PHONOLOGICAL (A)SYMMETRIES OF NASAL PREFIXES IN BANTU

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ABSTRACT

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This study investigates segmental alternations triggered by Bantu nasal prefixes of class 9/10 and 1SG subject and object (henceforth, /N/). The realization of /N/ is associated with a wide range of segmental altenations that affect the preceding vowel, /N/ itself, and stem-initial segments. The alternations examined in this study have been organized into three groups: (a) /N/ in prenasal vocalic and nonlocal alternations; (b) alternations that affect /N/; and (c) postnasal alternations. The vocalic processes that occur before /N/ include vowel epenthesis, vowel lengthening, and initial vowel shortening. The behavior of /N/ in nonlocal processes involve Meinhof's Law, Dahl's Law, and nasal-consonant harmony. The processes examined that target /N/ include nasal place assimilation, effacement, devoicing, aspiration, and syllabicity alternation. The realization of /N/ before vowel-initial stems is also examined. The effect of /N/ on stem-initial consonants is reflected in a series of postnasal alternations such as (de)nasalization, (de)voicing, (de)aspiration, debuccalization, de-implosion, (de)affrication, nasal substitution, consonant deletion, and hardening. These processes have been described and analyzed.

Thus, thiis dissertation brings together from a sample of 24 Bantu languages the range of segmental patterns associated with /N/ and formalizes them within two phonological models, that is, moraic theory and Element-based Dependency (EBD). This study is a big contribution to the study of nasality in general and develops an overview of the range of issues and data related to the study of /N/ in Bantu. The main goal of the study is to describe and account for the crosslinguistic variations of alternations conditioned by /N/. The (non-)occurrence of prenasal vowel epenthesis

and lengthening are attributed to differences related to contrastive vowel length. The two processes are shown to occur in languages with contrastive vowel length. They arise from the demorification of /N/. A moraic model is thus adopted to formalize these alternations that occur to rescue the mora vacated by /N/. /N/ is shown to be non-moraic in languages without contrastive vowel length, and thus disallow vowel epenthesis and CL before /N/. CL before /N/ is blocked initially due to an overriding Initial Vowel Shortening rule (IVS) in some Bantu languages.

The consonantal alternations conditioned by /N/ have been formalized within EBD. This model uses elements as monovalent features to represent segmental structure and processes. The main operations used to represent processes include linking, deletion/delinking, switching, and adding. Segmental alterntions that involve simpler and fewer operations are more frequent than those that involve more and/or complex operations. Switching of elemnts is the most complex operation while the rest are simple. Nasalization, nasal place assimilation, (de)voicing, and (de)aspiration are frequent alternations induced by /N/ beacause they each involve a simple and single operation. Postnasal (de)affrication are infrequent for they involve a switching operation.

The study shows that crosslinguistic variations in the processes triggered by /N/ are determined by language-specific phonology and the phonological structures of nasal manner, other manner types, place, and laryngeal properties of segments. Thus, some variations relate to laryngeal contrasts some of which, for instance, aspiration, voicelessness, and breathy voice have been reanalyzed as mere crosslinguistic phonetic variations of the same phonological segment represented by the same element that is used for fricatives.

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1PL	1^{st} person plural prefix
1SG	1^{st} singular prefix
2PL	2^{nd} person plural prefix
2SG	2^{nd}person singular prefix
3SG	3^{rd}Person singular prefix
CG	Consonant-glide sequence
CL	Compensatory Lengthening
CV	Consonant Vowel Sequence
DL	Dahl’s Law
IVS	Initial vowel shortening
ML	Meinhof’s Law
N	Nucleus
NN	Nasal-nasal sequence
NV	Nasal-vowel sequence
NC̥	Nasal-voiceless sequence
NC̬	Nasal-voiced obstruent sequence
NC(s)	Nasal-obstruent Sequence(s)
ND	Nasal-voiced obstruent Sequence
O	Onset
PRX	Prefix
C	Coda
SR	Surface Representation

UR	Underlying Representation
μ	Mora
σ	Syllable

CHAPTER 1

1. INTRODUCTION

1.1 Introduction

In Bantu languages, nasal prefixes that mark noun class 9/10 and 1SG (subject and object) have been associated with a wide range of segmental alternations. The most frequent of these processes include (de)nasalization, nasal substitution, (de)voicing, (de)aspiration, debuccalization, postnasal hardening, (de)affrication, postnasal consonant insertion, de-implosion, nasal deletion, prenasal vowel lengthening, prenasal vowel epenthesis, and nasal place assimilation. In this study, we use the placeless nasal symbol /N/ to refer to the class 9/10 and 1SG nasal prefixes for the simple reason that they generally assimilate to the place of articulation of the stem-initial segment. The segmental processes induced by /N/ tend to vary across languages. Consider the segmental processes that arise when /N/ occurs before voiceless plosives:[1]

(1) Segmental alternations in N + voiceless stop sequences

a.	Kikuyu:	/N-**k**ene/	→	[ŋ**g**ene]	‘Am I to rejoice?’ (Barlaw 1951:7)
b.	Shona:	/N-**p**asa/	→	[m**h**asa]	‘10-mat’ (Fortune 1955:42)
c.	Hehe:	/N-**t**eefu/	→	[**n**eefu]	‘10-red mat’ (Odden & Odden 1985)
d.	Rwanda:	/N-**t**oora/	→	[n̥**h**oora]	‘vote for me’(Kimenyi 1979:35)
e.	Swahili	/N-**k**aa/	→	[$\mathbf{k}^{\mathbf{h}}$aa]	‘9/10-crab’ (Meinhof 1932:114)
f.	Pokomo:	/N-**t**upa/	→	[n̥$\mathbf{t}^{\mathbf{h}}$upa]	‘9/10-bottle’ (Huffman & Hinnebusch 1998:9)

[1] In this study, the names of Bantu languages appear without the nominal prefixes such as Ki-, Shi-, Chi-, Eke-, etc.

The examples in (1) indicate that both /N/ and stem-initial voiceless stops undergo change. In (1), /N/ undergoes nasal place assimilation to become [ŋ] (1a), [m] (1b), and [n] (1c-d, f). In addition, /N/ is subject to effacement before the voiceless velar stop /k/ (1c). The changes that occur in the stem-initial voiceless stops include voicing of /k/ to [g] in Kikuyu (1a) and debuccalization that changes /p/ and /t/ to [h] in Shona (1b) and Rwanda (1d), respectively. In (1c), Hehe /t/ undergoes nasal substitution to surface as [n] while /k/ and /t/ are subject to aspiration to surface as [k^h] and [t^h] in Swahili (1e) and Pokomo (1f), respectively. This study examines the range of segmental alternations associated with /N/ to understand the underlying motivation behind the observed patterns. The main contribution of this study may be seen from four different angles. (a) This dissertation brings together from different languages the frequent segmental patterns associated with /N/. (b) The study accounts for the range of segmental patterns associated with /N/ within moraic theory and EBD. (c) This study contributes to the general study of nasality. (d) This dissertation develops an overview of the range of issues and data related to the study of /N/.

The behavior of /N/ has been explored in previous studies most of which focus on particular languages. Given that the segmental processes triggered by /N/ vary across languages, its behavior in individual languages may not reveal the full range of its phonological properties and influence.Besides, the asymmetric effect of /N/ on adjacent segments needs to be examined and explained. Thus, this study builds on previous accounts to bring together segmental patterns associated with /N/ and account for their occurrence. The main objective of the study is to develop an overview of the range of questions and data that arise in studying /N/ and account for crosslinguistic variations observed in the processes induced by /N/. The core aspects of this study involve identifying, describing, and accounting for the different segmental patterns related to /N/. The data presented in this study is formalized within two theoretical frameworks, namely moraic theory and Element-based Dependency (henceforth, EBD). The study is based on a survey of 24 Bantu languages taken from different zones. The data used in this study was sourced from descriptive grammars and previous studies of the /N/ phenomenon. The main issues addressed in this study are as follows:

(a) What are the segmental alternations associated with /N/?

(b) What determines the range of alternations induced by /N/?

(c) How can the alternations induced by /N/ be accounted for in phonological theory?

In the next section, we review some of the previous accounts of /N/ to show the issues and views generated about the /N/ phenomenon in Bantu.

1.2 Previous accounts

The aspects of /N/ that seem to have attracted much attention in recent studies relate to its variability in mora count and the question whether prenasalized consonants derived from /N/ constitute a single segment or two separate segments. The latter issue has generated an endless debate between the unary vs. two-segment views of Bantu NCs. Proponents of the unary segment account includeWalli-Sagey (1986), Clements (1986), Maddieson & Ladefoged (1993), Stegen (2002), Marlo & Brown (2003), and Morrison (2009). A number of arguments have been given to support the unary account: (a) The duration of an NC is more similar to single segments than clusters. (b) Bantu NCs occur initially and medially where the nasal and obstruent function as an onset. (c) Some of the phonological processesaffecting NCresult from the fusion of the nasal obstruent to form a single prenasalized consonant. (d) Native speakers syllabify the nasal as onset rather than coda. (e) The two components of an NC are always homorganic and appear to be tautosyllabic.

The two-segment account of Bantu NCs is defended in Herbert (1975, 1977, 1986), Hubbard (1995a), Myers (2003), and Downing (2005), among others. This view is supported with some claims:(a) Durational properties of Bantu NCs vary widely, ranging from one and a half to four times the length of individual nasals or obstruents. (b) Phonological evidence from tone assignment and compensatory lengthening suggests that the pre-consonantal nasal must be moraic, and since onsets cannot be moraic, the nasal cannot be part of the onset. (c) Most NCs in Bantu occur intervocalically despite the fact that they do occur initially in some languages where they are always split by a morpheme boundary. (d) Homorganic NCs almost never occur stem-initially although all other consonants do.The tension between the two views and the issues that arise from both views underline the problematic nature of /N/.

The moraicity of /N/ is equally intriguing (Clements 1986; Hyman 1992; Downing 2005; Bickmore 2007). Clements (1986) and Bickmore (2007), among others, argue that /N/ is moraic underlyingly such that when it is syllabified as part of the onset its mora is set afloat. The stranded mora is then associated to the preceding vowel, thus resulting in compensatory lengthening (CL) in the preceding vowel. On the other hand, Downing (2005) argues that the moraicity of /N/ arises from its syllabification as coda. The two approaches attribute the moraicity of /N/ to different sources. Hyman (1992) argues that Bantu preconsonantal nasals are ambiguous in their mora count. Hyman claims that these nasals may count as a mora for one process but not for another. In Ganda, the preconsonantal nasal counts as a mora for CL, prosodic morphology (i.e. reduplication), and tone assignment while in Bemba the preconsonantal nasal is moraic for CL but not for tone assignment. In Runyambo-Haya, the mora count of the preconsonantal nasal varies between tone and morphology (i.e. reduplication and suffix allomorphy). Thevariations in mora count of preconsonantal nasals in Bantu led Hyman to propose three solutions to what he terms ‘mora mismatches in Bantu’. The first solution is to assume two moraic projections, that is, tonal moras and quantity moras. The second is to adopt a derivational approach that allows different numbers of moras at different stages of the derivation. The third is to assume that all moras contribute to weight but only some count as tone-bearing units (TBUs). These studies show that the moraicity of /N/ remains a problem.

The behavior of /N/ is asymmetric in the segmental processes it triggers when it interacts with stem-initial segments. /N/ appears to trigger prenasal CL lengthening in some languages but not others. Languages that allow prenasal CL include Ganda (Clements 1986), Yao (Ngunga 2000), Kuria (Cammenga 2004), Lungu (Bickmore 2007), and Gusii (Nash 2011). Prenasal CL is not attested in some languages, e.g. Swahili and Kongo (Meinhof 1923). Vowel epenthesis before /N/ is also inconsistent given that it is observed only in some languages. Vowel epenthesis before /N/ is attested in languages such as Rwanda (Kimenyi 1979), Kuria (Cammenga 2004), Gusii (Cammenga 2002; Nash 2011), and Lungu (Bickmore 2007). This process is not attested in Swahili and Kongo (Meinhof 1932), among other languages. The changes that occur in /N/ are also inconsistent across languages. With the exception of nasal place assimilation, most of the changes that occur in /N/ vary across languages. The processes that occur in /N/ include deletion (e.g. Meinhof 1932), devoicing (e.g. Wa Mberia 2001), debuccalization/aspiration (Maganga & Schadeberg 1992; Huffman & Hinnebusch 1998), and syllabic alternation (Herbert 1986). The main question that arise from these patterns relate to what motivates their variation.

The effect of /N/ on stem-initial segments is manifested in various postnasal alternations. These processes include postnasal (de)voicing, postnasal (de)aspiration, postnasal nasalization, nasal substitution, postnasal consonant deletion, postnasal hardening, postnasal de-implosion, postnasal consonant insertion, and postnasal (de)affrication (Doke 1922, 1926; Meinhof 1932;

Kimenyi 1979; Kula 2002; Podile 2002; Hyman 2003; Bickmore 2007). The ability of /N/ to trigger such a wide range of segmental processes is interesting in different ways. The first issue relates to what properties of /N/ enables it to condition such a wide range of segmental processes. The second is what limits the number of possible alternations /N/ can trigger. The third is how to account the multiple segmental alternations induced by /N/.

The influence /N/ exerts on adjacent segments has been studied in previous works. Parallel analyses of the effect of nasals on other segments exist in other language families. Examples of nasal related processes that have been previously examined include postnasal voicing (e.g. Pater 1996, 1999; Hayes & Tanya 2000), postnasal devoicing (e.g. Solé et al. 2009, Halpert 2010, 2012; Downing & Hamman 2013), and prenasal vowel lengthening (Clements 1986; Ngunga 2000; Downing 2005; Bickmore 2007). In accounting for postnasal voicing, Pater (1996) formulated a universal markedness constraint *NÇ̥ that rules against a sequence of a nasal and a voiceless obstruent. This constraint is based on articulatory facts given that it is taxing to transition from voicing to devoicing in the articulation of a homorganic NÇ̥. However, this account may not explain why some languages allow NÇ̥s. Hayes and Tanya (2000) also explain postnasal voicing in terms of articulation, and attribute this process to two mechanisms they term "nasal leak" and "velar pumping". In "nasal leak", postnasal voicing results from air leaking through a nearly closed velar port during the co-articulatory period between the nasal and oral segment. In "velar pumping", postnasal voicing is induced when the closed velum raises in its vertical motion. The question this account fails to address is what happens in languages that allow NÇ̥.Hyman (1998) formulated the constraint *ND that rules against a sequence of a nasal followed by a voiced obstruent (NÇ̬). Hyman formulated this constraint to account for postnasal devoicing in Bantu (e.g. Makua, Bubi, Punu) and other language families. Hyman's (1998) constraint contradicts Pater's

(1996). Halpert (2010, 2012) argues that the correct characterization of postnasal voicing in Bantu is not in terms of *NÇ̥ but rather nasal place assimilation. Herbert (1986) considers postnasal voicing to be universal, but views postnasal devoicing in Tswana (Bantu) as "… rather unique and remains unexplained" (p. 241). Conclusions such as Herbert's underline the fact that some phenomena associated with /N/ are puzzling. The phonetic-based accounts of /N/ appear to be inadequate in explaining crosslinguistic variations in the segmental alternations induced by nasals.

A number of previous instrumental studies have confirmed the existence of some of the postnasal alternations induced by /N/. Huffman and Hinnebusch (1998) and Solé et al. (2009) confirmed the occurrence of postnasal aspiration and postnasal devoicing in Pokomo and Kgalagari, respectively. In addition, Nash (2011) established that the vowel preceding /N/ in Gusii does undergo lengthening. Experimental results seem to back up phonological processes.

1.3 Theoretical background

The data presented in this study is formalized within two theoretical frameworks, that is, moraic theory and EBD. Moraic theory is adopted in accounting for crosslinguistic variations in vowel epenthesis and vowel lengthening before /N/. We will use the EBD framework to explain postnasal alternations. An overview of moraic theory is presented in §1.3.1 and EBD in §1.3.2.

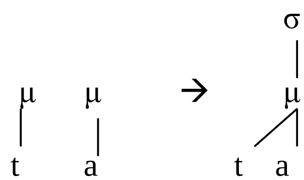
1.3.1 Moraic theory

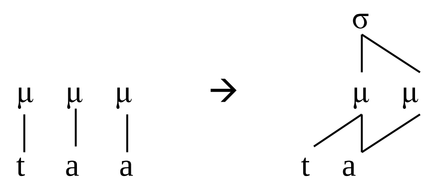
In this study, we propose to analyze vowel epenthesis and vowel lengthening before /N/ as compensatory processes that result from the demorification of /N/. The main argument is that these processes are attested in languages with contrastive vowel length but unattested in languages without contrastive vowel length. This proposal agrees with some of the principles of moraic theory. Moraic theory is based on the notion mora (μ) which is treated as the lowest unit of prosodic organization. The mora is a unit of phonological. The contemporary use of the mora is linked to studies on accentuation and syllable weight (e.g. Hyman 1985; Hayes 1989; Topintzi 2006). Since it is treated as the lowest unit of prosodic organization, the mora links prosodic and segmental structure. The mora is useful in making a number of phonological distinctions related to syllable weight and position: (a) Short and long syllables are distinguished by assigning the former one mora and the latter two moras. (b) In the onset vs. rime asymmetries, onsets are treated as non-moraic while codas are considered moraic in some languages. (c) Geminate and "doubled consonants" are distinguished by the fact that the former have a moraic structure while the latter do not. The mora plays a crucial role in interpreting phonological phenomena that relate to weight and other weight-sensitive phenomena since these rely on weight contributed by vowel length and coda consonants. However, the moraic approach to prosodic and segmental structure is debatable in the literature.

Hyman (1985) considers all segments to be underlyingly moraic but the Onset Creation Rule removes moras from prevocalic onset consonants, consequently linking these consonants to the next mora, as in (2) where a CV vs. CVV syllable contrast is made. In (2), vertical lines are used to link the different units of the hierarchy, that is, syllable (σ), mora (μ), and segments (/t, a/). The input segments /t/ and /a/ are assigned a mora each underlyingly. However, when /t/ is syllabified as onset, the Onset Creation Rule removes its mora and links /t/ to the next mora:

(2) a. CV Syllable b. CVV Syllable

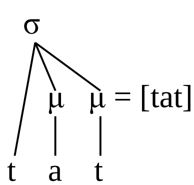
Input Syllabification Input Syllabification





Contrary to Hyman (1985), Hayes (1989), among others, maintains that only vowels and geminate consonants are underlyingly moraic while coda consonants in CVC syllables are assigned moras by a language-specific rule known as Weight by Position.[2] Hayes argues that languages with this rule treat both CVV and CVC syllables as heavy. The Weight by Position rule is illustrated in (3) (adapted from Hayes (1989:254):

(3) Weight by Position rule: heavy CVC syllable



In (3), the two moraic segments constitute a heavy (or bimoraic) syllable. The moraic structure illustrated in (3) has been used to account for CL illustrated in (4) below (e.g. Hayes 1989). This view of CL maintains that when a moraic segment is deleted its mora is stranded, but it is subsequently filled by spreading from the preceding vowel following the rule stated in (4b). This approach to CL is known as the Mora Conservation Hypothesis, and is illustrated in (4) using s-deletion in Latin (Hayes 1989:262):

[2]See Topintzi (2006) for a recent analysis that characterizes onset consonants as moraic.

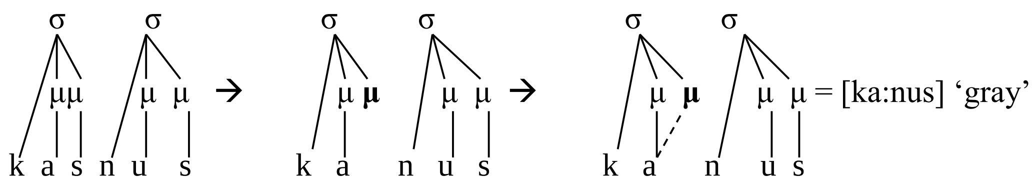
(4) a. /s/ Deletion

s → Ø / _____ [+son, +ant] (segmental tier only)

b. Compensatory lengthening

where μ′ is a segmentally unaffiliated mora

c.



In Latin, CVC syllables behave as heavy in representing prosodic phenomena such as stress and metrics. Thus, the assignment of a mora to the coda segment /s/ is based on Latin moraic structure (4c). In Latin, onsets have no mora; so, when /s/ occurs word-initially it has no mora to strand. The Latin example in (4) demonstrates the Mora Conservation Hypothesis of CL that has been adopted in a number of studies (e.g. Hyman 1985; Hayes 1989; McCarthy & Prince 1996).[3]

Although some aspects of moraic theory are subject to debate, the current study adopts the Mora Conservation Hypothesis and Hayes’ proposal on CL. The two principles are used to account for the crosslinguistic variation in vowel lengthening and vowel epenthesis before /N/. The main claim of Hayes’ (1989:254) proposal is that the prosodic frame that governs CL is partly language-specific since only languages that have syllable weight distinction allow CL. We will show in chapter 3 that the Bantu data on vowel lengthening and vowel epenthesis before /N/ are in line with this proposal. The two processes tend to occur only in languages with contrastive vowel

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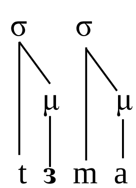
[3]For criticisms against the moraic approach to CL see, for example, de Chene & Anderson (1979); Timberlake (1993); Gordon (1997).

length. Besides, previous accounts of /N/ in languages with contrastive vowel length conclude that /N/ is moraic in these languages that include Ganda (Clements 1986; Hyman 1992); Yao (Ngunga 2000); Lungu (Bickmore 2007); and Gusii (Nash 2011). In contrast, /N/ appears to be non-moraic in languages without contrastive vowel length such as Swahili and Kongo (Meinhof 1932). The correlation between the CL and contrastive vowel length substantiates the Mora Conservation Hypothesis and Hayes (1989) proposal. Hayes (1989) identifies prenasalization, glide formation, and total assimilation as some of the contexts induce CL. These phenomena are robustly attested in Bantu; for instance, glide formation gives rise to CL only in languages with contrastive length, hence, corroborating Hayes' proposal and the Mora Conservation Hypothesis of CL.

In a moraic representation, the mora captures the contrast between light and heavy syllables in addition to providing a phonological position in which short and long segments can be linked (Hayes 1989). The two roles of the mora in representations are illustrated in (5-6) with examples from Gusii, a Bantu language with contrastive vowel length. In (5), the mora shows the contrast between a light (the first syllable in (5a)) and heavy syllable (the first syllable in (5b):[4]

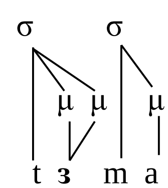
(5) A moraic contrast between a light and heavy syllable

a. Light syllable



= [tɜma] 'cut down'

b. Heavy syllable



= [tɜ:ma] 'try'

[4] Any undocumented Gusii and Swahili data are provided by the author who is a native speaker and near-native speaker of the two languages, respectively.

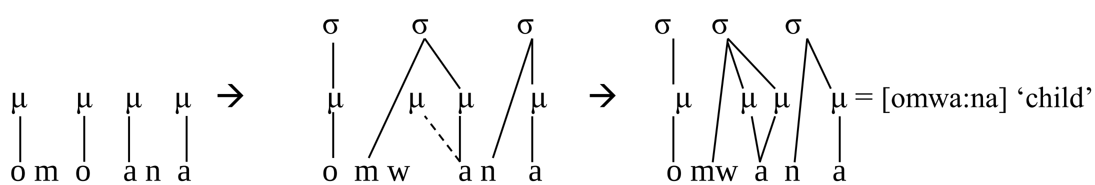
The moraic framework is suitable for explaining the occurrence and no-occurrence of CL and prenasal vowel epenthesis before /N/. The representations in (6) show this contrast using CL derived from glide formation in Gusii vs. the lack of CL in Swahili. In Gusii, CL arises when the vowel /o/ of the syllable /-mo-/ surfaces as a glide [w] before /a/ (6a). The mora assigned to /o/ underlyingly is then reassigned to /a/, giving rise to CL. However, there is no CL following glide formation in Swahili, a language with no contrastive vowel length (6b) (o- = augment, -mo- = class 2 prefix, -ana = nominal root):

(6) Occurrence vs. non-occurrence of postglide CL

a. Occurrence of postglide CL in Gusii

/o-mo-ana/ → [omwa:na] '1-child'

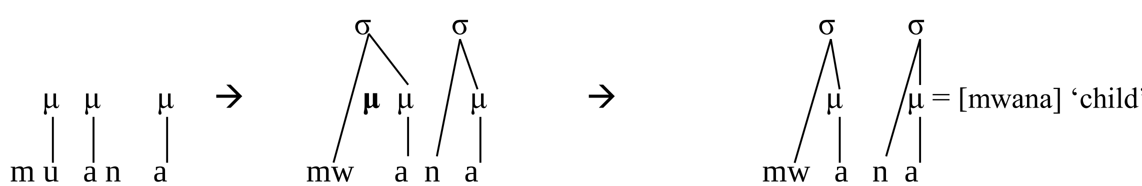
Mora assignment Demorification Surface representation



b. Non-occurrence of postglide CL in Swahili

/mu-ana/ → [mwana] '1-child'

Mora assignment Demorification Surface representation



The moraic approach to CL in (6) successfully accounts for the variation of postglide CL between Gusii and Swahili. This approach is adopted in chapter 3 where we account for crosslinguistic variations of CL and vowel epenthesis before /N/. Next is an overview of EBD.

