaus of cyclussen in fonologische regelapplicatie. Dit brengt met zich mee dat er geen notie is van “bracket erasure” voor woord-interne morfologische domeinen. Tenslotte is het woord niet de basis voor morfologische of fonologische operaties.

Curriculum Vitae

Nancy Chongo Kula was born on 5th December 1971 in Ndola, Zambia. She did her undergraduate studies at the department of Languages and Linguistics of The University of Zambia in Lusaka, Zambia. In 1996 she pursued a Masters degree in linguistics at the department of Linguistics of the School of Oriental and African Studies (SOAS), University of London. In 1998, she followed the Advanced Masters Programme at the University of Leiden Centre for Linguistics/Holland Institute of Generative Linguistics. She has held the position of PhD researcher at ULCL/HIL from 1999 to 2002. This present study is the result of her research.