1.3.2 Element-based Dependency

The consonantal alternations examined in this study are formalized within Element-based Dependency (EBD) (e.g. Botma 2004). The data presented in this study are however amenable to most phonological models. A number of reasons motivated the choice of EBD. Firstly, this framework eliminates some of the challenges facing the traditional binary feature approach. These challenges include overgeneralization in features such as [±nasal], inability for binary feature approaches to use relative segmental complexity as a diagnostic for phonological markedness, and the lack of clear phonetic correlates of features such as [sonorant] and [nasal]. EBD overcomes these challenges by minimizing featuresand feature values (EBD uses monovalent features). Secondly, EBD makes two important claims about nasality that we find relevant in to the processes under study. The two claims are that (a) nasal manner consists of a combination of vocalic and consonantal manner properties, and (b) nasalization is expressed by a dependent element |L| that may be interpreted as nasalization or voicing. The dual interpretation of dependent |L| is advantageous in that it accounts for the complementary distribution of nasalization and voice and provides a straightforward interpretation of processes that trigger either voicing or nasalization. Thirdly, EBD is able to capture both articulatory and acoustic properties of segments in the same representation. Fourthly, the clustering of laryngeal modifications in EBD is crucial in accounting for some of the variations noted in processes triggered by /N/. Lastly, the use of the same elements to characterize manner and phonation in EBD, for instance, element |H| for fricative manner and aspiration, captures the relationship that exists between manner and phonation. This is unlike in Feature Geometry where aspiration and continuancy belong to different nodes, thus showing no direct relation between aspiration and continuancy.

The principles underpinning EBDare drawn from two models, namely Dependency Phonology and Element Theory. The elements EBD uses as features are borrowed from Element Theory (Harris & Lindsey 1995; Harris 1994). EBD has borrowed a number of principles from Dependency Phonology: (a) the idea that phonological structure is maximally binary-branching, consisting of head-dependency relations. (b) The head component may be assigned a different (but related) interpretation depending on whether it occurs as a head or a dependent. (c) Manner and place are the core elements of a segment while phonation is peripheral. (d) Phonological featuresare monovalent (Anderson and Ewen (1987; Humbert 1995; Smith 2000). Consider the EBD structures of the labial stops (O = onset):

(7) Phonological structure of labial stops in EBD

```
a.    O          b.   O          c.   O          d.   O
      |\              |\              |               |\
      L  L            ʔ  L            ʔ               ʔ  H
      |               |               |               |
      ʔ               U               U               U
      |
      U

      /m/             /b/             /p/             /pʰ/
```

In (7), the element |L| that occurs directly below the onset represents vocalic (or “sonorant”) manner while branching |L| represents nasalization (7a) and voicing (7b).[5] The element |U| represents labial place while element |ʔ| represents stop manner (7a-d). The branching element |H| represents aspiration, but can also represent fricative manner. In EBD, branching elements represent laryngeal modification. Note that the structures in (7a), (7b), and (7d) are binary

[5] Elements are notated with capital letters enclosed in vertical lines, as in the labial place element |U|.

branching. In every structure, elements are connected with lines that show the dominancy relationships. The elements linked with the onset are said to be dominated by that subsyllabic position, and so on.

The notion of *dependency* refers to a binary but asymmetric relation in which a component in a construction is the head and the other a dependent. In EBD, manner and place are the core elements of a segment while phonation elements are dependent on this core. In complex manner structures (e.g. 7a), the element that is closest to the subsyllabic position is said to dominate the element that is below it (i.e. the dependent element). For example, in (7a) above, the onset dominates |L| and |L| dominates |ʔ|, which in turn dominates |U|.

In EBD, the elements |ʔ|, |H|, and |L| are used to characterize manner and phonation properties of segments while the elements |U|, |I|, and |A| are used to specify the place properties labial, coronal and dorsal in consonants, respectively. In vowels, the element |U| represents backness, |I| highness, and |A| lowness. There is no element for height, but the absence of |A| implies [high]. The combined elements |A, I| and |A, U| represent mid front and mid back vowels. The manner elements |ʔ|, |H|, and |L| represent the strictures of complete closure, close approximation, and wide approximation, respectively. The typical segment represented by theelements |ʔ|, |H|, and |L| are stops, fricatives, and sonorants, respectively. The structures in (8) demonstrate the elemental structures of four different consonants (8):

(8) Phonological structure of different segments

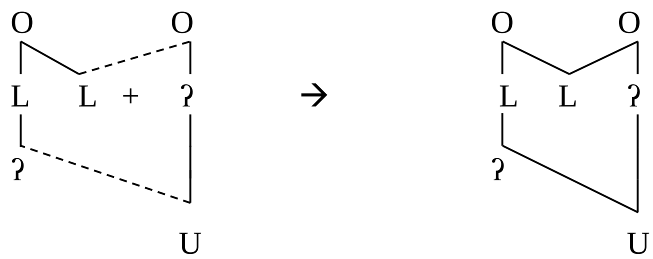
a.	b.	c.	d.
O	O	O	O
H	H	ʔ	ʔ
I		A	H
			I A
/s/	/h/	/k/	/ʧ/

The EBD model has also borrowed from Element Theory the idea that phonetic interpretation of elements is context-sensitive. This means that a particular phonetic entity does not have a unique phonological representation since its representation depends on the phonological system of the language. Hence, different elemental compositions may map onto identical patterns in the acoustic signal. This implies that the internal structure of a particular segment is determined by its phonological behavior, and not by its phonetic realization.

EBD makes two main claims about nasality. The first is that nasal manner consists of a combination of a head vocalic manner (|L|) and a dependent consonantal manner (|ʔ|). The second is that nasalization is expressed by a dependent element |L| that may be interpreted as nasalization or voicing. The interpretation of dependent |L| of nasal manner depends on the structure to which it is linked. When linked to a sonorant it is interpreted as nasalization, but when linked to an obstruent it is interpreted as voicing (Botma 2004:2). Botma argues that the dual interpretation of dependent |L| of nasal manneraccounts for the complementary distribution of nasalization and voice across languages. This duality also explains the lack of cross-linguistic evidence for languages with contrastive voiced sonorants or nasalized obstruents. Besides, the dual interpretation of dependent |L| accounts for the crosslinguistic cases of postnasal voicing and nasalization. The EBD derivations in (9) show postnasal voicing (9a) and nasalization (9b). EBD uses a number of operations on elements to show segmental processes. These operations include linking, delinking/deletion, switching, and addition of elements. The linking operation is represented by dotted lines as in (9a-b) below:

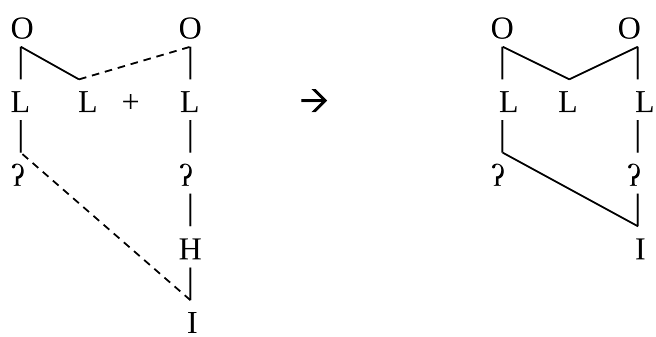
(9) Postnasal voicing and nasalization in EBD

a. Postnasal voicing in Yao: /N-**p**at-il-e/ → [m**b**atile] 'got me' (Ngunga 2000:60)



/N+p/ → [mb]

b. Nasalization in Ganda: /N-l̲onda/→[n**n**onda]'I choose' (Ashton et al 1954)



/N+l/ → [nn]

In (9a), postnasal voicing that changes /p/ to [b] is achieved by linking dependent |L| of the nasal to the dependent position of the obstruent /p/. This is accompanied by linking the place element |U| of /p/ to the stop element |ʔ| of the nasal to show nasal place assimilation. In (9b), postnasal nasalization changes /l/ to [n]. This process is achieved by linking dependent |L| of the nasal to the dependent position of the sonorant /l/ and deleting the manner element |H| of the liquid. The place element |I|of /l/ is linked to the stop element |ʔ| to show nasal place assimilation.

That EBD uses the elements |ʔ|, |H|, and |L| to represent both manner and phonation is appropriate because manner and phonation share certain general articulatory and acoustic characteristics. Phonological evidence from lenition and debuccalization processes suggests a relation between manner and phonation. Lenition processes in which voiceless stops are weakened to |ʔ|or |H|receive a straightforward interpretation if their outputis already present in the structure of the affected segments (Harris & Lindsey 1995). In EBD, phonation is represented as a dependent component and subsumes different laryngeal modifications. The view that the phonetic interpretation of elements is context-sensitive implies that the realization of phonation varies across phonological systems. The EBD categorization and realization of laryngeal contrasts are shown in (10). The phonation contrasts in (10) indicate that there are three laryngeal contrasts represented by elements |ʔ|, |H|, and |L| that have different phonetic realizations:

(10) Laryngeal contrasts and phonetic realizations

a. |ʔ| : glottalization, ejection, creaky voice, implosion

b. |H| : aspiration, breathy voice, voicelessness

c. |L| : voice, nasalization

The phonetic realization of laryngeal contrasts |ʔ|, |H|, and |L| varies according to language-specific phonetic implementation and the manner structure to which an element is associated. However, not all manner types are compatible with all phonation types. Segments that have |ʔ| as the head manner element (i.e. stops and affricates) are compatible with all types of phonation. Segments with |H| as the head manner element (i.e. fricatives) are compatible with voicing, aspiration, and glottalization. Segments that have |L| as their head element, that is, sonorants are compatible with aspiration and glottalization. To explain the phonetic realization of phonation elements, take dependent |H|, for example. This phonation element is interpreted as aspiration or breathy voice or voicelessness. Consider examples of segment types with dependent |H| in (11) (Botma 2004:89):

(11) Phonetic realization of dependent |H|

a.	b.	c.	d.
O	O	O	O
ʔ H	H H	L H	L H
U	I	A	ʔ
			U
/p^h/	/s^h/	/a^h/	/m^h/

In (11), the phonation element |H| occurs as a dependent element and its presence yields a variety of segments depending on the manner type to which it is linked. The consonantal alternations associated with /N/ will be formalized in terms of changes in manner, place and laryngeal contrast using EBD representations. The next section presents an overview of Bantu languages.

1.4 Overview of Bantu languages and data

This subsection presents basic facts about Bantu languages and the data used in this study. The information about Bantu languages provided in §1.5.1 relates to their classification and basic characteristics. The languages that constitute the study sample in this study are also listed in this section. In §1.5.2 we give an overview of the data used in this study.

1.4.1 Overview of Bantu languages

Bantu languages are spoken in Africa particularly in the area below the line from Nigeria in the west to Kenya in the east. The Bantu language family forms part of the Niger-Congo phylum. Some of the putative properties of Bantu languages include the following: (a) a fairly simple and symmetric vowel system; (b) a system of grammatical genders; (c) a vocabulary part of which can be related by fixed rules to a set of common roots; (d) an agglutinative word-forming process based on a set of invariable consonant-vowel-consonant roots. The exact number of languages in the Bantu family is not known, although a rough estimate of five hundred languages is suggested (Nurse and Philippson 2003). Bantu languages have been classified for ease of identification (e.g. Guthrie 1948-1971). Guthrie classifies the whole Bantu-speaking area into sixteen geographical zones identified with alphabetical letters in upper case. These zones divide into a number of groups presented in decades such as A10, A20, A30, A40, A50, A60, and A70. A single decade refers to a group of languages within a given zone. The alphanumerical symbols such as A11, A12, A13, A14, and A15 are used to designate specific languages within a group. The first numeral refers to the group and the second the language. The sample of languages used in this study is presented in (12):

(12) List of Bantu Languages cited according to their Zones

Babole	(C.101)	Luyana	(K.31)
Rwanda	(D. 16)	Lungu	(M.14)
Nande	(D. 42)	Nyamwezi	(M.22)
Ganda	(E.15)	Konde/Nyakyusa	(M.31)
Nyambo	(E.21)	Bemba	(M.42)
Gusii	(E.42)	Lamba	(M.54)
Jita	(E.25)	Yao	(P.31)
Kikuyu	(E. 51)	Shona	(S.10)
Tharaka	(E.54)	Tswana	(S.31)
Swahili	(G.42)	Kgalagari	(S.31d)

Kongo	(H.16)	Xhosa	(S.41)
Yaka	(H.31)	Zulu	(S.42)

1.4.2 Overview of the data

The data used in this study contains class 9/10 nominal stems with the prefix /N/ and verbal stems with 1SG subject and object prefix /N/. In this subsection, we provide examples from different languages to show the three contexts of /N/ and some of the segmental alternations associated with /N/. The nominal stems in (12) show /N/ of class 9/10 in Swahili:

(13) Noun class 9/10 /N/ in Swahili

a. /N-gumu/ → [ŋgumu] '9/10-hard'

b. N-refu/ → [ndefu] '9/10-long, tall, high'

c. /N-wili/ → [mbili] '10-two'

d. /N-kubwa/ → [k^{h}ubwa] '9/10-big'

e. /N-pya/ → [m̩pya] '9/10-new'

f. /N-eupe/ → [ɲeupe] '9/10-while'

In (13), Swahili /N/ assimilates the place of articulation of the stem-initial consonant. Swahili stem-initial approximants /w/ (13c) and /r/ (13b) undergo postnasal hardening before /N/ to become plosives [b] and [d], respectively. Swahili /N/ deletes before voiceless consonants in polysyllabic stems (13d) but is retained before voiceless consonants in monosyllabic stems where it surfaces syllabic (13e). The deletion of Swahili /N/ before voiceless consonants is accompanied by postnasal aspiration (13d). When it occurs before a vowel, Swahili /N/ is realized as a palatal nasal [ɲ] (13f).

In Bantu, /N/ occurs as the 1SG prefix in a number of languages such as Jita (Downing 1996). The behavior of /N/ in Jita differs from that of Swahili in two ways: (a) Jita /N/ is retained before voiceless consonants; (b) Jita /N/ induces lengthening in the preceding vowel. The data in (14) shows the behavior of 1SG object /N/ in Jita(Downing 1996:23):

(14) Realization of 1SG object /N/ in Jita

a.	/o-ku-N-sa:kura/	→	[oku:nsa:kura]	'to grab away from me'
b.	/o-ku-N-gánira/	→	[oku:nganíra]	'to tell me (a story)'
c.	/o-ku-N-cu:mya/	→	[oku:ncu:mya]	'to make me jump'
d.	/o-ku-N-taja/	→	[oku:ntaja]	'to step on me'

The 1SG subject prefix occurs as /N/ in a number of languages, for example, Kikuyu (Barlaw 1951). In Kikuyu, 1SG /N/ causes postnasal nasalization in stem-initial consonants if the stem contains a lexical nasal or NÇ (15a-b). However, postnasal nasalization does not arise if the stem does not have a lexical nasal or NÇ (15c-d). When preceded by /N/, Kikuyu /r/ undergoes postnasal hardening to surface as [d] (15c-d) (Barlaw 1951:7):

(15) Realization of 1SG subject /N/ in Kikuyu

a.	/N-**r**ũm-e/	→	[**n**ũme]	'Am I to bite?'
b.	/N-**r**iŋg-e/	→	[**n**iŋge]	'Am I to strike?'
c.	/N-**r**eki-e/	→	[**n**dekie]	'Am I to let go?'
d.	/N-**r**aθi-e/	→	[n**d**aθie]	'Am I to shoot?'

In (15a-b), Kikuyu /r/ is replaced by a homorganic nasal due to postnasal nasalization, a process widely known as Meinhof's Law (ML) in Bantu linguistics. In (15c-d), /r/ becomes [d] after /N/ when the conditions for ML are not met.

The data in (13) – (15) show that /N/ is associated with a variety of segmental alternations. In (13), Swahili /N/ undergoes deletion, homorganization, and syllabicity alternation, and triggers postnasal hardening and aspiration in stem-initial obstruents. In (14), Jita /N/ surfaces homorganic and induces prenasal vowel lengthening but is retained before voiceless and voiced consonants. In Kikuyu (15), /N/ undergoes homorganization, causes postnasal nasalization, and postnasal hardening. Note that /N/ triggers much more alternations than the ones observed in (13-15). Other alternations induced by /N/ include denasalization and nasal degemination observed in Yaka (Kidima 1991:4). Yaka denasalization occurs when initial /N+n/ surfaces as [d] (16a) and /N+m/ as [b]. In (16a), /N/ undergoes deletion. In (16b), stem-initial /b/ is unaffected but in (16d), /l/ is subject to postnasal hardening to become [b] (Kidima 1991:4-5):[6]

(16) Denasalization and nasal degemination in Yaka

a. /N-**n**uuk-ili/ → [d̲úúkíní] ‘I sniffed’

b. /N-**m**ak-ili/ → [mb̲ákíní] ‘I carved’

c. /N-**b**ak-idi/ → [mbakidí] ‘I caught’

d. /N-**l**uuk-ili/ → [nduukidií] ‘I became wise’

Note that it is the stem with an initial heavy syllable /nu:/ that conditions denasalization and nasal deletion (16a). The stem in which the initial syllable is light /ma/ retains /N/ (16b).

The data in (17) show additional postnasal alternations conditioned by /N/. These processes include voicing, affrication, consonant deletion, and consonant epenthesis (Ngunga 2000:60, Kula 2002:66-73, Hyman 2003:49-52):

---

[6] In Yaka, [d, n] may occur as variants of /l/, with [d] surfacing before /i/ (19c-d) and [n] due to nasal harmony (19a-b).

(17) Postnasal alternations in Bantu

a. Yao postnasal voicing: /ku-N-**p**élék-a/ → [kuu-m-**b**élek-a] 'to send me'

b. Kongo postnasal affrication: /ku-N-**f**il-a/ → [kú-m-**pf**il-a] 'to lead me'

c. Bemba postnasal epenthesis: /N-alul-a/ → [n**g**-alul-a] 'I redirect'

d. Shona deaffrication: /**bv**um-a/ 'agree' → [m-**v**um-o] 'permission'

e. Yao postnasal deletion: /ku-N-**g**ónéka/ → [kuu-**ŋ**ónek-a] 'to make me sleep'

In (17a), postnasal voicing in Yao changes /p/ to [b] while in (17b) Kongo stem-initial /f/ undergoes affrication to become [pf] after /N/. In (17c), Bemba [g] is "inserted" between /N/ and the stem-initial vowel /a/. In (17d), Shona /bv/ undergoes postnasal deaffrication to appear as [b]. In (17e), /N/ causes postnasal devoicing in Shona /b/ to become [p].

The study of /N/ includes its behavior in nonlocal processes, that is, Dahl's Law (DL), nasal-consonant harmony (NCH), and Meinhof's law (ML). Dahl's Law is a voicing dissimilation process in which the onset of a syllable undergoes voicing if the next syllable onset is voiceless. For example, in Gusii, /N/ appears to be transparent to DL when it occurs between the trigger and target. Consider the Gusii examples in (18):

(18) Transparent /N/ in Dahl's Law in Gusii

a. /o-ko-N-tur-a/ → [o-ɣoo-**n**-t̠ura] 'to wake me up'

b. /o-ko-N-kun-a/ → [o-ɣoo-**ŋ**-k̠una] 'to touch me'

c. /o-ko-N-siβa/ → [o-ɣoo-**n**-siβa] 'to tie me'

d. /o-ko-N-piim-a/ → [o-ɣoo-**m**-piima] 'to examine me'

e. /o-ko-N-caay-a/ → [o-ɣoo-**ɲ**-caaya] 'to despise me'

In (18), /k/ of the infinitive prefix /ko/ undergoes voicing to surface as [ɣ] due to DL triggered by the stem-initial voices obstruents /t, k, p, c/, respectively.

Meinhof's Law (ML) is a nasalization process in which a stem-internal lexical nasal or NÇ̬ conditions /N/ to trigger postnasal nasalization in a stem-initial voiced consonant. The stem-initial voiced consonant always becomes a homorganic nasal. The data in (19) shows ML in Ganda involving 1SG subject /N/ (19a-b) and class 10 /N/ (19c-d) (Ashton et al 1954:156):

(19) Ganda /N/ in Meinhof's Law

a.	/N-**b**omba/	→	[mmomba]	'I escape'
b.	/N-**l**inda/	→	[nninda]	'I wait'
c.	/e-N-**g**endo/	→	[eŋŋendo]	'10-journey'
d.	/e-N-**l**imi/	→	[ennimi]	'10-tongue'

In (19), Ganda stem-initial voiced consonants /b, l, g/ undergo nasalization to become [m, n, ŋ] when preceded by /N/ in stems with a plain nasal (19d) or voiced NÇ̬s (19a-c). The nasalization of stem-initial voiced consonants in (19) creates initial geminate nasals. An overview of the structure of the dissertation is provided next.

1.5 Organization of the dissertation

This dissertation is organized into six chapters. Chapter 2 presents the basic characteristics of the phonology and morphology of Bantu languages. The facts about Bantu phonology in this chapter include vowel and consonant inventories, syllable structure, tones, and segmental process involving vowels and oral consonants, respectively. The details on Bantu morphology provided in chapter 2 relate to nominal and verbal stems. Chapter 2 shows that in Bantu, nominals are put in classes and a noun may consist of four (or less) morphemes such as the preprefix (or augment/initial vowel), class prefix, nominal root, and nominalizing suffix. Verbal stems in Bantu consist of numerous affixes that include subject markers, tense markers, relative pronouns, object markers, focus markers, negative markers, verbal root, and a series of extension suffixes (e.g. applicative, reciprocal, stative, causative, and passive markers). The distribution of /N/ in nominal and verbal stems is also presented in chapter 2.

Chapter 3 discusses segmental alternations that affect the vowel preceding /N/ and the behavior of /N/ in nonlocal alternations. The prenasal processes examined in this chapter include vowel lengthening, vowel epenthesis, and vowel shortening. Prenasal vowel lengthening and prenasal vowel epenthesis are analyzed within moraic theory. The main generalization made regarding the two processes is that they correlate with contrastive vowel length. Vowel shortening before /N/ is attributed to Initial Vowel Shortening (IVS) which overrides CL. The behavior of Bantu /N/ in nonlocal processes involves processes such as nasal-consonant harmony (NCH), Dahl’s Law (DL), and Meinhof’s Law (ML). The behavior of /N/ in DL is discussed and four possible explanationsoffered to explain its behavior. The inability of Bantu /N/ to trigger NCH arises from the fact that /N/ as a prefix /N/ occurs outside of the domain of NCH which is the stem. The behavior of /N/ in ML is explained in terms of postnasal nasalization of sonorants and language-specific phonology.

Chapter 4 deals with the alternations that target /N/ itself when it interacts with stem-initial segments. When /N/ occurs before stem-initial vowels and/or glides it is always realized as a dorsal nasal, that is, palatal [ɲ] or velar [ŋ], hence, [m] and [n] are excluded. Other alternations that affect /N/ are triggered by oral consonants, and include nasal effacement, degemination, nasal place assimilation, nasal devoicing, and nasal aspiration. Bantu /N/ also alternates in its syllabicity. The alternations that affect /N/ have been formalized within EBD. In EBD, the changes that occur in /N/ are regulated by cluster licensing in individual languages and the properties of nasals and orals consonants.

Chapter 5 deals with the various processes /N/ conditions on stem-initial segments. Included in this chapter are cases where /N/ fails to trigger any alternation in some stem-initial segments. The postnasal processes discussed in this chapter include postnasal hardening, postnasal (de)voicing, postnasal (de)affrication, postnasal consonant insertion, postnasal consonant deletion, postnasal de-implosion, postnasal aspiration, and postnasal denasalization. These processes have been analyzed within EBD. Chapter 6 presents the summary and conclusion of the study. The next chapter provides an overview of Bantu phonology and morphology.

CHAPTER 2

2. CHARACTERISTICS OF BANTU PHONOLOGY AND MORPHOLOGY

2.1 Introduction

This chapter presents the basic facts about the phonology and morphology of Bantu languages. The purpose of this chapter is to lay the ground for chapters 3, 4, and 5 that deal with the phonological and morphological properties of /N/. The chapter is divided into two sections, that is, characteristics of Bantu phonology and characteristics of Bantu morphology. The section on phonology (§2.2) provides basic information about vowel and consonant inventories, syllable structure, tones, and phonological processes. The section on morphology (§2.3) focuses on nominal and verbal stems, and is divided into nominal morphology and verbal morphology. The summary of the chapter appears in §2.4.

2.2 Characteristics of Bantu phonology

2.2.1 Vowel inventories and vocalic processes

The exact number and quality of vowels reconstructed for Proto-Bantu (PB) is debatable. Meinhof's (1932:27) reconstruction of PB vowels includes *u, * ʊ, *i, *ɪ, *ɛ, *ɔ, *a.[7] Alternative reconstructions show that PB had both short and long phonemic vowels. Some reconstructions suggest that vowel length in PB was contrastive except before prenasalized consonants. The example vowel inventory in PB given in (1) consists of short and long vowels (Hyman 2003:45):

[7] Meinhof (1932) uses the term Ur-Bantu as an alternative term for Proto-Bantu.

(1) Proto-Bantu vowel phonemes

į įį	ų ųų
i ii	u uu
e ee	o oo
a aa	

The vowel system in (1) shows that PB vowels contrasted at four levels on the vertical dimension but three at the horizontal level. On height, PB vowels occurred as close, close-mid, open mid, and open. The high vowels contrast between [+ATR] (*į [i] and *ų [u]) and [-ATR] (*i [ɪ] and *u [ʊ]). At the horizontal level, PB vowels occurred as [front], [central], and [back]. As far as vowel sequences were concerned, PB had few vowel sequences that were restricted to the first (only) syllable of roots and morpheme boundaries (Schadeberg 2003:147). Sequences of dissimilar vowels in PB gave rise to glides especially if V_1 was non-low while sequences of identical vowels induced phonetic length in vowels (Meinhof 1932:23).

Present-day Bantu languages have simple vowel systems but differ in a number of aspects. They differ in terms of vowel inventories, phonemic vowel length, vowel distribution across stem syllables, vowel sequences, and vocalic processes (Nurse & Philippson 2003:7; Hyman 2003:45-49; Schadeberg 2003:147). Most daughter languages consist of seven or five vowel systems, with a few languages having more than seven vowels. The vowel inventories in (2) may not represent all attested inventories across Bantu, but they represent four different regions of the Bantu speaking area. The inventories are from Rwanda (Kimenyi 1979:1), Nyamwezi (1992:26), Yaka (Kidima 1991:2), and Shona (Mudzingwa 2010:39):

(2) Vowel inventories in four Bantu languages

(a) Rwanda vowels

i	ii	uu	u
e	ee	oo	o
a	aa		

(b) Nyamwezi vowels

i	u
ɪ	ʊ
e	o
a	

(c) Yaka vowels

i	ii	u	uu
e	ee	o	oo
a	aa		

(d) Shona vowels

i	u
e	o
a	

The vowel inventories in (2) show that the short vowel /i, e, a, o, u/ are common among the four languages while vowel length is contrastive in Rwanda (2a) and Yaka (2c). Nyamwezi (2b) and Shona (2d) have only short vowels, but Nyamwezi vowels contrast at four height levels. The examples in (3) illustrate contrastive vowel length in Rwanda (Kimenyi 1979:1-2):

(3) Contrastive vowel length in Rwanda

(a)	/i/ vs. /ii/:	[gus**i**ßa]	'to erase'	vs.	[gus**ii**ßa]	'to be absent'
(b)	/e/ vs. /ee/:	[gus**e**ga]	'toclimb a tree'	vs.	[gus**ee**ga]	'to beg'
(c)	/u/ vs. /uu/:	[gus**u**ra]	'to fart'	vs.	[gus**uu**ra]	'to visit'
(d)	/a/ vs. /aa/:	[gut**a**ka]	'to scream'	vs.	[gut**aa**ka]	'to ornate'
(e)	/o/ vs. /oo/:	[is**ó**ko]	'market'	vs.	[is**óo**ko]	'source'

A range of vocalic processes are observed across Bantu languages The most frequent examples of alternations that affect vowels include vowel lengthening, vowel harmony, vowel deletion, vowel coalescence, vowel shortening, and gliding. Vowel lengthening occurs in different environments, for example, before /N/, after glide formation, vowel concatenation, and penultimate syllables (vowel lengthening before /N/ is discussed in detail in chapter 3). Vowel lengthening due to vowel concatenation occurs when a morphological rule causes two heteromorphemic vowels to be adjacent. Vowel lengthening in this context means that the input vowels originate in different morphemes but their output is a long tautosyllabic vowel. This kind of vowel lengthening may be preceded by other vowel alternations, for instance, vowel harmony or vowel deletion. The data in (4) show vowel lengthening due to concatenation. The vowels /a, e, o/ undergo deletion (or total harmony with the following non-identical vowel), causing vowel lengthening (Hyman 2003:48):

(4) Vowel lengthening due to vowel concatenation in Ganda

a.	/mu-sib**ê** + **o**-mû/	→	[mu.si.b**óò**.mû]	'one prisoner'
b.	/mu-wal**â** + **o**-mû/	→	[mu.wa.l**óò**.mû]	'one girl'
c.	/n-dig**a** + **e**-mû/	→	[n.di.g**éè**.mû]	'one sheep'
d.	/ba-k**ô** + **a**-ba-o/	→	[ba.k**áà**.bo]	'those in-laws'

In (4), /e+o/ (4a) and /a+o/ (4b) undergo harmonization with concomitant lengthening to surface as [oo]. The vowel sequences /a+e/ (4c) and /o+a/ (4d) are realized as [ee] and [aa], respectively. Vowel lengthening due to concatenation in Ganda occurs to conserve the mora count of the input while at the same time resolving the vowel hiatus created by concatenation. Bantu vowel lengthening due to vowel concatenation is restricted to languages with contrastive vowel length. Languages such as Swahili and Kongo that lack contrastive vowel length do not allow vowel lengthening due to vowel concatenation, as evident in the Swahili examples in (5):

(5) Short vowel and gliding across morpheme boundary in Swahili

a. /wa- + -**a**ŋgu/ → [w**a**ŋgu] '1/2, 3-my'

b. /ku- + -**i**ŋgia/ → [kw**i**ŋgia] 'to enter'

c. /pa- + -**ɛ**nu/ → [p**ɛ**nu] '16-your (plural).'

d. /ku- + -**ɛ**puka/ → [kw**ɛ**puka] 'to evade'

In (5a) the vowel sequences /a+a/ surface as short [a] whereas in (5b, d) the vowel sequences /u+i/ and /u+ε/ inducegliding of /u/ to [w]. In (5c), the vowel sequence /a+ε/ surfaces as [**ɛ**]; this implies that /a/ is deleted or the two vowels coalescence. Note that in Swahili, neither postglide vowel lengthening nor vowel lengthening due to vowel concatenation is observed. In order to resolve vowel hiatus, Swahili deletes one of the identical vowels of the sequence and changes a high vowel to a glide when that vowel is followed by a non-identical vowel, as in (5b, d).

Bantu vowel lengthening is also observed in penultimate syllables in some languages. This phenomenon is common especially in eastern and southern zones (Hyman 2003). The data in (6) show penultimate vowel lengthening in Shona (Hyman 2009:195). The lengthening targets different syllables that occur in the penultimate position when verbal stems gain additional suffixes, for example, applicative and causative markers (6):

(6) Vowel lengthening in penultimate syllables in Shona

a. ku-s**e:**k-a 'to laugh'

b. ku-sek-**e:**s-a 'to cause to laugh'

c. ku-sek-**e:**r-a 'to laugh at'

d. ku-sek-es-**e:**r-a 'to cause to laugh at'

In (6a), the vowel in the penultimate syllable /se:/ is long but becomes a short vowel in (6b-d) when it occurs in non-penultimate positions after the verbal stem acquires more suffixes. Hence, only vowels in penultimate syllables /se:/ (6a) /ke:/ (6b-c) and /se:/ (6d) surface as long vowels.

In some languages, vowel lengthening occurs as a result of vowel coalescence across morpheme boundary and adjacent words. Bantu vowel coalescence may be of two kinds, depending on the quality of vowels involved. First, two adjacent vowels of the same quality may combine to form a single vowel of the same quality. Secondly, two vowels of a different quality may fuse to form a single vowel whose quality differs from that of the individual input vowels. The data in (7) show vowel lengthening due to coalescence in Yao (Ngunga 2000:21):

(7) Vowel lengthening due to vowel coalescence in Yao

a.	/d**i**+**í**ná /	→	[d**íí**.ná]	‘name’
b.	/m**u**+**ú**ɲu/	→	[m**uú**.ɲu]	‘graphite’
c.	/m**a**+**í**só/	→	[m**éé**.só]	‘eyes’
d.	/m**a**+**ú**ŋu/	→	[m**oó.**ŋu]	‘pumpkins’

In (7a-b), two identical vowels /i+i/ and /u+u/ combine to form a single long vowel of the same quality as the input vowels. However, in (7c-d), two non-identical vowels coalesce to form a long vowel of a different quality from the input vowels. The data in (7) suggests that some languages allow vowel coalescence with concomitant lengthening to resolve vowel hiatus across morpheme boundary.

Vowel harmony is a common alternation in Bantu, and involves different features such as [height], [ATR], and [round]. Vowel height harmony (VHH) is the most common. In Bantu languages, VHH originates in stems and spreads to extensions (Ngunga 2000, Hyman 2003). VHH may vary in terms of [front] vs. [back] vowels, five-vowel vs. seven-vowel systems, and from region to region (Leitch 1996; Hyman 1999). In Swahili, for example, VHH conditions the applicative morpheme /-i-/ to surface either as [i] or [e], depending on the preceding stem vowel.[8] The Swahili applicative /i/ vowel remains [i] if the stem vowel is high (/i, u/) or low (/a/), but [e] if the stem vowel is a mid vowel (/e, o/). Swahili VHH is illustrated in (8) where the applicative vowel is in the penultimate syllable (Ngonyani 1996:16):

(8) Vowel height harmony in Swahili applicative verbal stems

a.	/-fiʧa/	'hide'	→ [-fiʧ**i**a]	'hide for/at/with'
b.	/-fuŋga/	'close'	→ [-fuŋg**i**a]	'close for/at/on'
c.	/-kata/	'cut'	→ [-kat**i**a]	'cut for/at/on'
d.	/-peleka/	'send'	→ [-pelek**e**a]	'send to/for'
e.	/-omba/	'request'	→ [-omb**e**a]	'request for/with'

In (8), the Swahili applicative morpheme /-i-/ surfaces as [i] when the stem vowel in /i/ (8a), /u/ (8b), and /a/ (8c). The same morpheme becomes [e] when preceded by /e/ (8d) and /o/ (8e) as stem vowels. Thus, the Swahili data (8) exhibits vowel height harmony (except in (8c) where the default applicative suffix /-i-/ is retained after the stem vowel /-a-/).

Bantu vowels may undergo [ATR] harmony, as observed in Nande. In this language, underlying [-ATR] vowels /i, u, e, o/ become [+ATR] when followed by [+ATR] vowels /i̧, u̧/. Nande has a seven-vowel inventory consisting of /i̧, u̧, i, u, e, o, a/.[9] The second degree vowels /i, u/ shift to higher vowels equivalent to first degree vowels /i̧, u̧/ when they precede the [+ATR]

[8] Historical and comparative evidence suggests that /l/ of the applicative morpheme /-il-/ was lost in Swahili (most Bantu languages have /-il-, -ir-/ as the applicative morpheme (the vowel of the applicative suffix may vary across languages).

[9] The Nande seven-vowel system may be described as degree one /i̧, u̧/, degree two /ɪ, ʊ/, degree three /ɛ, ɔ/, and degree four /a/.

vowels. Nande vowel height shift is triggered by suffixes such the recent past /-i̧r-e/ and agentive /-i̧/ (Kenstowicz 2008:7):

(9) [ATR] harmony in Nande

	Infinitive	Recent past	Agentive	
a.	e-ri-lím-a	mó̧-twá̧-lî̧m-í̧r-e	o̧-mu̧-lî̧m-i̧	‘cultivate’
b.	e-ri-hék-a	mó̧-twá̧-hȩ́k-i̧r-e	o̧-mu̧-hȩ́k-i̧	‘carry’
c.	e-ri-húm-a	mó̧-twá̧-hú̧m-i̧r-e	o̧-mu̧-hú̧m-i̧	‘beat’

In (9), lexical [-ATR] vowels /i,/ (9a) /e/ (9b), /u/ (9c) become [+ATR] /i̧/ /ȩ/, and /u̧/ when followed by the [+ATR] vowel /i̧/ of the recent past and agentive suffixes.

In some languages, vowels are subject to a shortening alternation mostly in initial and final syllables. In (10), Rwanda stem-initial vowels that normally occur as long vowels word-medially surface as short vowels initially due to a vowel shortening rule. In (10), /o, a, u/ occur as long vowel medially but as a short vowel word-initially (Kimenyi 1979:25-26):

(10) Word-initial vowel shortening in Rwanda

			Medial position			Initial position	
a.	/ku-óog-a/	→	[k**óo**ga]	‘to swim’	vs.	[**o**ga]	‘swim’
b.	/ku-aak-a/	→	[kw**aa**ka]	‘to ask’	vs.	[**a**ka]	‘ask’
c.	/ku-úumva/	→	[kw**úu**mva]	‘to steal’	vs.	[**u**mva]	‘steal’

In Lungu, when /u/ becomes a glide, the following vowel undergoes compensatory lengthening (CL) word-medially. However, postglide vowel lengthening in Lungu is blocked word-finally due to a vowel shortening rule in this position. The data in (11) show word-final vowel shortening in Lungu (Bickmore 2007:53):

(11) Word-final vowel shortening in Lungu

a. /ú-ku-zu-il-a/ → [ú-kú-zw-**íí**-à] 'to leak on'

b. /ú-ku-zu-a/ → [ú-kú-zw-**á**] 'to leak'

c. /ú-ku-zu-a sáaná/ → [ú-kú-zw-**à** sáàná] 'to leak a lot'

In (11a) CL occurs word-medially to change /i/ to [i:] after /u/ becomes a glide [w]. However, in (11b-c) final /a/ surfaces as a short vowel [a] in spite of preceding /u/ becoming a glide [w] similar to medial /u/ in (11a). The lack of CL in (11b-c) is due to a final vowel shortening rule.

Vowel deletion and vowel epenthesis are also noted in Bantu in particular contexts (vowel epenthesis before /N/ will be discussed in chapter 3). Bantu vowel deletion (or total assimilation) involves particular qualities of vowels that delete in the context of non-identical vowels. In languages such as Yao and Kuria, vowel deletion induces vowel lengthening. This kind of vowel lengthening may be treated as CL as it arises to compensate for the mora lost due to vowel deletion. This phenomenon may also be interpreted as derived length due to total assimilation. Vowel deletion in Bantu languages may occur across adjacent morphemes or words. The forms in (12) show vowel deletion in Yao (Ngunga 2000:31) and Kuria (Cammenga 2004). Note that the input vowels differ in quality, but the output vowel is always identical to either vowel in the input:

(12) Vowel deletion in Yao and Kuria

a. Yao: [e+i → ee] /-sel**e**-**i**m-e/ → [-sel**ee**m-e] 'slid' (-selem 'slide)

b. Yao: [e+u → ee] /saasil**e** **ú**né/ → [saasil**ee**né] 'I said (lit.: said I')

c. Yao: [e+a → aa] /-diil**e** **a**pa/ → [-diil**aa**pa] 'ate here' (-di- 'eat')

d. Kuria: [a+u → uu] /N-ßa-r**a**-uruur-i/ → [mbar**uú**rúúri] 'they'll cause to float'

e. Kuria: [a+o → oo] /a-k**a**-omo/ → [ak**oó**mo] '12-dry'

f. Kuria: [a+ɔ → ɔɔ] /a-ß**a**-ɔß-a/ → [aß**ɔɔ**ßa] '2-fearful'

In Yao, the vowels /i/ (12a) and /u/ (12b) delete after /e/ while /e/ deletes before /a/ (12c). In Kuria, /a/ deletes before /u/ (12d), /a/ before /o/ (12e), and /a/ before /ɔ/ (12f). The long vowels formed are [ee] (12a-b), [aa] (12c), [uu] (12d), [oo] (16e), and [ɔɔ] (12f). We now turn to the phonology of Bantu consonants.

2.2.2 Consonants inventories and consonantal processes

The reconstructed consonant inventory for PB consists of few phonemes while consonant inventories in daughter languages range from simple to complex. The two sets of reconstructed PB consonant phonemes in (13) reveal some inconsistencies in these phonemes for PB:[10]

(13) (a) PB Consonants (Schadeberg 2003:146)

p	t	c	k
b	l/d	y/j	g
m	n	ny	
mp	nt	nc	nk
mb	nd	nj	ng

(b) PB consonants (Hyman 2003:42)

p	t	c	k
b	d	j	g
m	n	ɲ	

The PB inventories in (13) differ in two main respects. First, inventory (13a) includes prenasalized stops while inventory (13b) does not. Secondly, (13a) treats the pairs *d/*l and *j/*y as alternants while (13b) treats *d and *j as separate phonemes. In Bantu linguistics, it is generally accepted that *p, *t, *k were stops. However, the status of *b, *d, *g as stops or continuants *ß, *l, *ɣ is not clear. The status of *c and *j is also unclear, as it is not certain whether they should be classified

[10] The symbols in angle brackets are used instead of the IPA symbols shown in parentheses: <c>, <ch> (/ʧ/), <y> (/j/), <j> (/ʤ/), <sh> (/ʃ/), <ny> (/ɲ/), <ng> (/ŋg/), <nk> (/ŋk/), etc. In this study, I follow this transcription style except in cases where the sources have used different symbols.

as palatal stops or affricates, or whether they were palatal (Hyman 2003). In most Bantu languages *c is realized as /s/, and *j as /z/ while in some languages *j is realized as /y/ or /j/ (Hyman 2003:42). Due to these uncertainties, orthographic (rather than IPA) symbols are used for these segments. In this regard, some of the data cited in this study contain transcriptions based on orthographic symbols.

The consonant inventories in modern-day Bantu languages show crosslinguistic similarities and variations in the number and type of phonemes attested. These facts are noted in the figures below that show consonant inventories in four languages taken from different zones. This four randomly sampled from the sample of languages on which the study of /N/ is based. They include Ganda (E15), Xhosa (S41), Yao (P13), and Lungu (M14):

Table 1: Yao consonants (Ngunga 2000:5-8)

	Labial	Alveolar	Palatal	Velar	Glottal
Plosives	p b	t d		k g	
Fricatives	v	s			
Affricates			ʧ ʤ		
Nasals	m	n	ɲ	ŋ	
Liquids		l			
Glides	w		y		

Table 2: Xhosa consonants (Podile 2002)

<table>
<tr><td></td><td>Bilabial</td><td>Labio-dental</td><td>Alveolar</td><td>Post-alveolar</td><td>Palatal</td><td>Velar</td><td>Glottal</td></tr>
<tr><td>Plosive</td><td>p p^h b</td><td></td><td>t t^h d</td><td></td><td>c c^h</td><td>k k^h g</td><td></td></tr>
<tr><td>Implosive</td><td>ɓ</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Nasal</td><td>m</td><td></td><td>n</td><td></td><td>ɲ</td><td>ŋ</td><td></td></tr>
<tr><td>Trill</td><td></td><td></td><td>r*</td><td></td><td></td><td></td><td></td></tr>
<tr><td>Fricative</td><td></td><td>f v</td><td>s z</td><td>ʃ</td><td></td><td>ɣ</td><td>ɦ</td></tr>
<tr><td>Lateral fricative</td><td></td><td></td><td>ɬ ɮ</td><td></td><td></td><td></td><td></td></tr>
<tr><td>Affricate</td><td></td><td></td><td></td><td>ʧ ʤ</td><td></td><td></td><td></td></tr>
<tr><td>Approximant</td><td>(w)</td><td></td><td></td><td></td><td>j</td><td>(w)</td><td></td></tr>
<tr><td>Lateral approxim.</td><td></td><td></td><td>l</td><td></td><td></td><td></td><td></td></tr>
<tr><td>Clicks</td><td>Click</td><td>Aspir.</td><td>Nasal</td><td>Breath. Nas.</td><td>Glottal nasal</td><td colspan="2">Voiced</td></tr>
<tr><td>Dental</td><td>|</td><td>|^h</td><td>n|</td><td>ŋ^g|</td><td>ŋ^k</td><td colspan="2">g|</td></tr>
<tr><td>Alveolar</td><td>!</td><td>!^{h}</td><td>ŋ!</td><td>ŋg!</td><td>ŋk!</td><td colspan="2">g!</td></tr>
<tr><td>Lateral</td><td>ǁ</td><td>ǁ^h</td><td>ŋǁ</td><td>ŋgǁ</td><td>ŋkǁ</td><td colspan="2">gǁ</td></tr>
</table>

Table 3: Ganda consonants (Ashton et al (1954)

	Bilabial	Labio-dental	Alveolar	Palatal	Velar
Plosives	p pp		t d tt dd	c j cc jj	k g kk gg
Fricatives	β ββ	f v ff vv	s z ss zz		
Nasals	m mm		n nn	ɲ ŋɲ	ŋ ŋŋ
Lateral frictionless			l		
Rolled			r		
Glides	w			y	

Table 4: Lungu consonants (Bickmore 2007:426)

	Labial	Labio-dental	Alveolar	Alveo-palatal	Velar
Stops	p b		t d		k g
Fricatives	f v		s z	ʃ	
Affricates				c j	
Liquids			l		
Nasals	m		n	ny	ŋ
Glides				y	w

The consonant inventories above include contain the main manner categories, that is, stops, fricatives, affricates, nasals, liquids, and glides. There is variation in the total number of phonemes since Xhosa has 48, Ganda 30, Lungu 20, and Yao 17. The status of /w/ varies; it may function as a phoneme as in Ganda, a derived semi-vowel as in Xhosa, and an off-glide, as in Gusii. The most common affricates are /ʧ/ (c) and /ʤ/ (j). Click phonemes (/ŋ!, $|^h$, $ŋ^g|$/), aspirated stops (/p^h, t^h, k^h/), and implosives (/ɓ/) do occur in Xhosa. Ganda has geminate consonants that occur as stops /pp, tt, dd/, fricatives /ßß, ss, zz/ and nasals /mm, nn, ɲɲ, ŋŋ/ (Ashton et al 1954).

Besides alternations that involve /N/, the most common consonantal alternations in Bantu include palatalization, palatal harmony, Dahl's Law (DL), spirantization, consonant insertion, metathesis, and deletion. These processes will be described and illustrated in turn. Front (semi)vowels /i, e, y/ may condition the articulatory point of adjacent consonants to shift to the palate (or front part) of the oral cavity. This is process is commonly known as palatalization. In the languages under study, palatalization is observed in Rwanda (Kimenyi 1979), Swahili (Meinhof 1932), and Nyamwezi (Maganga & Schadeberg 1992), among others. Rwanda velar stops /k, g/ undergo palatalization to become [ǩ, ǧ] before vowels /i, e/ (Kimenyi 1979:41-42):

(14) Palatalization in Rwanda

a.	/a-re**k**-e/	→	[are**ǩ**e]	'he should stop'
b.	/a-ro**g**-e/	→	[aro**ǧ**e]	'he should poison'
c.	/ku-se**k**-ir-a/	→	[guse**ǩ**ira]	'to smile at'
d.	/ku-tu**k**-ir-a/	→	[gutu**ǩ**ira]	'to insult for'

Palatal harmony occurs when a non-palatal consonant becomes palatal to agree in [place] with the following non-contiguous palatal consonant that triggers the process. Palatal harmony is observed in Rwanda where it is regressive and iterative. Rwanda palatal harmony is triggered by palatals /š, y/ and targets alveolar fricatives /s, z/. Thus, this alternation involves segments with adjacent place features such as alveolars and palatals. The data in (15) demonstrate palatal harmony in Rwanda caused by palatals /y, š/ and targets alveolars /z, s/ (Kimenyi 1979:43):

(15) Palatal harmony in Rwanda

a. /ku-**s**ooz-iiš-a/ → [gu**š**oo**ž**eeša] 'to cause to finish' (Cf. ku-sooz-a 'to finish')

b. /a-**s**a**s**-ye/ → [a**š**a**š**e] 'he just made the bed' (Cf. ku-sas-a 'to make bed')

c. /ku-**s**aa**z**-iiš-a/ → [gu**š**aa**ž**iiša] 'to cause to get old (Cf. ku-saaz-a 'to get old')

d. /ku-u**z**u**z**-iiš-a/ → [kuu**ž**u**ž**iiša] 'to cause to fill' (ku-uzuz-a 'to fill)

In some languages, consonants are also subject to a voicing dissimilation process known as Dahl's Law (DL). In DL, a voiceless onset undergoes voicing triggered by a voiceless onset of the next syllable. Thus, the trigger and target consonants of DL are normally separated by a vowel(s). DL is regressive given that the target precedes the trigger. In some languages, DL is iterative. DL occurs in languages such as Kikuyu, Meru, Kuria, Gusii, and Tharaka (Armstrong 1967; Davy & Nurse 1982; Cammenga 2002; Cammenga 2004). The data in (16) illustrate DL in Kuria (Cammenga 2004:86):

(16) Dahl's Law in Kuria

a. /a-**k**a-seese/ → [a**ɣ**aséésé] 'small dog'

b. /a-**k**a-te/ → [a**ɣ**até] 'small tree'

c. /o-**k**o-kam-a/ → [o**ɣ**okáma] 'to milk'

d. /e-**k**e-keß-i/ → [e**ɣ**ekéßi] 'knife'

The voiceless segments that condition DL in Kuria are /s/ (16a, c), /t/ (16b), and /k/ (16c-d). The target of DL is /k/ of the previous syllable that changes to a voiced velar fricative [ɣ] (note that the velar obstruents in Kuria are /k, ɣ/; the plain velar stop [g] is not attested but occurs as a prenasalized stop). So, the alternation of /k/ to [ɣ] is dictated by the phonemic inventory.

Some Bantu languages allow spirantization, a type of lenition in which stops undergo weakening to become spirants, that is, fricatives or affricates (Kenstowicz 1994:35). In these languages, spirantization occurs before high vowels /i, u/. This process is observed in languages such as Nyamwezi (Maganga & Schadeberg 1992) and Bemba (Kula 2002). In Nyamwezi, for example, the suffix /i/ used to derive agent nouns and suffix /u/ used to derive quality nominals (adjectives and nouns) may lead to spirantization that causes underlying /l/ to surface as [z] (Maganga & Schadeberg 1992:19):

(17) Spirantization in Nyamwezi

a.	/-toó**l**a/	'to marry'	→	[m̩toó**z**i]	'groom'
b.	/-su**l**á/	'forge '	→	[m̩su**z**í]	'blacksmith'
c.	/-ka**l**á/	'become dry'	→	[-ka**z**u]	'dry' (adj.)
d.	/-ho**l**á/	'become calm'	→	[ßoho**z**ú]	'peace'

The data in (17) show that /l/ occurs as the onset of the stem-final syllable surfaces as [z] when followed by the suffix vowels /i/ (17a-b) and /u/ (17c-d).

Consonant insertion in Bantu is not very common, but is observed in Rwanda where it occurs in four different contexts: (a) between a consonant and a glide; (b) between the prefix *-iN* (class 10) and stem vowel; (c) before the aspect marker *-ye* when preceded by the causative suffix *-y-* or *-iiš-*; and (d) between the vowel of a verbal stem and another morpheme starting with a vowel. The forms in (18) illustrate the four contexts of consonant insertion in Rwanda (Kimenyi 1979:47-51):

(18) Consonant insertion in Rwanda

a.	/tu-aanga/	→	[t**k**waaŋga]	'we hate'
b.	/iN-eémbe/	→	[in**z**eêmbe]	'10-razor'
c.	/ku-kin-iiš-ir-a/	→	[gukiniiširi**iz**a]	'to play for with'
d.	/ßa-aa-úumv-a/	→	[ßaa**ku**úumva]	'they would hear'

In (18a), the velar voiceless stop [k] is inserted between the alveolar stop /t/ and the derived glide [w] while in (18b) [z] is inserted between the class 10 prefix /iN-/ and the initial vowel of the stem. In (18c) [z] is inserted between the aspect marker /-a/ and the applicative morpheme /-ir-/. In (18d) /-k-/ is inserted between the stem vowel and conditional tense marker /-aa-/.

Metathesis is not a common process among Bantu languages but it occurs in Rwanda (Kimenyi 1979) and Gusii (Bickmore 1998). Metathesis refers to the relocation of a segment from its original position to another position within a phonological word. In Rwanda, this process occurs in two different contexts. In one context, /y/ of the perfective marker /-ye/ shifts to the front of the passive morpheme /-w-/ and then deletes but vowel /e/ of suffix /-ye/ is retained. The palatalization of /s/ to [š] and the insertion of [k] and [z] confirm that /y/ undergoes metathesis in this context prior to deletion. In the second case, /-r-/ of the applicative suffix /-ir-/ shifts to the position before the fricative /z/ at the end of the verb stem (Kimenyi 1979:61-62):

(19) Metathesis in Rwanda

a.	/ßa-ras-w-**y**e/	→	[ßarašk**w**e]	'they just got shot'
b.	/ßa-vug-w-**y**e/	→	[ßavuzg**w**e]	'they just got talked about'
c.	/ku-sókoz-i**r**-a/	→	[gusókore**z**a]	'tocombfor'
d.	/ku-ßáz-i**r**-a/	→	[kußari**z**a]	'to ask for'

In languages such as Yao (Ngunga 2000) and Rwanda (Kimenyi 1979), consonant deletion may occur in certain environments. In Rwanda, consonants that are subject to deletion include glides /y, w/, liquid /r/, palatal nasal /ɲ/, and half of the nasal geminate (/N/ deletion is discussed in detail in chapter 4). In Rwanda, /y/ deletes in three environments: (a) when used as the causative suffix and followed by the insertion of /-iz/, (b) before the labio-velar glide /w/, and (c) after palatal consonants (Kimenyi 1979). The deletion of /w/ occurs after consonant insertion if the consonant that triggers insertion is bilabial (/p, b, m/). The liquid /r/ also deletes if it is part of the applicative marker /-ir-/ and is preceded by a long vowel. Consonant deletion in Rwanda is exemplified in (20) (Kimenyi 1979:56-57):

(20) Consonant deletion in Rwanda

a.	/ku-rí-a/	→	/kur**y**ǧa/	→	[kúrǧa]	'to eat'
b.	/umu-áana/	→	/um**w**ŋáana/	→	[umŋáana]	'child'
c.	/ßa-kin-i**r**-ye			→	[ßakiniye]	'they played for'
d.	/ßa-raa**r**-ye/			→	[ßaraaye]	they are spending the night'

In (20a) [y] derived from /i/ deletes after the insertion of the palatal consonant [ǧ]. We noted earlier that in Rwanda a palatal consonant is inserted between a consonant and palatal glide. The palatal glide [y] is then deleted after the insertion of the palatal consonant. In (20b), the derived labiovelar glide [w] is dropped after the insertion of the velar nasal [ŋ]. In (20c-d) /r/ deletion before /y/ occurs in polysyllabic stems. In monosyllabic stems, /r/ is retained but a vowel is inserted between /r/ and /y/ (e.g. /ßa-gu-ir-ye/ → [ßagwii**r**i̲ye] 'they just fell on'). In the next subsection, we provide an overview of Bantu syllables.

2.2.3 Bantu syllables

The basic syllable structure reconstructed for PB is *(N)CV, but other syllable structures posited include CVV, V and N. These structures imply that PB syllables were consistently open. The majority of PB syllables consisted of a single consonant followed by a short or long vowel. In some cases, the consonant would be preceded by a homorganic nasal. Syllables consisting of a short vowel or syllabic nasal appeared mainly in prefixes. Some of the reconstructed roots in PB had sequences of non-identical vowels which were treated as heterosyllabic. Syllabic nasals in PB involved the nasal prefixes of class 9/10, 1SG subject, and 1SG object. In PB, the nasal in morpheme-internal NCs was not syllabic but conditioned lengthening on the preceding vowel. Syllabic nasals also arose from the loss of the vowel in *mo- prefixes of noun classes 1, 3, and 18. The typical syllable structure in PB roots was CVC on which morphological rules applied to create open syllables. The data in (21) illustrate syllable structure in PB (Meeussen 1980):

(21) Syllable structures in PB

a.	CV	*ndà	'9/10-flea'
b.	CVC	*pád-	'scrape'
c.	CV.V.C	*bịad-	'give birth'
d.	CVC	*gènd-	'walk'

In most modern Bantu languages, open syllables are frequent, with CV as the basic syllable structure. However, crosslinguistic variations occur and new syllable structures have been added in some languages through segment loss and loanword adaptation. In most cases, morphological rules maintain the preferred open syllables in surface forms. We illustrate syllable structure in modern Bantu languages with examples from Lungu where syllables are always open, e.g. NCV, CGV, CV(V), V (Bickmore 2007). Nasal-obstruent (NC) and consonant + glide (CG) sequences are the only consonant clusters in Lungu (Bickmore 2007:15-17):

(22) Syllable structure in Lungu

a.	V.CGV	í.fwá	'5-leaf'
b.	V.CV.CV	ú.mú.tì	'3-tree'
c.	V.NCVV.NCV	í.nkóó.ndè	'9-banana'
d.	V.NCV	í.ndá	'9-stomach'

We will complete the overview of Bantu phonology with tones in the next subsection.

2.2.4 Bantu tones

The majority of Bantu languages are tonal although there are significant crosslinguistic variations in tonal patterns. Languages that are non-tonal include Swahili and Tumbuka. These languages usually utilize ‘stress’ (or ‘accent’) to mark prominent syllables, and many of them place prominence on the penultimate syllable. Prominence is signaled by vowel length or pitch perturbation (Kisseberth 2003). Tonal languages distinguish two surface tones, that is, high (H) and low (L), usually analyzed as H vs. toneless (Ø). The four main tonal processes involving Bantu tones are the following: (a) down-step between Hs; (b) spreading (usually to the right); (c) avoidance of contour tones; and (d) disfavoring successive Hs (Nurse & Philippson 2003). For example, in Lungu, the High tone from the 1PL subject prefix /tú-/ can spread rightward through the penultimate syllable of an underlyingly toneless verbal root, as in (21) (Bickmore 2007:148):

(21) Tone spreading in Lungu

	UR	SR	Meaning
a.	/tú-ku-mu-ful-a/	[tú-kú-mú-fúl-à]	‘we are washing him/her’
b.	/tú-ku-mu-ful-il-a/	[tú-kú-mú-fúl-íl-à]	‘we are washing for him/her’
c.	/tú-ku-mu-lamuk-a/	[tú-kú-mú-lámúk-à]	‘we are greeting him/her’
d.	/tú-ku-mu-nyemul-a/	[tú-kú-mú-nyémúl-à]	‘we are lifting him/her’
e.	/tú-ku-mu-sukilil-a/	[tú-kú-mú-súkílíl-à]	‘we are accompanying him/her’
f.	/tú-ku-mu-suel-il-a/	[tú-kú-mú-swéél-él-à]	‘we are brewing for him/her’

Tones in Bantu languages vary across lexical categories, for example, nominals vs. verbs. Nominal tonology is simple, with disyllabic nominals having four possible tonal patterns HH, HL, LH or LL. The noun class prefix is L and preprefix H while derivational suffixes display distinctive tones. Since Bantu verbal morphology is complex, verbal tonology is equally complicated. In many languages, verbal stems have lexical tone and grammatical morphemes carry tone. For instance, 1st and 2nd person object markers and singular person subject markers are L in many languages. The rest of the object and subject markers are H. Some grammatical morphemes are typically toneless (e.g. causative, stative, reciprocal, applicative, and reversive). In the Gusii nouns in (22), the augment surfaces with H and class prefixes L while the underlying stem H spreads rightward to the final syllable (Nash 2011:84):

(22) Left-edge low tones in Gusii

	UR	SR	Meaning
a.	/bákí/	[é-kè-bákí]	'hawk'
b.	/bóri/	[é-m-bórí]	'goat'
c.	/bɔ́kɔ/	[ɔ́-kɔ̀-bɔ́kɔ́]	'hand'
d.	/sóni/	[ó-mò-sóní]	'tailor'

The tone bearing unit (TBU) in Bantu languages is uncertain (Kisseberth 2003). In languages without vowel length, it is impossible to distinguish between syllable and mora as TBU. Yet, evidence is contradictory in languages with vowel length. In Matuumbi, the mora is the TBU since certain generalizations are based on vowel count (mora), for example, assigning H to the third vowel irrespective of syllable count (Odden 1995a). Moreover, rising and falling tones in Matuumbi are restricted to bimoraic syllables. The contrast between rising and falling tone is never represented underlyingly in Bantu. In Babole, the syllable is taken to be the TBU because Babole does not have contrastive length (Leitch 2003). In this language, there are four basic tone patterns on disyllabic noun stems: HL, HH, LL, and LH.[11] Babole nominal prefixes have L. In verbs, a lexical tone (H or L) is always associated with the initial syllable of the root. The non-initial stem syllables take a tone specification provided by the suffixal inflection tone melodies. According to Leitch (2003), underlyingly, the non-initial syllables in the Babole verb stem can be analyzed as toneless, except for the final vowel. Minimal tone pairs in Babole in disyllabic nouns are given in (23):

(23) Minimal tone pairs in Babole disyllabic noun stems

a.	HL:	e-lóŋgò	'stable'
b.	LH:	e-lòŋgó	'caterpillar'
c.	LL:	mu-ŋgòlò	'tobacco'
d.	HH:	mu-ŋgóló	'watershortcut'

The tonal behavior of /N/ tends to vary across languages (Hyman 1992). The status of pre-consonantal /N/ as a TBU is problematic. Nevertheless, Bickmore (2007) argues that in Lungu the mora is the TBU and that /N/ sponsors a tone realized as shown in (24) (Bickmore 2007:455):

(24) Moraic status of Lungu pre-consonantal /N/

a.	/ń-lim-é/	→	[(í)n-dí[!]m-é]	'that I farm'
b.	/ń-ful-é/	→	[(í)m-fú[!]l-é]	'that I wash'
c.	/ń-luk-il-é/	→	[(í)n-dúl-ìl-é]	'that I weave for'
d.	/ń-ku-ful-a/	→	[(í)n-kú-fúl-à]	'I am washing'
e.	/ń-la-ful-a + H/	→	[(í)n-dá-fùl-á]	'I will wash'

[11] Although Babole is not classified in Guthrie (1967/70), in Maho's (2009) revision of Guthrie's (1948) classification of Bantu languages, Babole is classified as C101.

In (24), the 1SG subject prefix /ń/ sponsors a H tone which undergoes rightward spreading. Lungu /N/ undergoes demorification when syllabified as part of the onset, but its mora is recovered through the insertion of [i] before the nasal. In other words, initial [i] epenthesis in Lungu occurs to recover the mora abandoned by /N/ (this issue will be expounded in chapter 3). The following subsection presents an overview of Bantu morphology.

2.3 Characteristics of Bantu morphology

Bantu languages have an intricate agglutinative nominal and verbal morphology. Verbs especially have an elaborate set of affixes in addition to preverbal agreement morphemes and other inflections. Nouns may be non-derived or derived, with the latter having inflectional prefixes and derivational suffixes. The next two subsections provide details about Bantu nominal and verbal morphology.

2.3.1 Bantu nominal morphology

Nouns in PB were lexically specified for class and gender and morphologically marked by a nominal prefix to reflect their specific classes (Meinhof 1932). However, proper nouns and kinship terms occurred as single morphemes. In PB, grammatical number (singular/plural) was encoded on nominal prefixes. The maximum number of noun classes in PB was twenty-four. The first recorded numerical classification of Bantu nouns appeared in Bleek (1862). Significant changes on this system were done by Meinhof (1899/1932, 1906) but retained Bleek's numbering system. The number of noun classes and the morphophonological shapes of noun prefixes may vary across Bantu. There is no one single language with all the twenty-four noun classes of PB, but languages such as Ganda have as high as twenty-one.[12] The Swahili noun classes in (25) illustrate the Bantu nominal system (PB prefixes are from Meinhof 1932):

(25) Noun classes in Swahili

Class	Prefix	Example	Gloss	PB prefixes
1	m-	m-tu	person	*mu-
2	wa-	wa-tu	persons	*υa
3	m-	m-ti	tree	*mu-
4	mi-	mi-ti	trees	*mi
5	ji-	ji-no	tooth	*li-
6	ma-	me-no	teeth	*ma-
7	ki-	ki-chwa	head	*ki-
8	vi-	vi-chwa	heads	*υî-
9	N-	ny-umba	house	*ni-
10	N-	ny-umba	houses	*li-, *ni-
11	u-	u-ta	bow	*lu-
14	u-	u-zuri	goodness	*υu-
15	ku-	ku-la	to eat, eating	*ku-
16	pa-	pa-zuri	good (specific)	*pa-
17	ku-	ku-zuri	good (indefinite)	*ku-
18	mu-	m-zuri	good (inside)	*mu-

[12]A number of Bantu languages have an extra prefix known as the preprefix (or augment/initial vowel) that precedes the noun prefix, e.g. **o-** in the Gusii noun ***o**-mo-nto* ‘person’.

These nouns consist of two morphemes, that is, the prefix and root (Swahili does not have preprefixes). In Swahili, as in most Bantu languages, the class 9/10 prefix occurs as a nasal prefix /N/ (this is one of the prefixes discussed in the subsequent chapters). In Bantu nominal systems, the class 10 prefix /N/ serves as the plural marker for class 9 and 11.

Deverbal nouns constitute a special class of nouns in Bantu. These nouns are derived from verbal stems, and in most languages, they include a suffix that marks the change from verb to noun. In languages that have an augment, deverbal nouns consist of four morphemes, that is, the augment, class prefix, root, and the nominalizing suffix. Consider the Gusii data in (26):

(26) Deverbal nouns in Gusii

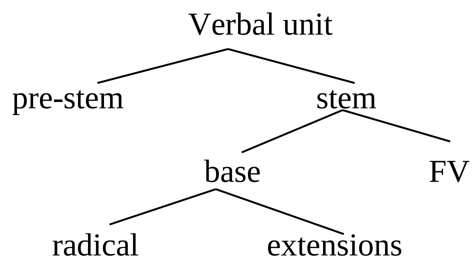
	Verb		Deverbal noun	
a.	kɔ-gɔɔk-a	'to be happy'	ɔ-mɔ-gɔɔk-ɔ	'3-happiness'
b.	ɣo-taar-a	'to walk'	e-taar-ɔ	'9-walk'
c.	kɔ-rɔɔt-a	'to dream'	ɛ-n-dɔɔt-ɔ	'9-dream'
d.	ko-iß-a	'to steal'	o-ßo-iß-i	'14-theft'

The remainder of this chapter provides an overview of Bantu verbal morphology.

2.3.2 Bantu verbal morphology

Bantu verbs have a complex morphology that is a direct result of the fact the verb agglutinates numerous affixes that encode different grammatical and lexical information. The number of affixes in a single Bantu verbal word may be as high as fourteen. In PB, the stem constituent is generally accepted as having consisted of (a) an obligatory verb root or radical, (b) optional extensions (either derivational suffixes or formal "expansions"), and (c) an obligatory inflectional final vowel (FV), e.g. the /-a/ ending found in most verb forms. The morphemes that occur in the verbal word are ordered before and after the root or radical. Below is the verbal template proposed by Meeussen (1967):

(27) PB verbal template proposed by Meeussen (1967)



In the template (27), the constituent that is less understandable is the pre-stem; it is not well understood whether the pre-stem was a constituent, and whether it was part of the stem or occurred as an independent entity. However, according to Meeussen (1967), the pre-stem consisted of the following elements:

(28) Structure of the pre-stem

Pre-initial + Subject + Negative + Tense + Formative + Object (followed by verb stem)

The verbal template (27) and the structure of the pre-stem (28) show that the verbal unit consists of numerous constituents. Subject, negative, and object markers are some of the prefixes that occur before the verbal stem. The stem is made up of the base and the final vowel. Bantu languages have many extension suffixes some of which increase the valency of the verb. These include causative, stative, reciprocal, reversive, applicative and passive suffixes. We will illustrate some of the constituents of the Bantu verbal unit. Most verbal roots in Bantu end in a consonant, as in Yao (28) (Ngunga 2000):

(29) Verbal roots in Yao

a.	/-di-/	[-dy-]	'eat'
b.	/-aas-/	[-aas-]	'lose'
c.	/-vak-/	[-vak-]	'build'

When suffixes are added onto the verbal root, the verbal stem formed may be simplex, derivational, inflectional, reduplicated, or macro stem. A simplex stem consists of the root and the default final vowel. The final vowel is the morpheme that occurs in the final position of a verb form, and in most languages it occurs as /-a/ (however, some rules may alter it). The data in (30) contain simplex verbal stems in Shona (Fortune 1955:159):

(30) Simplex verbal stems in Shona

a.	/-end-a/	'got'
b.	/-om-a/	'become dry'
c.	/-ibv-a/	'become ripe'
d.	/-umb-a/	'mould'

The derivational stem is formed by adding derivational suffixes between the root and the final vowel of the simplex stem. The derivational stem may also be formed by adding derivational suffixes to stems of other lexical categories such as nouns, adjectives, and adverbs. In (31), Swahili derivational verbal stems are in the right column (derivational suffixes are in bold):

(31) Derivational verbal stems in Swahili

a.	/-pat-a/	'get'	→	/-pat-**i**-a/	'give to'
b.	/-end-a/	'go'	→	/-end-**e**-a/	'go to'
c.	/-pit-a/	'pass'	→	/-piti-**an**-a/	'pass (a) each other'
d.	/-fupi/	'short'	→	/-fupi-**sh**-a/	'shorten'

The inflectional stem in Bantu consists of the root, or derivational stem, and inflectional suffixes. The data in (32) demonstrate inflectional stems from Swahili:

(32) Inflectional stems in Swahili

a. /-lim-a/ 'cultivate' → /-lim-**w**-a/ 'cultivated'

b. /-lim-a/ 'cultivate' → /-lim-i-**w**-a/ 'cultivated for'

A reduplicated stem includes prefixes and a reduplicant (repeating element), and can be a whole or part of a verb. The data in (33) consists of Swahili reduplicated stems:

(33) Reduplicated verbal stems in Swahili

a. /-ni-pig-e pig-e/ 'hit me repeatedly'

b. /a-som-e som-e/ 's/he to read with breaks'

c. /chek-a chek-a/ 'laugh repeatedly'

In Bantu verbal stems, nasal prefixes may occur as 1SG subject and object (some studies show that nasal prefixes may also occur as the focus and negative marker (e.g. Cammenga 2002)). In Jita, /N/ may occur as 1SG object, as shown in the infinitival verb stems in (34). The Jita examples in (34) demonstrate the location of 1SG nasal prefix in the verbal unit (o = augment, -ku- = infinitive marker, -a = final vowel (Downing 1996:23):

(34) Jita verbal stems with 1SG object /N/

a. /o-ku-N-sa:kur-a/ → [o-ku:-n-sa:kur-a] 'to grab away from me'

b. /o-ku-N-gán-ir-a/ → [o-ku:-ŋ-gan-ír-a] 'to tell me (a story)'

c. /o-ku-N-cu:my-a/ → [o-ku:-n-cu:my-a] 'to make me jump'

d. /o-ku-N-taja/ → [o-ku:-n-taj-a] 'to step on me'

More details about the behavior of /N/ in nominal and verbal stems will be seen in the subsequent chapters where /N/ is the subject of study. The next subsections sums up this chapter.

2.4 Summary

This chapter presented the basic phonological and morphological properties of Bantu languages. Bantu languages have simple vowel inventories, mostly five-to-seven vowels. Some languages have contrastive vowel length. The vowels are subject to a number of processes including lengthening, shortening, deletion/assimilation, coalescence, ATR harmony, and height harmony. A number of the languages have simple consonant inventories, but some have complex consonant systems. The common consonantal processes include palatalization, palatal harmony, dissimilation, spirantization, insertion, deletion, and metathesis. Most languages are tonal and syllables are generally open. The common processes involving tones are down-step in Hs, right spreading, and avoidance of contour tones and successive Hs. The morphology of nominals in Bantu is simple. Nouns are classified into classes that are marked by prefixes. Nasal prefixes occur as markers of class 3, 18, and 9/10. Verbal stems are complex, with the root agglutinating a series of affixes that mark negation, tense, aspect, mood, subject, object, stative, causative, passive, reversive, and reciprocal. In addition, Bantu verbs have a default final vowel /-a/. In verbal stems, /N/ marks 1SG subject and 1SG object.

CHAPTER 3

3. BANTU /N/ IN PRENASAL AND NONLOCAL ALTERNATIONS

3.1 Introduction

This chapter examines the segmental processes that occur in the vowel preceding /N/ and the behavior of /N/ in three nonlocal segmental processes. The chapter has two main goals. The first is to describe and explain the asymmetry observed in the vowel realized before /N/. The second goal is to describe and account for the behavior of /N/ in three nonlocal segmental processes, namely nasal-consonant harmony (NCH), Dahl's Law (DL), and Meinhof's Law (ML). Before we examine the behavior of /N/ in these contexts, we will first distinguish the syllabic nasal prefix /m̩/ from /N/. This chapter is organized as follows. In §3.1, we present the properties of the syllabic nasal prefix /m̩/. Prenasal alternations are presented in §3.2, that is, vowel epenthesis (§3.2.1), vowel lengthening (§3.2.2), and initial vowel shortening (§3.2.3). The analysis of prenasal processes is given in §3.2.4. In §3.3, weexamine the behavior of /N/ in nasal-consonant harmony (NCH) (§3.3.1), Dahl's Law (DL) (§3.3.2), analysis of DL (§3.3.3), Meinhof's Law (ML) (§3.3.4), and summary (§3.4)

3.2 The Bantu syllabic nasal /m̩/

There are two kinds of nasal prefixes in Bantu languages, that is, bilabial and syllabic /m̩/ and /N/ (e.g. Odden 1986; Hyman & Ngunga 1997; Ngunga 2000). These nasal prefixes may be traced back to Proto-Bantu syllables *mʊ̣- and *nɪ̣-, respectively (Meinhof 1932). Nonetheless, a number of present-day Bantu languages have retained the syllables *mʊ̣- and *nɪ̣-. Although this study is about /N/, we will present some basic facts about /m̩/ to distinguish it from /N/.

The Bantu bilabial nasal prefix /ṃ/ occurs regularly as the marker for noun classes 1, 3, and 18; 2PL subject, and 3SG object. There are however some crosslinguistic variations in the distribution, shape, and influence of /ṃ/ on adjacent segments. For instance, in Swahili, Proto-Bantu (PB) *mụ has two allomorphs /ṃ/ and /mu/. The former tends to occur before consonants while the latter occurs before vowels. When followed by a non-identical vowel, the /u/ of /mu/ may become a glide [w]. In Gusii, PB *mụ is realized as /mo/. The data in (1) show the distribution and realization of *mụ in Swahili and Gusii (Gusii nouns contain the augment /o/):

(1) Realization of PB *mụ in Swahili and Gusii

	Swahili /ṃ/			Gusii /mo/		
a.	/m-tu/	→	[m̱tu]	/-o-mo-nto/	→ [omo:nto]	‘1-person’
b.	/m-katɛ/	→	[m̱katɛ]	/o-mo-gaati/	→ [omogaati]	‘3-bread’
c.	/m-baya/	→	[m̱baya]	/o-mo-βe/	→ [omoβe]	‘1/3-bad’
d.	/m-lal-ɛ/	→	[m̱lalɛ]	/mo-raar-e/	→ [moraare]	‘you pl.sleep’
e.	/m-fuat-ɛ/	→	[m̱fuatɛ]	/mo-βuati-e/	→ [moβwa:ti]	‘follow him’
f.	/mu-on-ɛ/	→	[mwone] ‘see him’	/mo-oni-e/	→ [mo:ni]	‘sell him’

The examples indicate that Swahili retained *mụ before vowels (1f) while /ṃ/ of noun class 1 and 3 occurs before different consonants, for example, voiceless stops (1a-b), voiced stops (1c), liquids (1d), and voiced fricatives (1e).

The behavior of /ṃ/ varies across languages. In Swahili, /ṃ/does not undergo any change nor does it trigger alternations in stem-initial segments. However, in Yao, /ṃ/undergoes nasal place assimilation, causes postnasal hardening in approximants /w, ʋ/, and postnasal nasalization in liquid /l/ and glide /y/ (Hyman & Ngunga 1997; Ngunga 2000). Yet, Yao /ṃ/ has no effect on voiceless and voiced stops as well as nasals. The examples in (2) illustrate the behavior of Yao /m̩/ of 3SG (2a) and 2SG (2b-e) (Adapted from Ngunga 2000:73):[13]

(2) Alternations caused by /m̩/ in Yao

a.	/tu-m-ʋak-i-il-le/	→	[tu-m̩-baciil-e]	'we built for him'
b.	/tu-m-pat-il-e/	→	[tu-m̩-pat-il-e]	'we got you/him/her'
c.	/tu-m-jiim-il-e/	→	[tu-ɲ̩-jiim-il-e]	'we did not give you'
d.	/tu-m-nik-ile/	→	[tu-n̩-nic-il-e]	'we dyed for you'
e.	/tu-m-yi-il-k-e/	→	[tu-ɲ̩-ɲiic-e]	'we reached you'

In (2), /m̩/ causes the stem-initial voiced bilabial fricative /ʋ/ to undergo hardening and surface as [b] (2a) while/p/ (2b), /j/ (2c), and /n/ (2d) are not affected by /m̩/. However, /y/ undergoes nasalization after /m̩/ to become a palatal nasal [ɲ].

In Matuumbi, /m̩/assimilates the place of articulation of the stem-initial segment and triggers postnasal nasalization and hardening. Matuumbi /m̩/ also conditions lengthening in the preceding vowel.The data in (3) demonstrate the behavior of Matuumbi /m̩/ of class 18 (3a), 3SG (3b, 3d), and 2SG (3c) (Odden 1996:79-84):

(3) Alternations caused by /m̩/ in Matuumbi

a.	/m̩-li̹i̹tóbo/	→	[n̩n̩i̹i̹tóbo]	'in the hole'
b.	/ku-m̩-télekya/	→	[ku̹u̹ntélekya]	'to cook for him'
c.	/m̩-teleké/	→	[nteleké]	'you should cook'
d.	/m̩-némulí/	→	[nnémulí]	'dancer'

[13]In Ngunga (2000) Yao /m̩/ is represented as /mu/ underlyingly, but the vowelis not realized.

In (3) Matumbi, /m̩/ assimilates the place of articulation of the stem initial segment (3a-d). In (3a), stem-initial /l/ undergoes nasalization to become [n]. In (3b-c), /m̩/ has no effect on /t/ but it conditions lengthening in the preceding vowel /u/ (3b) (for more facts about /m̩/ see Odden 1986; Ngunga 2000). In some languages /m̩/ and /N/ differ in the way they interact with adjacent segments; in others they may have common properties. In (3), we saw the behavior of /m̩/ in Matuumbi. Now consider the distribution and behavior of Matuumbi /N/ (Odden 1996:88-97):

(4) The distribution and effect of Matuumbi /N/

a.	/N-báu/	→	[mbáu]	‘10-rib’
b.	/N-lịmị/	→	[ndịmị]	‘10-tibgue
c.	/N-paláaí/	→	[mbaláaí]	‘10-bald head’
d.	/N-yóká/	→	[njóká]	‘10-stomach warm’
e.	/N-maɲa/	→	[maɲa]	‘I know’

In (4), /N/ occurs as the prefix for class 9/10, 1SG subject, and 1SG object, and undergoes two changes, that is, place assimilation (4a-d) and deletion before stem initial nasals (4e). Besides, /N/ causes postnasal voicing (4d), delateralization (4c), and postnasal hardening (4d) of /y/ to [j]. In Matumbi, both /m̩/ and /N/ undergo nasal place assimilation and cause postnasal hardening. However, /m̩/ causes prenasal vowel lengthening and nasalization while /N/ does not. On the other hand, /N/ causes postnasal voicing and deletes before nasals while /m̩/ does not. Having distinguished between the two nasal prefixes in Bantu, we now focus our attention to /N/. In the next subsection, we explore the effect of /N/ on the preceding vowel.

3.3 Prenasal alternations in Bantu

In a number of languages, the realization of /N/ is associated with three vocalic processes, namely vowel epenthesis, vowel lengthening, and initial vowel shortening. The occurrence of these processes tends to vary across contexts and languages. In the following four subsections, we examine these vocalic processes that occur before /N/.

3.3.1 Vowel epenthesis before Bantu /N/

In a number of languages, the realization of /N/ is accompanied by an epenthetic vowel word initially. Some of the languages in which this process is attested include Rwanda (Kimenyi 1979), Kuria (Cammenga 2004), Lungu (Bickmore 2007), and Gusii (Nash 2011). In these languages, the vowel inserted before /N/ is the high front vowel /i/. In these languages, when /N/ occurs word-medially the preceding short vowel undergoes lengthening. This situation suggests that vowel lengthening and vowel epenthesis before /N/ are related processes. In some of these languages, for example, Gusii and Lungu, the insertion of [i] before /N/ is optional such that when the epenthetic vowel is not realized, /N/ surfaces syllabic if followed by a consonant. Vowel epenthesis before /N/ in Gusii is illustrated (5) with /N/ of 1SG subject (Adapted from Nash 2011):

(5) Vowel epenthesis before /N/ in Gusii

a.	/N-káan-e/	→	[(í)n-káàn-é]	'I refuse'
b.	/N-róm-e/	→	[(ì)n-dóm-á]	'I bite'
c.	/N-ta-a-káan-a/	→	[(ì)n-tá-á-káàn-à]	'I do not refuse'
d.	/N-na-akún-ir-e/	→	[(ì)ná-á-kún-ìr-è]	'I have touched (just now)'

Prenasal vowel epenthesis in Lungu is exemplified in (7) where initial /N/ of 1SG subject is assigned a high tone, but the tone is reassigned the optional epenthetic vowel [i] in surface forms (Bickmore 2007:173):

(6) Vowel epenthesis before /N/ in Lungu

a.	/ń-ku-ziik-a/	→	[(í)n-kú-zíík-à]	'I am burying'
b.	/ń-ku-ful-a/	→	[(í)n-kú-fúl-à]	'I am washing'
c.	/ń-ku-mu-ful-il-a/	→	[(í)n-kú-mú-fúl-íl-à]	'I am washing for him/her'

Prenasal vowel epenthesis before /N/ is not observed in some languages such as Konde/Nyakyusa, Swahili, and Kongo (Meinhof 1932). In these languages, word-initial /N/ is realized without a preceding epenthetic vowel. The examples in (7) illustrate the non-occurrence of vowel epenthesis before /N/ of 1SG subject in Konde (Meinhof 1932:136):

(7) Non-occurrence of vowel epenthesis before /N/ in Konde

a.	/N-t^hum-il-e/	→	[ndumile]	'I have sent'
b.	/N-k^ham-il-e/	→	[ŋgamile]	'I have milked'
c.	/N-p^hon-il-e/	→	[mbonile]	'I have recovered'
d.	/N-ɣw-il-e/	→	[ŋgwile]	'I have fallen'
e.	/N-lond-il-e/	→	[ndondile]	'I have sought'
f.	/N-ʋon-il-e/	→	[mbwenile]	'I have seen'

In (7),/N/ surfaces without a preceding epenthetic vowel but causes voicing in stem initial voiceless aspirated stops /t^h, k^h, p^h/, changing them to [d, g, b]. Besides, Konde /N/ conditions postnasal hardening of approximants /l, ʋ/, changing them to voiced stops [d, b].

Kongo is another language where vowel epenthesis before /N/ is not attested. The Kongo data in (8) illustrate this fact (Meinhof 1932:159). In (8), /N/ of 1SG subject is realized before voiceless stops and conditions hardening of the liquid /l/ to a stop [d] (8d) and /ʋ/ to [p] (8c):

(8) Lack of vowel epenthesis before /N/ in Kongo

a.	/N-kemi/	→	[ŋkemi]	'I have squeezed'
b.	/N-tumini/	→	[ntumini]	'I have sent'
c.	/N-ʋeni/	→	[mpeni]	'I have given'
d.	/N-lendi/	→	[ndendi]	'I have followed'

In Babole, prenasal vowel epenthesis involves oral and nasalized vowels. When /N/ is dropped before voiceless obstruents, the epenthetic vowel is nasalized. However, when /N/ is retained before voiced obstruents, the epenthetic vowel is oral. Apparently, the epenthetic vowel is nasalized to preserve the nasality of /N/ that undergoes effacement. The need to preserve nasality does not arise when /N/ is present; so the epenthetic vowel is oral (Leitch 2003:397):

(9) Initial vowel epenthesis before /N/ in Babole

a.	/N-bésé/	→	[i.^{m}bé.sé]	'turtle (species)'
b.	/N-dèŋgà/	→	[i.^{n}dè.^{ŋ}gà]	'unmarried person'
c.	/Ngɔndɔ/	→	[i.^{ŋ}gɔ.^{n}dɔ]	'chimpanzee'
d.	/N-pàkó/	→	[ĩ.pà.kó]	'stubbornness'
e.	/N-tɛhì/	→	[ĩ.tɛ.hì]	'saliva'
f.	/N-tsɛtsí/	→	[ĩ.tsɛ.tsí]	'the ripping apart of something'
g.	/N-kɛtì/	→	[ĩ.kɛ.tì]	'anger'
h.	/N-sáèlò/	→	[ĩ.sáè.lò]	'downstream'

The question that arises from the variations noted in vowel epenthesis before /N/ concerns the cause of the (non)-occurrence of prenasal vowel epenthesis in Bantu. This question will be addressed in §3.2.4. Vowel lengthening before /N/ is also characterized by crosslinguistic variations, as we will see in the following subsection.

3.3.2 Vowel lengthening before Bantu /N/

The other notable prenasal alternation associated with /N/ is vowel lengthening. This alternation is noted in a number of languages such as Rwanda (Kimenyi 1979), Matuumbi (Odden 1996), Jita (Downing 1996), Yao (Ngunga 2000), Kuria (Cammenga 2004), Gusii (Cammenga 2002; Nash 2011), and Lungu (Bickmore 2007).Yet, vowel lengthening before /N/ is not allowed in some languages including Swahili, Kongo, and Konde, (Meinhof 1932). Vowel lengthening before /N/ may arise when /N/ occurs before vowels, nasals, or oral consonants. Consider the Kuria examples of vowel lengthening before /N/ of 1SG object (10a-c) and class 10a (10d) (Cammenga 2004:114-115):[14]

(10) Vowel lengthening before /N/ in Kuria

a.	/o-N-ɔk-er-i/	→	[**uu**ɲokiíyi]	'you have lit for me (today)'
b.	/o-N-eβ-er-er-e/	→	[**uu**ɲeβeré]	'you have forgotten me (today)'
c.	/o-N-aɣ-er-er-e/	→	[**uu**ɲaɣeéye]	'you have weeded for me'
d.	/eN-aNɣ-o/	→	[**ii**ɲááŋgo]	'9a-quick'

[14] The word-initial short vowels in Kuria that are subject to prenasal lengthening also undergo raising, e.g. /e/ → [i] and /o/ → [u].

In (10), the stem-initial short vowels /o, e/ surface as long vowels before /N/. Kuria /N/ is realized as a palatal nasal [ɲ] before stem-initial vowels (the behavior of /N/ before vowels is discussed in detail in chapter 4).

Vowel lengthening before /N/ is also noted when /N/ occurs before another nasal as well as an oral consonant, as in Jita (11). In (11), prenasal vowel lengthening arises when /N/ is put before an obstruent (11a-b) and before a nasal (11c-d). In (11), /N/ occurs as the 1SG object prefix (Downing 1996:114):

(11) Vowel lengthening before /N/ in Jita

a.	/o-ku-N-té:ker-a/	→	[ok**u:**ntu:kéra]	'to cook for me'
b.	/o-ku-N-jing-a/	→	[ok**u:**nji:nga]	'to surround me'
c.	/o-ku-N-mír-a/	→	[ok**u:**míra]	'to swallow me'
d.	/o-ku-N-nénesy-a/	→	[ok**u:**nénesya]	'to make me fat'

Note that when /N/ occurs before a nasal (11c-d), only one nasal is realized implying that geminate nasals are disallowed in Jita.

In some languages, for example, Rwanda, vowel lengthening before /N/ may occur in all the three different contexts, that is, when /N/ is prefixed before a vowel, nasal, and obstruent. The Rwanda data in (12) demonstrate this fact with /N/ of 1SG object (Kimenyi 1979:18-19). Note that Rwanda /N/ undergoes effacement in nasal-initial stems (12c-d):

(12) Prenasal vowel lengthening in Rwanda

a.	/ku-N-gaya/	→	[ku:ŋgaya]	'to despise me'
b.	/mu-N-ßona/	→	[m**u:**mbona]	'you see me'
c.	/ku-N-meɲ-a/	→	[k**u:**meɲa]	'to know me'
d.	/ßa-N-nanir-a/	→	[ß**a:**nanira]	'they tire me'

e. /ßa-N-aaka/ → [ß**a:**ɲaka] 'they ask me'

f. /ku-N-íißa/ → [k**û:**ɲißa] 'to robe me, to steal me'

Vowel lengthening before /N/ is disallowed in some languages, for example, Zulu, Swahili, Kongo, and Konde. The Zulu forms in (13) show that class 10 /N/ surfaces without causing lengthening in the preceding vowel /i/. Note that Zulu /N/ causes stem-initial aspirated stops to become ejectives postnasally (Meinhof 1932:88):

(13) Non-occurrence of vowel lengthening before /N/ in Zulu

a. /izi-N-k^hezo/ → [iz**i**ŋk'ezo] '10-spoon'

b. /izi-N-k^hamba/ → [iz**i**ŋk'amba] '10-vessel'

c. /izi-N-t^haŋgo/ → [iz**i**nt'aŋgo] '10-fence'

d. /izi-N-p^hondo/ → [iz**i**mp'ondo] '10-horn'

e. /izi-N-p^hasa/ → [iz**i**mpa'asa] '10-roof'

The inability of /N/ to trigger prenasal vowel lengthening is also observed in Kongo, as seen in (14) where the short vowels preceding /N/ surface unchanged. Kongo 1SG object /N/ causes hardening that turns /l/ to [d] and /ʋ/ to [p] but does not affect voiceless stops /t, k/ (Meinhof 1932:159):

(14) Non-occurrence of vowel lengthening before /N/ in Kongo

a. /ba-N-land-a/ → [bandanda] 'they followed me'

b. /ba-N-tum-il-e/ → [bantumini] 'they have sent me'

c. /ba-N-ʋen-i/ → [bampeni] 'they have given me'

d. /ba-N-keŋg-i/ → [baŋkeŋgi] 'they have bound me'

The data on vowel epenthesis and lengthening before /N/ reveal that the languages that allow one also allow the other. On the other hand, languages that do not allow vowel epenthesis also do not allow vowel lengthening before /N/. The asymmetry involving the two prenasal alternations will be analyzed in §3.3.3. The other aspect of vowel lengthening before /N/ that needs to be addressed is the fact that this process appears to be blocked word-initially in some languages. In the next subsection, we discuss initial prenasal vowel shortening in Bantu.

3.3.3 Initial vowel shortening before Bantu /N/

In some of the languages that allow vowel lengthening before /N/, this process is not observed word-initially. This situation may be attributed to a rule known as Initial Vowel Shortening (IVS) (e.g. Hyman 2003). IVS overrides prenasal vowel lengthening since it appears to shorten long vowels appearing before /N/ in languages that allow vowel lengthening before /N/. Vowel shortening in Bantu is also active word-finally (Ngunga 2000; Hyman 2003; Bickmore 2007;and Nash 2011). Vowel shortening in the two locations suggests a preference for short vowels at word edges. Still, some languages do allow vowel lengthening before /N/ word-initially. The effect of IVS is that it creates an asymmetry of vowel length before /N/ in languages that allow prenasal vowel lengthening. This asymmetry needs to be demonstrated and explained.

The shortening of initial vowels before /N/ is observed in a number of languages, among them Rwanda (Kimenyi 1979), Gusii (Nash 2011), and Lungu (Bickmore 2007). Rwanda allows vowel lengthening before /N/ word-medially (15), but this lengthening is blocked word-initially (16). The data in (15) and (16) show the variation of prenasal vowel length in Rwanda. In (15), /N/ of 1SG conditions lengthening in the preceding vowel but this alternation is blocked word-initially in (16) (Kimenyi 1979:25-26):

(15) Word medial vowel lengthening before /N/ in Rwanda

a.	/ku-N-gaya/	→	[k**uu**ŋgaya]	'to despise me'
b.	/mu-N-ßona/	→	[m**uu**mbona]	'you see me'
c.	/ku-N-meɲ-a/	→	[k**uu**meɲa]	'to know me'
d.	/ßa-N-aka/	→	[ß**aa**ɲaka]	'they ask me'
e.	/ku-N-íßa/	→	[k**uû**ɲißa]	'to robe me, to steal me'

In (15), Rwanda short vowels preceding /N/ undergo lengthening but this process does not arise word-initially, as the data in (16) demonstrate (Kimenyi 1979:25):

(16) Initial vowel shortening before /N/ in Rwanda

a.	/iN-da/	→	[**i**nda]	'9-pregnancy, stomach'
b.	/iN-zu/	→	[**i**nzu]	'9-house'
c.	/u-N-gur-ir-a/	→	[**u**ŋgurira]	'you buy for me'
d.	/a-N-ßon-a/	→	[**a**mbona]	'he sees me'

In (16), vowels /i, u, a/ that precede /N/ are expected to undergo lengthening, but instead they surface as short vowels. The intra-linguistic variation of vowel lengthening before /N/ may be attributed to IVS that shortens initial vowels. We will not have anything to add about this alternation beyond this point. In the next subsection we analyze vowel epenthesis and vowel lengthening before /N/.

3.3.4 Moraic analysis of CL and prenasal vowel epenthesis

Two basic questions arise from the data on vowel epenthesis and vowel lengthening before /N/: (a) what determines crosslinguistic variations of prenasal vowel epenthesis and vowel lengthening? (b) How can the variations be accounted for? The proposal we put forward is that the two processes arise from CL in languages with contrastive vowel length. In other words, these processes do not occur in languages without contrastive vowel length. The two processes can be accounted for adequately within moraic theory (e.g. Hayes 1989). There are two principles of moraic theory that are particularly relevant to our proposal, namely the Mora Conservation Hypothesis and Hayes' (1989) proposal that the prosodic frame that governs CL is partly language-specific. We interpret Hayes' (1989) proposal to imply that CL is possible in languages with contrastive vowel length but not languages without contrastive vowel length. The Mora Conservation Hypothesis holds that CL occurs when a moraic segment is deleted and its mora is stranded but is filled by spreading from the preceding vowel.

The data presented in the previous subsections showed that prenasal vowel epenthesis and vowel lengthening occur only in languages with contrastive vowel length. A number of previous accounts analyzed /N/ as a moraic nasal in languages with contrastive vowel length, for instance, Ganda (Clements 1986), Yao (Hyman and Ngunga 1997; Ngunga 2000), Gusii (Nash 2011), and Lungu (Bickmore 2007). Thus, prenasal vowel epenthesis and lengthening occur in languages where /N/ is treated as moraic. In other words, /N/ is treated as moraic in languages with contrastive vowel length. The data in (17) illustrate contrastive vowel length in Lungu, a language in which /N/ is treated as moraic and allows vowel epenthesis and lengthening before /N/ (Bickmore 2007:42):

(17) Contrastive vowel lengthening in Lungu

a.	[ú-kú-z**í**k-à]	'to be deep'	vs.	[ú-kú-z**íí**k-à]	'to burry'
b.	[ú-kú-p**é**l-à]	'to shave'	vs.	[ú-kú-p**éé**l-à]	'to swing'
c.	[ú-kú-l**á**y-à]	'to say goodbye	vs.	[ú-kú-l**áá**y-à]	'to set off early'

There is no analysis that we know of that shows that /N/ is moraic in languages that do not have contrastive vowel length such as Swahili, Kongo, Zulu, and Konde. Moreover, these languages do not allow prenasal vowel epenthesis and lengthening. The logical conclusion is that the two processes correlate with contrastive vowel length. The moraicity of /N/ can also be said to correlate with contrastive vowel length. These facts from Bantu demonstrate Hayes (1989) proposal that the prosodic frame that governs CL is partly language-specific. In this case, vowel lengthening before //N/ is best analyzed as CL, and happens in languages with contrastive vowel length. In these languages, /N/ behaves moraic, and has been treated as so in some languages.

There is additional evidence in Bantu that CL and prenasal vowel epenthesis correlate with contrastive vowel length. Hayes (1989) treats vowel lengthening due to glide formation as an instance of CL. In Bantu, CL due to glide formation tends to occur only in languages with contrastive vowel length. In Bantu, postglide CL is unattested in languages that do not have contrastive vowel length. These facts support Hayes' (1989) proposal on CL. Postglide CL results from the mora abandoned by the vowel that becomes a glide. This process is observed in languages with contrastive vowel length such as Lungu, Ganda, Kuria, Rwanda, Bemba, and Gusii. The Lungu data below show the parallelism in prenasal CL (18) and postglide CL (19) (Bickmore 2007):

(18) Prenasal CL in Lungu

a. /ú-kú-N-mányá/ → [ú-k**úú**-mányá] 'to know me'

b. /ú-ku-N-ful-a/ → [úk**úú**-m-fú-à] 'to wash for me'

c. /a-ka-N-baazo/ → [ák**áá**-m-báázò] 'small carving axe'

(19) Postglide CL in Lungu

a. /tú-ku-ví-um-a/ → [tú-kú-ꜜvy-**úú**m-à] 'we are putting them (C8)'

b. /tú-ku-ela/ → [túkw**éé**là] 'we are winnowing'

c. /tú-ku-ak-i-a/ → [túkw**áá**sh-á] 'we are lighting'

In (18), the short vowels /u, a/ that occur before /N/ surface as long vowels [u:, a:] whether /N/ is realized (18b-c) or deleted (18a). In (19), when the high vowels /i/ (19a) and /u/ (19b-c) surface as glides [y, w] when followed by dissimilar vowels, the postglide vowels /u, e, a/ undergo lengthening to surface as [u:] (19a), [e:] (19b), and [a:] (19c).

On the other hand, languages without contrastive vowel length allow neither postglide CL nor prenasal CL. Languages in this group include Kongo and Swahili. The Kongo data in (20) and (21) demonstrate the non-occurrence of prenasal CL (19) and postglide CL (20):

(20) Non-occurrence of prenasal CL in Kongo (Meinhof 1932:159)

a. /ba-N-keŋgi/ → [b**a**ŋkeŋgi] 'they have bound me'

b. /ba-N-tumini/ → [b**a**ntumini] 'they have sent me'

c. /ba-N-landa/ → [b**a**ndanda] 'they followed me'

(21) Non-occurrence of postglide CL in Kongo (Meinhof 1932:164)

a. /ki-ata/ → [ky**a**ta] 'chap, crack under the foot'

b. /di-ambu/ → [dy**a**mbu] 'word'

c. /ku-ata/ → [kw**a**ta] 'seize'

d. /lo-kua/ → [lokw**a**] 'to be witched'

In (20), the vowel /a/ preceding /N/ fails to undergo lengthening similar to the vowel /a/ that follows the derived glides[y, w] in (21). The non-occurrence of CL in Kongo correlates with the lack of contrastive vowel length is this language and others in this group.

Table 3.1 below summarizes results showing the correlation between contrastive vowel length and CL in a sample of twelve Bantu languages. The results show that the four languages that do not have contrastive vowel length lack prenasal and postglide CL. These languages include Kongo, Konde, Shona, and Swahili. The rest of the languages in the sample have contrastive vowel length and allow both prenasal and postglide CL. The languages in this group include Bemba, Gusii, Jita, Lungu, Kuria, Nyamwezi, Rwanda, and Yao. In the table, "yes" indicates that the phenomenon in question is attested while "no" denotes that it is unattested. Note that the languages that allow CL also allow prenasal vowel epenthesis.

Table 5: Correlation between contrastive vowel length and CL

Language	**Contrastive vowel length**	**Prenasal CL**	**Postglide CL**
Bemba	yes	yes	yes
Gusii	yes	yes	yes
Jita	yes	yes	yes
Kongo	no	no	no
Konde	no	no	no
Kuria	yes	yes	yes

Table 5 (cont’d)			
Lungu	yes	yes	yes
Nyamwezi	yes	yes	yes
Rwanda	yes	yes	yes
Shona	no	no	no
Swahili	no	no	no
Yao	yes	yes	yes

In the moraic framework we adopt in this study, /N/ is assigned a mora underlyingly in languages with contrastive vowel length (e.g. Bickmore 2007; Hyman & Ngunga 1997; Ngunga 2000; Nash 2011). Thus, /N/ and short lexical vowels are assigned a mora each underlyingly. When /N/ is deleted or syllabified as part of the onset of the following syllable, vowel epenthesis occurs to preserve the mora vacated by /N/. Prenasal CL also has a similar motivation. In CL, the mora abandoned by /N/ is disassociated and attached to the vowel of the preceding syllable. The diagrams in (22a-b) represent the derivation of vowel epenthesis (22a) and CL (22b) before /N/ in Gusii and Lungu, respectively:

(22) a. Moraic account of vowel epenthesis before /N/ in Gusii

N-ß-ε ‘I be’ UR

μ μ Mora assignment

N-ß-ε

σ

μ μ Demorification & Syllabification

mb ε

σ σ Vowel epenthesis & SR

μ μ = [(ì)mbɛ̀]

i mb ε

In (22a), /N/ and the short nucleus vowel /ε/ are assigned a mora each underlyingly. However, /N/ undergoes demorification when it is syllabified as part of the onset of the next syllable /bε/. As a result, the mora assigned to /N/ is set afloat (in bold). Vowel epenthesis occurs to preservethe stranded mora. In (22b), CL arises when the mora vacated by deleted /N/ is linked to the preceding vowel in the Lungu example /*u-ku-many-a*/ ‘to know me’ (Bickmore 2007:51):

(22) b. Moraic account of CL before /N/ in Lungu

```
u-ku-N-many-a                      UR

μ   μ  μ    μ   μ                  Mora assignment
u-ku-N-many-a

σ    σ        σ      σ             Demorification & Syllabification
μ        μ  μ      μ     μ
u-k   u -  m   a ny-  a

σ   σ           σ        σ         CL & SR
μ        μ   μ        μ        μ = [ukuumanya]
u-k   u -   m    a    ny-  a
```

In (22b), Lungu assigns a mora underlyingly to /N/ and each short lexical vowel. When /N/ undergoes deletion before the nasal /m/, its mora is set afloat. The stranded mora is attached to the vowel /u/ of the preceding syllable, thus making it a bimoraic or long syllable [ku:].

The non-occurrence of vowel epenthesis and vowel lengthening before /N/ in some languages is a direct consequence of the non-moraic status of /N/ in such languages. The non-moraic status of /N/ in these languages is based on the fact that these languages lack contrastive vowel length in their prosodic frame. In Kongo /*N-kemi*/ 'I have squeezed' (23a), vowel epenthesis does not arise before /N/ because this nasal / has no mora to set afloat after demorification. Similarly, in Kongo /*ba-N-landa*/ 'they followed me' (23b), CL does not arise before /N/ for the same reason vowel epenthesis does not arisez:

(23) a. Non-occurrence of vowel epenthesis before /N/ in Kongo

N-kemi ‘I have squeezed’ UR

μ μ
N- kemi — Mora assignment

σ σ — Syllabification & SR
μ μ = [ŋkemi]
ŋk e m i

In (23a), Kongo does not assign a mora to /N/ underlyingly; only underlying short vowels are assigned moras in this language. So, when /N/ is syllabified as part of the onset of the following syllable, it has no mora to set free to attract prenasal vowel epenthesis. A similar situation obtains in (23b) where medial /N/ fails to trigger CL in the vowel of the preceding syllable:

(23) b. Non-occurrence of CL before /N/ in Kongo

ba-N-landa ‘they followed me’ UR

μ μ μ
ba-**N**-land a — Mora assignment

σ σ σ — Syllabification & SR
μ μ μ = [bandanda]
b a nd a nd a

The representations in (21-23) attribute the variation of vowel epenthesis and lengthening before /N/ to language-specific phonology. It has been shown that the two processes occur in languages where vowel length is contrastive and /N/ is treated as a moraic segment. On the other hand, these processes are not attested in languages without contrastive vowel length and thus /N/ must be non-moraic. More asymmetries of /N/ are noted in its behavior in nonlocal processes. In the next section, we examine the behavior of /N/ in three nonlocal processes, namely nasal consonant harmony (NCH), Dahl's Law (DL), and Meinhof's Law (ML).

3.4 Bantu /N/ in nonlocal alternations

The behavior of /N/ in nonlocal processes reveals some of its morphophonological properties. The relevant nonlocal processes are nasal consonant harmony (NCH), Dahl's Law (DL), and Meinhof's Law (ML). The examination of /N/ in these contexts is presented as follows: nasal consonant harmony (3.3.1), Dahl's Law (3.3.2), analysis of /N/ in DL (§3.3.3), and Meinhof's Law (ML) (3.4.3).

3.4.1 Bantu /N/ in nasal consonant harmony

Nasal consonant harmony (NCH) occurs when a nasal in the stem (i.e. root and suffixes) triggers nasalization in certain voiced consonants in the suffix (Kidima 1991; Ao 1991; Marten et el. 2000). NCH affects liquids /l, r/ and the voiced alveolar stop /d/ and conditions each of these consonants to surface as [n]. In Herero, NCH causes nasalization of suffixal /r/ of the perfective suffix /-ire/ to [n] (due to vowel harmony /-ire/ is realized either as /ine/ or /ene/). Consider the Herero examples in (24) (Marten et al. 2000, adapted from Kula 2002:65):

(24) Herero NCH triggered by prevocalic stem nasals

a.	/N-ba-mun-i**r**e/	→	[mbamun-i**n**e]	'I had seen'
b.	/N-ba-man-i**r**e/	→	[mbaman-e**n**e]	'I had finished'
c.	/N-ba-pem-i**r**e/	→	[mbapem-e**n**e]	'I had blown my nose'

In (24), suffixal /r/ becomes [n] due to nasalization triggered by the root nasals /n, m/. The data (24) portray NCH as progressive assimilation given that the trigger nasal precedes the target. Intervening non-target segments, that is, vowels, voiceless consonants, and NCs remain neutral or transparent to NCH. Besides, lexical and affixal preconsonantal nasals do not trigger NCH. NCH is observed in a number of languages such as Kongo, Yaka, Bemba, Chokwe, Herero, Ila, Kwanyama, Lamba, Lunda, Subiya, and Tonga (Kula 2002). The forms in (25) reveal that /N/ and stem-internal lexical preconsonantal nasals do not induce NCH in Herero; thus, suffixal /r/ surfaces unaffected (Marten et al. 2000, adapted from Kula 2002:65):

(25) /N/ and pre-consonantal nasals do not trigger NCH in Herero

a.	/N-ba-kumb-ire/	→	[mbakumb-i**r**e]	‘I had asked’
b.	/N-ba-hiŋg-ire/	→	[mbahiŋg-i**r**e]	‘I had chased’
c.	/N-ba-hiŋg-ire/	→	[mbahiŋg-i**r**e]	‘I had chased’
d.	/N-ba-jend-ere/	→	[mbajend-e**r**e]	‘I had walked’
e.	/N-ba-hit-ire/	→	[mbahit-i**r**e]	‘I had entered’

In Herero, /N/ fails to trigger NCH because it is a prefix; NCH is triggered by stem-internal prevocalic nasals.

In Kongo, NCH targets /d/ and /l/ of the perfective active suffix /idi/ and perfective passive suffix /ulu/ and changes them to /ini/ and /unu/, respectively. Kongo NCH is also triggered by stem internal nasals (26a-b). /N/ is unable to trigger NCH; so, the target segments /l, d/ surface unaltered (26c-f) (Ao 1991:194):

(26) Trigger and non-trigger nasals of NCH in Kongo

a.	/tu-kun-i**d**i/	→	[tu-kun-i**n**i]	‘we planted’
b.	/tu-mik-i**d**i/	→	[tu-mik-i**n**i]	‘we ground’

c. /N-bud-i**d**i / → [m-bud-i**d**i] 'I hit'

d. /N-bul-u**l**u/ → [m-bul-u**l**u] 'I was hit'

e. /N-suk-i**d**i/ → [n-suk-i**d**i] 'I washed'

f. /N-suk-u**l**u/ → [n-suk-u**l**u] 'I was washed'

Evidence from Yaka suggests that NCH occurs prior to /N/ prefixation (Kidima 1991). In Yaka, /N/ causes denasalization (27a-b) and postnasal hardening (27d) in stem-initial segments (Kidima 1991:4-5). In (27a-b), stem-initial nasals /m, n/ cause NCH that changes suffixal /d/ to [n]. In (27a-b), /N/ causes denasalization in stem-initial nasals /m, n/ changing them to [b, d], respectively. These facts suggest that denasalization of /m, n/ occurs after these nasals have induced NCH. NCH would not arise if denasalized occurred first (Kidima 1991:4-5):

(27) NCH and Denasalization in Yaka

a. /N-mak-i**d**i/ → [mbaki**n**í] 'I carved'

b. /N-nuuk-i**d**i/ → [nduuki**n**í] 'I sniffed'

c. /N-bak-i**d**i/ → [mbaki**d**i] 'I caught'

d. /N-luuk-i**d**i/ → [nduuki**d**í] 'I became wise'

Note that Yaka NCH does not obtain in (27c-d) because there is no lexical nasal within the stem. Therefore, /N/ cannot trigger NCH in (27-c-d) because it is a prefix, and thus lies outside of the domain of NCH (i.e. the stem).

The examples from Herero, Kongo, and Yaka provide conclusive evidence that /N/ cannot trigger NCH because as a prefix it occurs beyond the domain of NCH. The domain of NCH is the stem, and thus only stem-internal plain nasals can trigger NCH. This conclusion is reinforced by denasalization that is caused by /N/ and affects stem-initial nasals in Yaka. NCH and denasalization are sequenced processes with denasalization happening after NCH, as in (28):

(28) Domains of NCH and denasalization in Yaka

a. Derivation: /N-**m**ak-i**d**i/ → [m**b**aki**n**i]

b. 1st cycle: [mak-i**d**i]$_{stem}$] → [mak-i**n**i]$_{stem}$

c. 2nd cycle: [N-[**m**ak-ini]$_{stem}$]$_{word}$ → [m- [**b**ak-ini]$_{stem}$]$_{word}$

The derivation in (28a) involves both NCH and denasalization happening is succession. In (28b), NCH is triggered by stem-initial /m/ and alters suffixal /d/ to [n]. In (28c), /N/ occurs outside of the stem boundary. In this position /N/ can induce denasalization of stem-initial /m/ to [b] (postnasal nasalization and denasalization are analyzed in chapter 5). It would be in order to conclude that Yaka denasalization gets rid of geminate nasals in favor of NÇ̬s.

3.4.2 Bantu /N/ in Dahl's Law (DL)

Dahl's Law (DL) is a term used for a common voicing dissimilation process in Bantu in which the onset of a syllable undergoes voicing when followed by a voiceless onset of the next syllable (e.g. Davy & Nurse 1982). Thus, the domain of DL covers two adjacent syllables. The trigger of DL may be any voiceless consonant, but the target in most languages is the voiceless velar stop /k/ that becomes [g] or [ɣ]. In some languages the target may be any voiceless consonant. DL is a regressive dissimilation process in that the target precedes the trigger. DL is observed in a number of languages, for example, Gusii, Kikuyu, Kuria, Embu, Meru, Lungu, and Nyamwezi (Davy & Nurse 1982; Maganga & Schadeberg 1992; Kula 2000). The data in (29) illustrate DL in Gusii (a = augment, -ka- = class 12 prefix; ko- infinitive prefix):

(29) Dahl's Law in Gusii

a. /a-**k**a-sese/ → [a-**ɣ**a-sese] 'a small dog'

b. /a-**k**a-tue/ → [a-**ɣ**a-tu] 'a small head'

c. /a-**k**a-cuure/ → [a-**ɣ**a-cuure] 'a small deer'

d. /a-**k**a-kara/ → [a-**ɣ**a-kara] 'a small piece of coal'

In (29), the voiceless velar stop /k/ of the class 12 prefix /-ka-/ surfaces as a voiced velar fricative [ɣ] due to DL triggered by the voiceless consonants /s, t, c, k/, respectively. Note that the velar stop /k/ becomes a velar fricative [ɣ] because Gusii does not have /g/ in its phonemic inventory. When /N/ occurs between the trigger and target of DL it appears to be transparent, as in (30):

(30) Transparent /N/ in Gusii DL

a. /ko-N-tur-a/ → [ɣo:-**n**-tur-a] 'to wake me up'

b. /ko-N-kun-a/ → [ɣo:-**ŋ**-kun-a] 'to touch me'

c. /ko-N-sari-a/ → [ɣo:-**n**-sari-a] 'to spoil me'

d. /ko-N-ciik-a/ → [ɣo:-**n**-ciik-a] 'to invite me'

In (30), /k/ of the infinitive prefix /ko/ 'to' surfaces as [ɣ] due to DL. If it is correct to consider /N/ as transparent in (30), then the triggers are voiceless consonants /t, k, s, c/. There are however four competing interpretations of the behavior of /N/ in (30). We will turn to them shortly.

The other aspect of DL that relates to /N/ is the fact that DL can affect a voiceless consonant preceded by /N/ in an NÇ̥. The Gusii data in (31) illustrate this situation. In (31), postnasal /k/ of the 2SG prefix /ko-/ is realized as [g] due to DL triggered by voiceless consonants /k, t, s, c/ (/N/ occurs as the 1SG subject prefix):

(31) DL targets /k/ in an NÇ̥ in Gusii

a. /N-**ko**-k̠ɔɔɲ-ɛ/ → [ŋ-**g**ɔ-k̠ɔɔɲ-ɛ] 'I help you'

b. /**N-k**o-t̠om-e/ → [ŋ-**g**o-t̠om-e] 'I send you'

c. /**N-k**o-s̠aß-e/ → [ŋ-**g**o-s̠aß-e] 'I beg you'

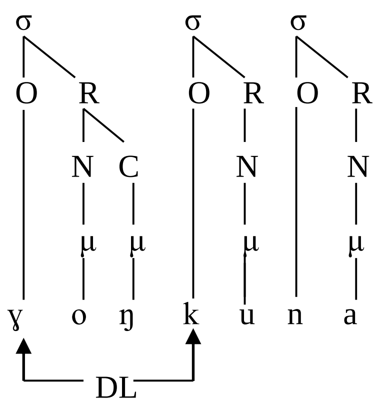
d. /N-**k**o-c̠iik-e/ → [ŋ-**g**o-c̠iik-e] 'I invite you'

It was stated earlier that there are four competing views on the behavior of /N/ in DL. In the next subsection, we discuss these views as we analyze the behavior of /N/ in DL.

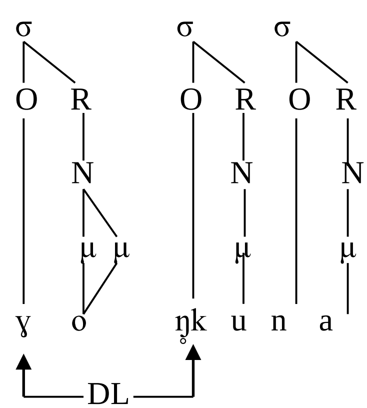
3.4.3 Analysis of /N/ in DL

The behavior of /N/ in DL is ambiguous, attracting at least four possible interpretations. The first is to treat /N/ in an NÇ̥ as a devoiced nasal capable of triggering DL (see w Mberia 2002). Devoiced nasals have been proposed in Bantu (e.g. Maganga & Schadeberg 1992; wa Mberia 2002). The second view is to treat /N/ as transparent to DL for being a coda, and argue that DL involves onset consonants (for coda view of /N/ see e.g. Odden 1994; Downing 2005). The third view is to treat /N/ in NÇ̥s as a component of a voiceless prenasalized stop onset that can trigger DL (for prenasalized stop view see e.g. Morrison 2011). The fourth is that as a prefix /N/ cannot trigger DL (as in NCH). These views are represented in (32a-d) using the Gusii example: */ko-N-kuna/* → *[ɣo:**ŋ**kuna]* 'to touch me' (O = onset, R = rhyme, N = nucleus):

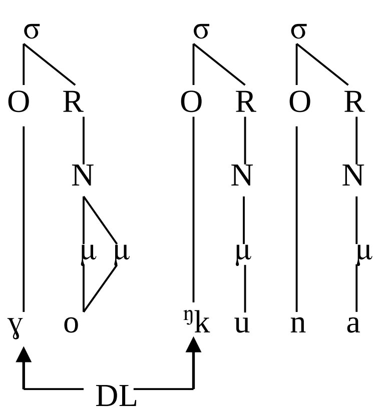
(32) a. Coda analysis of /N/ in DL



b. Nasal devoicing in DL



c. /N/ as component of voiceless prenasalized stop



d. Prefix analysis of /N/ in DL

/ɣo-N-kuna/ → [ɣo:-ŋ-kuna]

The four accounts in (32a-d) are possible explanations of the behavior of /N/ in DL. However, it is unlikely that all are correct. We will discuss each view.

The coda analysis of /N/ (32a) is unpersuasive given that the basic syllable structure in Bantu is open (i.e. CV). In the absence of independent evidence for codas in DL languages, the coda account is simply farfetched. The other challenge of this view relates to CL before /N/. In §3.2.4, it was shown that the (non-)occurrence of CL before /N/ is best attributed to the varying moraicity of /N/, which in turn depends on whether a languages has contrastive vowel length or not. However, Downing (1996; 2005) and Odden (1994) favor the coda account. Downing (1996) attributes prenasal vowel lengthening in Jita to the syllabification of /N/ as coda. However, this account cannot explain prenasal lengthening in N+V sequences where /N/ is syllabified unambiguously as an onset as in the forms in (33):

(33) Prenasal CL in N+V sequences in Gusii

a.	/ko-N-it-a/	→	[k**o:**ŋita]	'to beat me'
b.	/ko-N-eß-a/	→	[k**o:**ɲeßa], [ko:ŋeßa]	'to forget me'
c.	/ko-N-oombi-a/	→	[k**o:**ŋoombia]	'to assume me '
d.	/ko-uußi-a/	→	[k**o:**ŋußya]	'to block me'

The data in (33) argues against the coda analysis of vowel lengthening before /N/. They support the view that /N/ is assigned a mora underlyingly (or by rule). This view accounts fully for the data in (33) and the facts in /ko-N-kuna/ → [ɣo:ŋkuna] 'to touch me'.

The nasal devoicing analysis (32b) is a viable account of /N/ in DL except that it is still debatable if Bantu NCs are clusters or unitary prenasalized segments. The unitary segment account (32c) is also viable but for the unresolved tension between the cluster vs. unary views of Bantu NCs. Both the nasal devoicing and unary segment views can tolerably account for prenasal CLand the behavior of /N/ in DL. In the nasal devoicing analysis, the voiceless [ŋ̊k] unit is considered a voiceless onset capable of triggering DL. In the unary segment account, the prenasalized voiceless stop [ᵑk] is also capable of triggering DL.

The prefix analysis of /N/ (32d) is not viable since DL involves affixes. In the example /ko-N-kuna/ in (32), DL targets the prefix /k/. Suffixes also play a role in DL, for example, /t/ of the past tense suffix /-et-/ in Gusii (34):

(34) Role of suffixes in Gusii DL

a.	/-ɣoo**k**-et-e/	→	[ɣo:**ɣ**ete]	'came off'
b.	/-i**k**-et-e/	→	[i**ɣ**ete]	'arrived'
c.	/- βee**k**-et-e/	→	[βe:**ɣ**ete]	'put [past]'
d.	/-soo**k**-et-e/	→	[so:**ɣ**ɛtɛ]	'went out'

In (34), /t/ of the past tense suffix /-et-/ triggers DL that changes root final /k/ to [ɣ]. Since DL involves segments in prefixes and suffixes, it is unlikely that /N/ is transparent to DL because it is a prefix. This conclusion leaves the nasal devoicing and prenasalized stop accounts as the most likely accounts of the behavior of /N/ in DL. The behavior of /N/ in Meinhof's Law (ML) reveals more properties of this prefix as we will see in the next subsection.

3.4.4 Bantu /N/ in Meinhof's Law (ML)

Meinhof's Law (ML), also known as Ganda Law, is a process observed in some Bantu languages. In ML, /N/causes postnasal nasalization in stem initial voiced consonants when a lexical NC̬ or plain nasal occurs in stem-internally (Hebert 1975, 1977, 1986; Katamba & Hyman 1991; Kula 2002). Consider the Ganda examples of ML in (35):

(35) Meinhof's Law in Ganda

a.	/N-**g**e:<u>nd</u>-a/	→	[**ŋŋ**e:nda]	'I go'
b.	/N-**b**o<u>mb</u>-a/	→	[**mm**omba]	'I escape'
c.	/N-**l**o<u>nd</u>-a/	→	[**nn**onda]	'I choose'
d.	/N-**l**i<u>m</u>i/	→	[**nn**imi]	'10-tongue'
e.	/e-N-**g**ero/	→	[e**ŋg**ero]	'10-story'

In (35),/N/ causes the nasalization of stem-initial /g, b, l/ to surface as [ŋ, m, n] in stems that contain /nd, mb, nd, m/, respectively. Ganda nasalization creates geminate nasals [ŋŋ, mm, nn] initially. Note that ML does not arise in (35e) since the stem lacks a trigger NC̬ or plain nasal.

There are crosslinguistic variations in the operation of ML. The target NC̬ may surface as a short nasal in some languages but a geminate nasal in others as in Ganda (35). Besides, the stem-internal trigger of ML may be a plain nasal or an NC̬. In some languages, the NC̬ containing /N/ may act as a trigger and simplify the target lexical NC̬ to a C̬. In most languages, ML involves NC̬s only but there are some that take NC̥s as triggers. ML has both local and nonlocal dimensions. The local aspect of ML involves the nasalization of stem-initial obstruents when preceded by /N/. The nonlocal aspect of ML is noted when the effect of /N/ is regulated by a non-adjacent stem-internal NC or nasal. Let us look at the crosslinguistic variations of ML.

In Bemba, ML results in a geminate nasal and the interacting NÇs must be separated by a vowel (36a-c). However, ML fails to occur in (35d) when the target is an NÇ (/Np/). In (36e), ML does not arise because the trigger and target NÇs are separated by a CV instead of a V. In the vowel-initial stem (36c), the velar nasal /ŋ/ is "inserted" between the vowel and /N/ to create a geminate nasal. The Bemba data involves /N/ of 1SG subject (Kula 2002:70):

(36) Meinhof's Law in Bemba

a.	/N-**β**ó:<u>mb</u>el-e/	→	[**mm**ó:mbele]	'I have worked'
b.	/N-**l**a:<u>nd</u>il-e/	→	[**nn**a:ndile]	'I have spoken'
c.	/N-ó:<u>nd</u>el-e/	→	[**ŋŋ**ó:ndele]	'I have become thin'
d.	/N-**p**á:<u>ŋg</u>il-e/	→	[**mp**á:ŋgile]	'I have made'
e.	/N-**β**éle:<u>ŋg</u>el-e/	→	[**mb**éle:ŋgele]	'I have read'

In Kikuyu, ML is triggered by a plain nasal or NÇ and word-initial nasalization produces short nasals. ML in Kikuyu causes the NÇs /N-ɣ/ (37a-b) and /N-r/ (37c-d) to surface as short nasals [ŋ] and [n], respectively. In (37e), ML does not occur since there is no trigger NÇ or nasal in the stem. Thus, in (37e), /r/ undergoes postnasal hardening to become [d] (Barlaw 1951:7):

(37) Meinhof's Law in Kikuyu

a.	/N-**ɣ**aa<u>mb</u>-e/	→	[**ŋ**aa<u>mb</u>e]	'Am I to speak?'
b.	/N-**ɣ**a<u>n</u>-e/	→	[**ŋ**a<u>n</u>e]	'Am I to recite (a story)?'
c.	/N-**r**ũ<u>m</u>-e/	→	[**n**ũ<u>m</u>e]	'Am I to bite?'
d.	/N-**r**i<u>ŋg</u>-e/	→	[**n**i<u>ŋg</u>e]	'Am I to strike?'
e.	/N-**r**eki-e/	→	[**nd**ekie]	'Am I to go?'

In Kwanyama, an interesting version of ML is observed. Kwanyama ML does not lead to postnasal nasalization after /N/. Instead, the lexical NC in the final syllable drops the nasal, hence reducing the lexical NC̬ to a C̬. This version of ML suggests that the NC containing /N/ acts as a trigger while the lexical NC̬ is the target. Kwanyama ML is progressive while the other cases of ML we have examined are regressive. The Kwanyama facts are illustrated in (38) (Tirronen 1977a; adapted from Kula 2002):

(38) Meinhof's Law in Kwanyama

a. /o-N-ga**nd**u/ → [oŋga**d**u] 'crocodile'

b. /o-N-go**mb**e/ → [oŋgo**b**e] 'beast'

c. /o-N-ba**mb**i/ → [omba**b**i] 'steenbuck'

d. /o-N-ba**ñdj**e/ → [omba**dj**e] 'jackal'

e. /o-N-dja**mb**i/ → [oñdja**b**i] 'reward'

The last case of ML we will consider occurs in Lamba (Doke 1922). Lamba ML is also unique in its own right. In Lamba, ML may be triggered by an NC̬ or NC̥ and causes the reduction of initial NC̬ to a short homorganic nasal, similar to Kikuyu. In (39), Lamba stem-initial voiced consonants /β, l/ are replaced by a homorganic nasal due to ML (the initial vowel /i/ is the augment) (Doke 1922):

(39) Meinhof's Law in Lamba

a. /i-N-**β**a<u>ŋg</u>o/ → [i**m**aŋgo] 'bonds'

b. /i-N-**β**a<u>ns</u>a/ → [i**m**ansa] 'courtyard'

c. /i-N-**l**e<u>mb</u>o/ → [i**n**embo] 'tattoo'

d. /i-N-**l**u<u>mb</u>ulula/ → [i**n**umbulula] 'yellow fungus'

3.5 Summary

In this chapter we examined the effect of /N/ on the preceding vowel and its behavior in non-local processes NCH, DL, and ML. It emerged that both vowel epenthesis before and vowel lengthening before /N/ occur in languages with contrastive vowel length following the demorification of a moraic /N/. These alternations are not observed in languages without contrastive vowel length where /N/ may not be moraic. In some languages, prenasal CL may be blocked initially by the IVS. In NCH languages, /N/ fails to trigger this process because it is a prefix while NCH is triggered by prevocalic lexical nasals within the stem. In DL, we concluded that /N/ is part of the trigger onset either because it is devoiced or a component of a voiceless prenasalized stop. The ML data we examined revealed that /N/ exhibits different behavioral patterns. First, when /N/ occurs in the target NC̬, it triggers nasalization in the stem-initial consonant, creating a geminate nasal. Secondly, /N/ may cause nasal substitution in the stem-initial consonant when it occurs in the target NC̬. Thirdly, when /N/ occurs in the trigger NC̬ both /N/ and the stem-initial consonant surface unchanged. Fourthly, /N/ may trigger nasal substitution of the next consonant in ML triggered by a voiceless NC̥. It is apparent that the role /N/ plays in ML depends on language-specific phonology. However, the main alternation /N/ induces on stem-initial voiced consonants is nasalization. We will postpone the formalization of this process to chapter 5 where the range of postnasal alternations triggered by /N/ is formalized.

CHAPTER 4

4. ALTERNATIONS IN BANTU /N/

4.1 Introduction

This chapter investigates the processes that affect /N/ when it interacts with stem-initial segments. The most common changes that occur in /N/ include nasal place assimilation, aspiration, devoicing, effacement, and syllabicity alternation. A number of these processes are shared across Bantu; others vary, while most of them are determined by the type of stem-initial segment. The changes that occur in /N/ have been observed is specific languages, for instance, Swahili, Kongo, Zulu, and Konde (Meinhof 1932), Tswana (Cole 1955), Kikuyu (Barlaw (1954), Shona (Fortune (1955), Rwanda (Kimenyi 1979), and Yao (Ngunga 2000). The main objective of this chapter is to bring together from different languages these processes and account for their occurrence and variation within the Element-based Dependency framework (EBD) (e.g. Botma 2004). The chapter is organized as follows: realization of /N/ before vowel-initial stems (§4.1), nasal place assimilation (§4.2), syllabicity alternations of /N/ (§4.3), nasal devoicing (§4.4, nasal aspiration (§4.5), analysis (§4.6), and summary (§4.7).

4.2 Realization of /N/ before vowel-initial stems

When /N/ occurs before vowel-initial stems, it is always realized as a dorsal nasal, that is, palatal [ɲ] or velar [ŋ]. The labial [m, ɱ] and alveolar [n] nasals seem to be excluded from this context. The behavior of /N/ before vowel-initial stems is uncovered when examined across multiple languages. We will illustrate the crosslinguistic behavior of /N/ before vowel-initial stems with examples from Swahili, Kuria, and Gusii. Swahili has five contrastive vowels /i, ɛ, a, ɔ, u/ and four nasal phonemes /m, n, ɲ, ŋ/. However when /N/ of class 9/10 occurs before vowel-initial stems it always surfaces as a palatal nasal [ɲ]. This situation is illustrated in (1):

(1) Realization of /N/ before vowel-initial stems in Swahili

a.	/N-ɛmbɛ/	→	[**ɲ**-ɛmbɛ]	'10-razor'
b.	/N-imbɔ/	→	[**ɲ**-imbɔ]	'10-song'
c.	/N-uki/	→	[**ɲ**-uki]	'9/10-bee'
d.	/N-ɔrɔrɔ/	→	[**ɲ**-ɔrɔrɔ]	'9/10-soft'
e.	/N-ɛupɛ/	→	[**ɲ**-ɛupɛ]	'9/10-white'

The data indicates that Swahili /N/ becomes a palatal nasal [ɲ] before vowel /ɛ/ (1a, e), /i/ (1b), /u/ (1c), and /ɔ/ (1d). Thus, Swahili /N/ is realized as a palatal nasal before various vowels.

In Kuria, /N/ occurs as the prefix for class 9/10 and 1SG (subject and object). In (2), /N/ of 1SG object (2a-c) and class 10a surface as a palatal nasal before vowel-initial stems (Cammenga 2004:114-115):

(2) Realization of /N/ before vowel-initial stems in Kuria

e.	/o-N-ɔk-er-i/	→	[uu**ɲ**okiíyi]	'you have lit for me (today)'
f.	/o-N-eβ-er-er-e/	→	[uu**ɲ**eβeré]	'you have forgotten me (today)'
g.	/o-N-aɣ-er-er-e/	→	[uu**ɲ**aɣeéye]	'you have weeded for me'
h.	/eN-aNɣ-o/	→	[ii**ɲ**ááŋgo]	'9a-quick'

In Gusii, /N/ may surface as a palatal [ɲ] or velar [ŋ] nasal before vowel-initial stems. Gusii has four nasal phonemes /m, n, ɲ, ŋ/ and fourteen contrastive vowels, seven short and seven long. The vowel phonemes in Gusii include /a/, /aa/, /e/, /ee/, /ɛ/, /ɛɛ/, /i/, /ii/, /o/, /oo/, /ɔ/, /ɔɔ/, /u/, /uu/ (Cammenga 2002; Nash 2011). When Gusii /N/ occurs before vowel-initial stems it always surfaces either as a palatal [ɲ] or velar [ŋ] nasal. An optional epenthetic vowel [i] may appear before /N/ in Gusii (vowel epenthesis before /N/ was discussed in chapter 3). The examples in (3) demonstrate the behavior of /N/ before vowel-initial stems in Gusii. /N/ surfaces as a velar nasal [ŋ] in (3a-d), but as either a palatal [ɲ] or velar [ŋ] nasal in (3e-g):

3) Realization of /N/ before vowel-initial stems in Gusii

a.	/N-at-e/	→	[i**ŋ**-ate], *[i**ɲ**-ate]	'I break, burst'
b.	/N-et-e/	→	[i**ŋ**-ete], *[i**ɲ**-ete]	'I pass'
c.	/N-ombi-e/	→	[i**ŋ**-oombi], *[i**ɲ**-oombi]	'I assume'
d.	/N-uut-e/	→	[i**ŋ**-uute], *[i**ɲ**-uute]	'I blow, start a fire'
e.	/N-ik-e/	→	[i**ɲ**-ike], [i**ŋ**-ike]	'I come down'
f.	/N-ɔki-e/	→	[i**ɲ**-ɔki], [i**ŋ**-ɔki]	'I light'
g.	/N-ɛr-e/	→	[i**ɲ**-ɛrɛ], [i**ŋ**-ɛrɛ]	'I sieve'

The behavior of /N/ before vowel-initial stems in Swahili, Kuria and Gusii reveals that both /N/ and the vowel are realized (neither segment undergoes deletion) and /N/ is always realized as a palatal [ɲ] or velar [ŋ] nasal. The nasals [m, ɱ, n] are not realized in this environment. The realization of /N/ as a palatal [ɲ] or velar [ŋ] nasal before vowel-initial stems was observed across a subsample of ten languages. The results from this sample are shown in Table 6. These results show that /N/ is realized as a palatal nasal [ɲ] in all the ten languages, with one language, Gusii, allowing /N/ to surface as a palatal [ɲ] and velar [ŋ] nasal:

Table 6: Realization of /N/ before vowel-initial stems

Language	**Nasal variant preferred before vowels**
Gusii (Cammenga 2002, Nash 2011)	[ɲ], [ŋ]
Jita (Downing 1996)	[ɲ]
Konde/Nyakyusa (Meinhof 1932)	[ɲ]
Kuria (Cammenga 2004)	[ɲ]
Matuumbi (Odden 1996)	[ɲ]
Nyamwezi (Maganga & Schadeberg 1992)	[ɲ]
Rwanda (Kimenyi 1979)	[ɲ]
Shona (Fortune 1955)	[ɲ]
Swahili (Meinhof 1932)	[ɲ]
Zulu (Meinhof 1932)	[ɲ]

The issue related to the behavior of /N/ before vowel-initial stems is the motivation behind the preference for dorsal nasals in this context. This issue will be discussed in §4.6. The changes that occur in /N/ before consonant-initial stems are more interesting and exhibit far more patterns than the ones observed before vowel-initial stems. In the subsequent sections, we will examine different alternations that occur in /N/ before consonant-initial stems, starting with nasal place assimilation.

4.3 Nasal place assimilation

The most pervasive alternation observed in /N/ is nasal place assimilation. When it occurs before consonant-initial stems, /N/ always assimilates to the place of articulation of the consonant. Nasal place assimilation before consonant-initial stems conditions /N/ to assume various surface shapes, that is, labial [m], labio-dental [ɱ], alveolar [n], palatal[ɲ], and velar [ŋ]. The realization of /N/ as a homorganic nasal before consonant-initial stems is attested across Bantu, for example, Lamba (Doke 1922), Swahili, Kongo, Zulu, and Konde (Meinhof 1932), Shona (Fortune 1954), Tswana (Cole 1955), Rwanda (Kimenyi 1979), Yaka, (Kidima 1991), Matuumbi (Odden 1996), Yao (Ngunga 2000), Bemba (Kula 2002), Gusii (Cammenga 2002), and Lungu (Bickmore 2007). However, we will limit our illustration of nasal place assimilation to three languages, namely Bemba (Kula 2002), Yao (Ngunga 2000), and Rwanda (Kimenyi 1979).

In Bemba, /N/ assimilates to the place of articulation of stem-initial obstruents (both voiceless and voiced) and nasal stops. Bemba has four phonemic nasals that include /m, n, ɲ, ŋ/. In the Bemba data below (4), /N/ occurs as the prefix for 1SG subject (Kula 2002:67-68):[15]

(4) Nasal place assimilation in Bemba

a.	/N-pat-a/	→	[**m**pat-a]	'I hate'
b.	/N-fut-a/	→	[**ɱ**fut-a]	'I pay'
c.	/N- ßil-a/	→	[**m**bil-a]	'I sew'
d.	/N-mas-a/	→	[**m**mas-a]	'I plaster walls'
e.	/N-lek-a/	→	[**n**dek-a]	'I stop'

[15] There are no underlying voiced oral obstruents in Bemba, but voiced continuants /ß, l/ undergo postnasal hardening after /N/ to become [b, d], respectively.

f. /N-nak-a/ → [**n**nak-a] ‘I get tired’

g. /N-ɲu:ng-a/ → [**ɲ**ɲu:ng-a] ‘I sieve’

h. /N-kúl-a/ → [**ŋ**kúl-a] ‘I grow’

Bemba /N/ becomes labial ([m, ɱ]) before stem-initial labials /p, f, b, m/ (4a-d), alveolar ([n]) before stem-initial alveolars /d, n/ (4e-f), palatal ([ɲ]) before the palatal nasal /ɲ/ (4g) and velar ([ŋ]) before a velar stop /k/ (4i). The Bemba labio-dental nasal [ɱ] is not phonemic but occurs as a phonetic variant of /N/.

The next set of data is from Yao, a language with four nasal phonemes /m, n, ɲ, ŋ/. Nasal place assimilation of /N/ in Yao is illustrated in (5) with /N/ of 1SG object. The stem-initial segments that condition this alternation include voiceless consonants /p/ (5a) and /t/ (5b); voiced consonants /g/ (5c) and /l/ (5d), and nasals /m/ (5e) and /ɲ/ (5f) (Ngunga 2000:60):

(5) Nasal place assimilation in Yao

a. /ju-N-pat-il-e/ → [juu-**m**-bat-il-e] ‘s/he got me’

b. /ju-N-tiis-il-e/ → [juu-**n**-diis-il-e] ‘s/he ran away from me’

c. /ju-N-gav-il-e/ → [juu-**ŋ**-av-il-e] ‘s/he cut me’

d. /ju-N-loomb-il-e/ → [juu-**n**-oomb-il-e] ‘he married me’

e. /ju-N-met-il-e/ → [juu-**m**-et-il-e] ‘s/he shaved me’

f. /ju-N-ɲaku-il-l-e/ → [juu-**ɲ**-akwiil-e] ‘s/he lifted me’

The data indicate that Yao /N/ becomes [m] before /p/ but /p/ undergoes postnasal voicing to become [b] (5a). In (5b), /N/ assimilates the alveolar place of /t/ and surfaces as [n]; /t/ is subject to postnasal voicing to surface as [d]. In (5c), /N/ is realized as [ŋ] before the voiced velar stop /g/ with concurrent /g/ effacement. In (5d), Yao /N/ becomes an alveolar nasal [n] before the liquid /l/, but the liquid undergoes deletion. When Yao /N/ occurs before nasals (5e-f), only one nasal is realized implying /N/ deletion. Note that Yao /N/ undergoes deletion before nasals, but induces nasalization in voiced consonants /g, l, m, ɲ/ and voicing in voiceless consonants /p, t/ (the influence of /N/ on stem-initial consonants is discussed in chapter 5).

Nasal place assimilation in Rwanda gives rise to four surface forms of /N/, namely [m, n, ɲ, ŋ]. Rwanda has three nasal phonemes /m, n, ɲ/. The velar nasal [ŋ] occurs only as a variant of /N/ before velar consonants. The examples in (6) demonstrate nasal place assimilation in Rwanda involving /N/ of class 9/10 (6a-d) and 1SG subject (6e) (the augment [i] precedes /N/ in nominal stems) (Kimenyi 1979:34-35):

(6) Nasal place assimilation in Rwanda

a.	/iN-bwa/	→	[í**m**bwa]	'dog'
b.	/iN-da/	→	[i**n**da]	'stomach, pregnancy'
c.	/iN-ßoga/	→	[i**m**bóga]	'vegetables'
d.	/iN-papuro/	→	[i**m̥**hapuro]	'paper'
e.	/N-toora/	→	[**n̥**hoora]	'I vote', 'vote for me'

In (6a), /N/ assimilates labial place of /b/ and surfaces as [m] while in (6b) it surfaces as [n] before the voiced alveolar stop /d/. In (6c), /N/ is homorganic with stem-initial /ß/, surfacing as [m] while /ß/ changes to [b]. In (6d-e), homorganic /N/ becomes devoiced to become [m̥, n̥] before voiceless stops /p, t/ which undergo debuccalization (or aspiration) to surface as a laryngeal fricative [h], respectively (nasal devoicing and aspiration are discussed below while postnasal debuccalization/aspiration and devoicing are discussed in chapter 5). Syllabicity alternations of /N/ are considered next. Included in this alternation is /N/ effacement because the same data is used to illustrate the two alternations.

4.4 Syllabic alternations of /N/

In a number of languages, /N/ is conditioned to undergo effacement in specific contexts. The common segment types that condition /N/ effacement include voiceless obstruents and nasals. The deletion of /N/ is especially common before voiceless fricatives /s, f, h/ as observed in languages such as Swahili (Meinhof 1932), Luyana (Givón 1970), Ndali (Vail 1972), Umbundu (Schadeberg 1982), and Yao (Ngunga 2000). The deletion of /N/ before other voiceless obstruents is attested in languages such as Tswana (Cole 1955), Shona (Fortune 1955), and Swahili (Meinhof 1932). In these languages, /N/ deletes before voiceless obstruents in polysyllabic stems but surfaces in monosyllabic stems. We will provide data from a couple languages to demonstrate the contexts that condition /N/ effacement.

In Swahili, /N/ undergoes deletion before voiceless obstruents in polysyllabic stems. The trigger segments undergo aspiration following /N/ deletion.However, Swahili /N/ is retained in monosyllabic stems where it surfaces as a syllabic nasal. In other words, Swahili /N/ is non-syllabic in polysyllabic stems but surfaces syllabic in monosyllabic stems. The Swahili examples in (7) demonstrate /N/ effacement before voiceless obstruents in polysyllabic stems:

(7) /N/ deletion before voiceless obstruents in Swahili:

a.	/N-kubwa/	→	[k^{h}ubwa]	‘9/10-big’
b.	/N-paŋga/	→	[p^{h}anga]	‘9/10-machete’
c.	/N-tatu/	→	[t^{h}atu]	‘10-three’
d.	/N-ʧaʧɛ/	→	[ʧ$^{\text{h}}$aʧɛ]	‘10-few’

The data reveal that Swahili /N/ deletes before stem-initial voiceless obstruents /k, p, t, ʧ/ which in turn undergo aspiration to surface as [k^{h}, p^{h}, t^{h}, ʧ$^{\text{h}}$]. Nonetheless, /N/ effacement in Swahili is blocked in monosyllabic stems where /N/ is retained as a syllabic nasal, as shown in (8):

(8) /N/ retention before voiceless obstruents in Swahili monosyllabic stems

a. /N-ʧi/ → [n̩ʧ^{h}i] ‘9/10-country’

b. /N-swi/ → [n̩swi] ‘9/10-fish’

c. /N-ta/ → [n̩t^{h}a] ‘9-wax’

d. /N-pya/ → [m̩p^{h}ya] ‘9/10-new’

e. /N-ʧa/ → [n̩ʧ^{h}a] ‘9/10-edge’

The data in (8) show that Swahili class 9/10 /N/ resists effacement before voiceless consonants in monosyllabic stems. The realization of Swahili /N/ as a syllabic nasal in these stems is crucial in that it enables the stems to meet the minimal word-size requirement of two moras in content words (Park 1997). Thus, the retention vs. deletion of Swahili /N/ depends on the [voice] feature of the stem-initial obstruent and the size of the host stem. The minimal word-size requirement seems to override effacement as a repair strategy in NÇ̥ sequences in Swahili.

Another language that allows /N/ effacement is Tswana. In Tswana, similar to Swahili, /N/ is deleted before voiceless obstruents in polysyllabic stems but is retained in monosyllabic stems. The realization of Tswana /N/ in monosyllabic stems is accompanied by postnasal devoicing and hardening. Tswana /N/ deletion before voiceless consonants is illustrated in (9). In (9a), stem-initial /d/ undergoes devoicing to surface as [t], implying that /N/ deletion is conditioned by [t]. In (9b), /N/ triggers the change of /f/ to [p^{h}] after which the nasal undergoes effacement. In (9c), /r/ becomes [t] after /N/, and then the nasal is deleted. In (9d), /N/ deletion is accompanied by the devoicing of /b/ to [p] (adapted from Cole 1955:40):[16]

[16] In Tswana, /N/ of 1SG object is always retained irrespective of the size of the stem (Cole 1955:41).

(9) /N/ deletion before voiceless obstruents in Tswana

a. /N-dirô/ → [tirô] 'work' (< -dira 'do, make')

b. /N-fê̞ɲô/ → [p^{h}ê̞ɲô] 'victory' (< -fê̞ɲa 'conquer'

c. /N-rut^{h}ô/ → [tut^{h}ô] 'teaching' (< -ruta 'teach')

d. /di-N-baka/ → [dipaka] 'times/occasions' (< lo-baka 'time/occasion)

The voiceless stops that trigger nasal deletion in Tswana are /t, p^{h}, p/. On the other hand, Tswana /N/ effacement is blocked in monosyllabic stems where /N/ is realized as a syllabic nasal. Consider the behavior of Tswana /N/ in the monosyllabic stem (Cole 1955: 40, 87):

(10) /N/ retention in Tswana monosyllabic stems

a. /N-fô/ → [**m̩**p^{h}ô] 'gift'

b. /N-lwa/ → [**n̩**twa] 'war'

c. /N-gô/ → [**ŋ̩**kgô] 'water pot'

d. /N-tša/ → [**ɲ̩**tša] 'dog'

In (10), /N/ is retained before voiceless obstruents [p, t, kg, tš] in monosyllabic stems. Postnasal hardening induced by /N/ changes /f/ to [p^{h}] (10a), /l/ to [t] (10b), and /r/ to [t^{h}] (10d). Tswana /N/ induces postnasal devoicing in (10c) where /d/ surfaces as [t] after /N/.

The deletion of /N/ before voiceless consonants is not attested in all Bantu languages. There are a number of languages that allow /N/ to surface before voiceless obstruents in polysyllabic stems. The realization of /N/ before voiceless obstruents is observed in languages such as Nyamwezi (Maganga & Schadeberg 1992), Tharaka (wa Mberia 2002), and Gusii (Cammenga 2002; Nash 2011). The examples in (11) are proof that that /N/ is allowed to surface as a devoiced nasal before voiceless consonants in these languages:

(11) Bantu /N/ retention before voiceless consonants

a. Nyamwezi: /N-ʃiímbá/ → [ɲ̥ʃiímbá] '9/10-lion'

b. Nyamwezi: /N-seßuú/ → [n̥seßuú] '9/10-hot'

c. Tharaka: /ka-N-tan-ɛ/ → [ɣan̥tanɛ] 'let me circumcise'

d. Tharaka: /ka-N-ko:r-ɛ/ → [ɣaŋ̥ko:rɛ] 'let me uproot'

e. Gusii: /N-son-e/ → [n̥sone] 'I sew'

f. Gusii: /N-tom-e/ → [n̥tome] 'I send'

In Nyamwezi, /N/ is realized before voiceless fricatives /ʃ/ (11a) and /s/ (11b) (Maganga & Schadeberg 1992:17). In Tharaka, /N/ surfaces before voiceless consonants /t/ (11c) and /k/ (11d) (wa Mberia 2002). Gusii /N/ is also allowed to surfacebefore /s/ (11e) and /t/ (11f). It appears that the devoicing of /N/ is what prevents it from effacement in the data shown in (11). In other words, languages that allow /N/ deletion before voiceless obstruents do so because they disallow nasal devoicing. This proposal will be developed and formalized in §4.6.

In some languages, stem-initial nasals condition /N/ to undergo effacement, especially in word medial position. Nasal deletion before other nasals is attested in a number of languages, for example, Lungu (Bickmore 2007), Gusii (Nash 2011), and Yao (Ngunga 2000). In Lungu, when /N/ deletes before anasal this triggers vowel epenthesis word-initially (Bickmore 2007):[17]

(12) /N/ deletion before another nasal in Lungu

a. /ń-mil-é/ → [í-míl-é] 'that I swallow'

b. /n-mila +H/ → [ìmìl-á] 'and when I swallowed'

c. /n-mo-a +H/ → [ì-mw-á] 'and then I drank'

[17] Bickmore (2007) uses /n/ for the nasal prefixes we represent as /N/ in this study.

d. /ń-ɲép-é/ → [í-ɲé[!]p-é] 'that I tie a knot'

In (12), when /N/ is prefixed before nasals it is not allowed to surface. In (12a-c), Lungu /N/ undergoes effacement before stem-initial /m/ and in (12d) before /ɲ/. Note that /N/ effacement in (12) is accompanied by [i] epenthesis before the stem-initial nasal (prenasal vowel epenthesis was discussed in chapter 3).

The deletion of /N/ before stem-initial nasalsin word-medial position is illustrated in (13) with examples from Gusii. In Gusii, medial /N/ deletion triggers vowel lengthening before /N/:

(13) Medial /N/ deletion before stem-initial nasals in Gusii

a. /ko-N-mer-a/ → [ko:mera] 'to swallow me'

b. /ko-N-nar-a/ → [ko:nara] 'to get used to me'

c. /ko-N-ɲɔɔr-a/ → [ko:ɲɔɔra] 'to find me'

d. /ko-N-ŋain-a/ → [ko:ŋaina] 'to lie to me'

In (13), the 1SG object /N/ deletes before stem-initial nasals /m/ (13a), /n/ 13b), /ɲ/ (13c), and /ŋ/ (13d). The facts in (13) suggest that Gusii disallows geminate nasals medially.However, word-initially, Gusii /N/ may be retained as a syllabic nasal before stem-initial nasals. Whenever Gusii /N/ undergoes deletion word-initially, epenthetic [i] appears before the stem-initial nasal.The data in (14) demonstrates /N/ retention before stem-initial nasals in Gusii:

(14) Initial /N/ retention in Gusii N+N sequences

a. /N-mer-e/ → [**m̩m**ere], [imere] 'I swallow'

b. /N-nar-ɛ/ → [**n̩n**arɛ], [inarɛ] 'I get used to'

c. /N-ɲɔɔr-ɛ / → [**ɲ̩ɲ**ɔɔrɛ], [iɲɔɔrɛ] 'I find'

d. /N-ŋaaɲ-ɛ/ → [**ŋ̩ŋ**aaɲɛ], [iŋaaɲɛ] 'I move/migrate'

In (14), /N/ is allowed to surface as a homorganic nasal before stem-initial nasals /m/ (14a), /n/ (14b), /ɲ/ (14c), and /ŋ/ (14d). Thus, Gusii /N/ deletion before nasals is limited to medial position as /N/ may surface initially in Gusii. The Gusii examples indicate that the location in a word where /N/ occurs determines whether it will undergo effacement or not. The data also show that when /N/ is allowed to surface initially it becomes syllabic.

Stem-initial nasals in condition /N/ to undergo deletion in some languages, for instance, Yao. The Yao examples in (15) illustrate this pattern (Ngunga 2000:60). In (15), Yao /N/ is dropped before stem-initial nasals /m/ (15a), /n/ (15b), /ɲ/ (15c), and /ŋ/ (15d). Note that the deletion of /N/ in Yao induces lengthening in the preceding vowel:

(15) /N/ deletion before stem-initial nasals in Yao

a.	/ju-N-met-il-e/	→	[juu-met-il-e]	‘s/he shaved me’
b.	/ju-N-nik-il-e/	→	[juu-nic-il-e]	‘s/he dyed me’
c.	/ju-N- ɲaku-il-l-e/	→	[juu- ɲakwiil-e]	‘s/he lifted me’
d.	/ju-N-ŋo-el-e-il-l-e/	→	[juu-ŋweeleel-e]	‘s/he drunk for me’

In this section we presented data to illustrate syllabicity alternations of /N/ and the related phenomenon of /N/ effacement. It emerged that /N/ undergoes effacement especially before voiceless obstruents and nasals in polysyllabic stems. Two main questions stem from these patterns: (a) what is the motivation behind /N/ deletion before voiceless obstruants and nasals? (b) What is the implication of /N/ retention before the same segments in other languages? These questions will be addressed in §4.6. We also observed that when /N/ is retained before voiceless obstruents it is subject to devoicing. Let us examine further /N/ devoicing in the next subsection.

4.5 Nasal devoicing

We noted in §4.3 that when /N/ surfaces before voiceless consonants it becomes a devoiced nasal [N̥] in languages such as Nyamwezi (Maganga & Schadeberg 1992), Pokomo (Hinnebusch 1975), Rwanda (Kimenyi 1979), and Tharaka (wa Mberia 2002). We will provide data from some of these languages to illustrate /N/ devoicing. In Pokomo, /N/ undergoes devoicing when it surfaces before aspirated obstruents and voiceless fricatives (Hinnebusch 1975). In this language, /N/ of class 9/10 causes aspiration in stem-initial voiceless stops (16a-c) but not in voiceless fricatives (16d). The Pokomo data shows /N/ devoicing before aspirated stops (16a-c) and a voiceless fricative (16d) (Hinnebusch 1975):

(16) /N/ devoicing in Pokomo (Masalani and Lower)

a.	/N-peǿo/	→	[m̥p^{h}eǿo]	'wind'	(*N-pepo)
b.	/N-tahu/	→	[n̥t^{h}ahu]	'three'	(*N-tatu)
c.	/N-kuyu/	→	[ŋ̊k^{h}uyu]	'big'	(*N-kudu)
d.	/N-funda	→	[ɱ̊funda]	'cheek'	(*N-funda)

In (16), Pokomo /N/ of class 9/10 becomes devoiced when it surfaces before aspirated stops [p^h, t^h, k^h] and [f]. These data suggest that devoiced /N̥/ is preferred before voiceless aspirated stops or voiceless fricatives. This suggests that voiceless aspirated stops and voiceless fricatives share some phonological properties. This issue will be explained in chapter 5 where we discuss postnasal alternations. It will be argued that voiceless and aspirated nasals are different phonetic realizations of the same phonological segment.

Nasal devoicing is also attested in Nyamwezi. Nyamwezi has phonemic voiceless nasals represented as /mh, nh, ɲh, ŋh/ in Maganga and Schadeberg (192:15). In Nyamwezi, /N/ of class

9/10 is realized as a voiceless nasal before stem initial voiceless fricatives and affricates /f, s, ʃ, ʧ/, as in the examples in (17) (Maganga & Schadeberg 1992:17):[18]

(17) /N/ devoicing in Nyamwezi

a.	/N-fulá/	→	[ɱ̥fula]	<	-fulá	'good'
b.	/N-seßuú/	→	[n̥seßuú]	<	-seßuú	'hot'
c.	/N-ʃihú/	→	[ɲ̥ʃihú]	<	-ʃihú	'deep'
d.	/N-ʧißá/	→	[ɲ̥ʧißá]	<	-ʧißá	'block a hole'

In (17), /N/ devoicing in Nyamwezi is triggered by voiceless fricatives and affricates. However, when /N/ precedes voiceless stops such as /p, t, k/ the stops undergo postnasal aspiration to become [h], respectively, similar to Pokomo. In some languages, /N/ is said to undergo aspiration in particular contexts. This alternation is considered in the following subsection.

4.6 Nasal aspiration

The realization of /N/ as an aspirated nasal is noted in a number of languages including Nyamwezi (Maganga and Schadeberg 1992), Shona (Fortune 1955), and Rwanda (1979). In these languages, /N/ may be treated as an aspirated nasal when it surfaces as a breathy voiced nasal or is followed by an aspirated obstruent or glottal fricative. In Nyamwezi, Maganga and Schadeberg (1992) maintain that when /N/ occurs before voiceless consonants it surfaces either as a voiceless or aspirated nasal. This conclusion supports our proposal that devoiced and aspirated nasals are

[18] In Maganga and Schadeberg (1992), the symbols /mh, nh, ɲh, ŋh/ and [m̥, n̥, ɲ̥, ŋ̊] are used interchangeably to denote voiceless nasals in Nyamwezi.

two phonetic interpretations of the same phonological segment. The Nyamwezi data in (18) illustrate /N/ aspiration arising from postnasal debuccalization (Maganga & Schadeberg 1992:17):

(18) /N/ aspiration in Nyamwezi

a. /N-p̲aáŋá/ → [**mh**aáŋá] ‘9/10-healthy’

b. /N-t̲uubú/ → [**nh**uußú] ‘9/10-misery’

c. /N-k̲azú/ → [**ŋh**azú] ‘9/10-dry’

In (18), /N/ causes stem-initial voiceless stops /p, t, k/ to lose their [place] feature and become [h] (i.e. debuccalization), respectively. We follow Maganga and Schadeberg’s (1992) and treat the surface forms [mh, nh, ŋh] as aspirated nasals. The realization of /N/ as an aspirated nasal is also observed in languages such as Rwanda (Kimenyi 1979) and Shona (Fortune 1955). In these languages, /N/ influences stem-initial voiceless stops /p, t, k/ to surface as [h], similar to Nyamwezi. The data in (19) demonstrate /N/ aspiration in Rwanda (Kimenyi 1979:35) and Shona (Fortune 1955:83):

(19) /N/ aspiration in Rwanda and Shona

a. Shona: /N-pasa/ → [**mh**asa] ‘10-mat’

b. Shona: /N-tiʋi/ → [**nh**iʋi] ‘10-side’

c. Rwanda: /N-keeka/ → [**ŋ̥h**eeka] ‘guess me’

d. Rwanda: /N-toora/ → [**n̥h**oora] ‘vote for me, vote me’

e. Rwanda: /N-papuro/ → [i**m̥h**apuro] ‘9/10-paper’

In (19), stem-initial voiceless stops /p, t/ k/ are neutralized after /N/ to surface as the glottal fricative [h] in both Shona and Rwanda. The data on /N/ aspiration completes our description of changes that affect /N/. The range of data provided in the preceding sections show that /N/ is subject to a variety of alternations, namely nasal place assimilation, syllabicity alternation, effacement, devoicing, and aspiration. It also emerged that before vowel-initial stems /N/ always surfaces as a palatal [ɲ] or velar [ŋ] nasal. We will analyze these processes within EBD in §4.6.

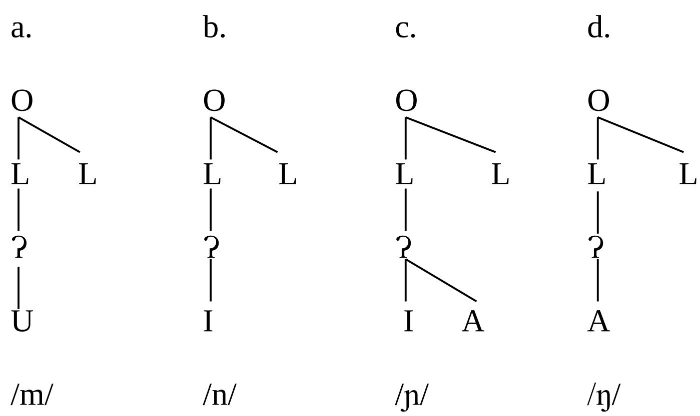
4.7 Analysis

In this section we address four questions that arise from the alternations that occur in /N/. (a) Why are palatal and velar nasals preferred before vowel-initial stems? (b) What makes some languages to retain /N/ in contexts where other languages allow /N/ effacement? (c) What is the motivation behind /N/ devoicing and aspiration and why are they not attested in other languages? (d) How can the various alternations of /N/ be formalized? The alternations that occur in /N/ will be formalized within Element-based Dependency (EBD) (e.g. Botma 2004). The analysis presented here will be organized around the preceding questions.

The realization of /N/ as a palatal [ɲ] or velar [ŋ] nasal before vowel-initial stems reveals the asymmetry among nasal stops /m, ɱ, n, ɲ, ŋ/. The labial [m, ɱ] and alveolar [n] nasals are disfavored before vowel-initial stems in the concerned languages. This asymmetry is grounded in the phonetics. Acoustic and articulatory properties of nasals indicate that palatal and velar nasals are more vocalicthan labial and alveolar nasals (e.g. Ohala and Ohala 1993). In their articulation, transitions of the dorsal nasals /ɲ, ŋ/ are relatively long and more glide-like than the shorter transitions of the labial /m, ɱ/ and apical /n/ nasals. These articulatory mechanisms translate into vocalic properties for dorsal nasals and strong consonantal properties for front nasals. Therefore, dorsal nasals are preferred before stem-initial vowels because they are more vowel-like than front nasals. So, front nasals are excluded from this context because of their strong consonantal properties. In this respect, the realization of /N/ as a dorsal nasal before vowel-initial stems manifests some sort of harmony.

In EBD, the asymmetry between dorsal and front nasals may be reflected at the level of place elements. This is appropriate because all nasals have the same manner structure in which the vocalic element |L| dominates the consonantal element |ʔ|. To show the realization of /N/ as a dorsal nasal before vowel-initial stems in the EBD framework, the placeless nasal is represented without a place element before the derivation but with palatal or velar place elements after the derivation. Although Botma (2004) proposes two nasals, inert and active, in this study we adopt only the latter because we find the structure of an inert nasal to be ambiguous as it does not refer to a contrastive phoneme. The diagrams in (20) show the structures of active nasals specified for bilabial, alveolar, palatal, and velar places. In (20), the sonorant manner element |L| is dominated by an onset while |L| in turn dominates the stop element |ʔ|. The dependent element |L| shows that the nasal is active, that is, is capable of causing voicing or nasalization when linked to the dependent position of the target segment.[19]

(20) Elemental structure of nasals

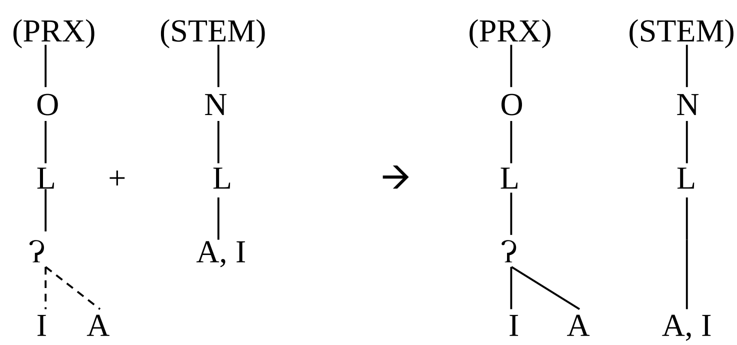


[19] In this study, we assume the nasal and other consonants are dominated by onset unless specified otherwise.

In (20), /m/ and /n/ are characterized by labial |U|and alveolar |I|place elements, respectively. The palatal nasal /ɲ/ consists of a complex place component, with head |I| and dependent |A| while the velar nasal is characterized by the place element |A|. The two dorsal nasals share the place element |A| which makes them attractive for vowel-initial stems. The representation that shows the alternation of /N/ to a dorsal nasal is given in (21). The EBD representations used here show the structures of segments before and after the alternations. The operations used to indicate alternations include linking, deletion/delinking, switching, and addition of elements (O = onset; N = nucleus):

(21) Realization of /N/ as a dorsal nasal

Swahili: /N-εupε/ → [**ɲ**-εupε] ‘9/10-white’



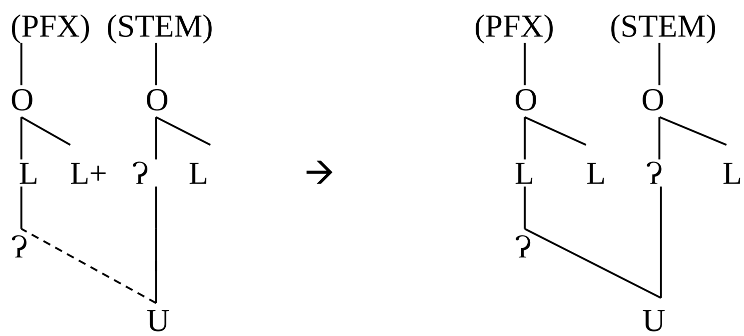
/N + ε/ → [ɲε]

In (21), the stem-initial vowel /ε/ is dominated by a nucleus position while /N/ is dominated by onset position. In both segments, the sonorant manner element |L| is dominated by a subsyllabic position. The place elements for the vowel /ε/ are |A, I|. When /N/ occurs before /ε/ it by default acquires the dorsal place elements |I, A| for consonants (shown by dotted lines before the derivation). The representation shows that after the derivation /N/ becomes a palatal [ɲ] nasal.

Nasal place assimilation of /N/ before stem-initial consonants can be formalized within the EBD framework. In EBD, nasal place assimilation is represented by linking the place element of the trigger consonant to the stop |ʔ| element of the nasal. This is so because between the two manner elements of nasal manner, that is, vocalic |L| and consonantal |ʔ|, it is the latter that determines the place specification of the nasal. This view is supported by the fact that nasal stops share place specifications with oral stops across languages. The diagrams in (22) show nasal place assimilation at labial (22a), alveolar (22b), palatal (22c), and velar (22d) places:

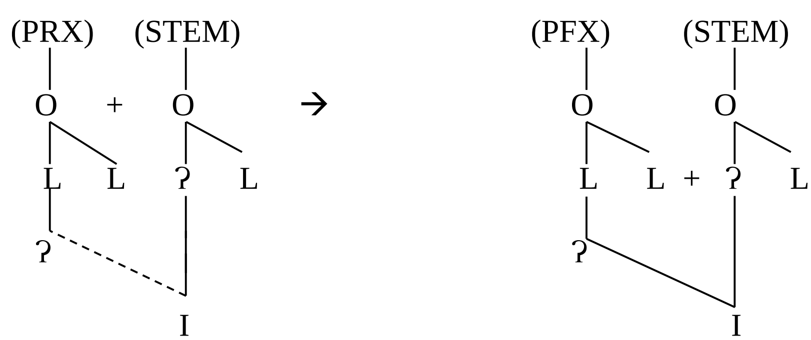
(22) Nasal place assimilation in EBD

a. Rwanda: /iN-bwa/ → [í**m**bwa] ‘dog’ (Kimenyi 1979:34)



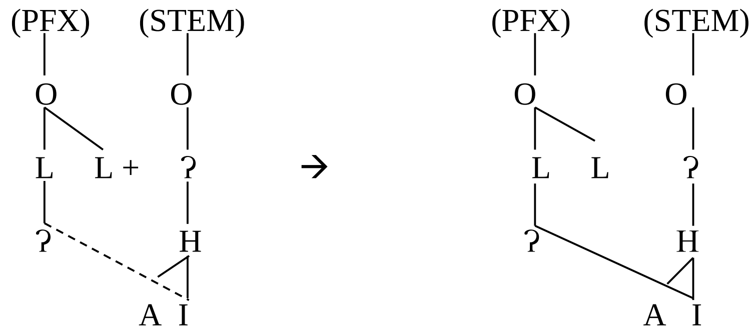
/N+b/ → [mb]

b. Rwanda: /iN-da/ → [i**n**da] ‘stomach, pregnancy’ (Kimenyi 1979:34)



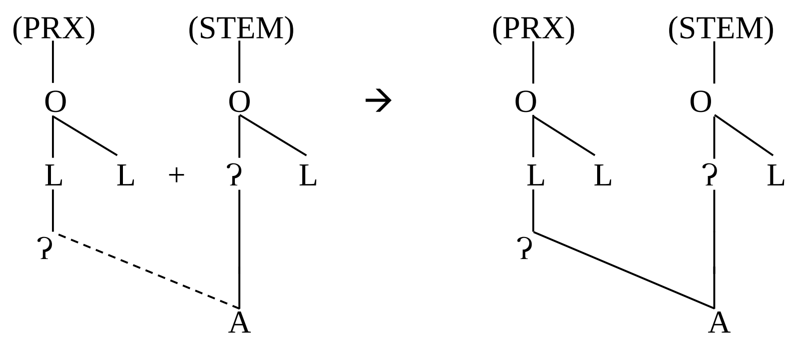
/N+d/ → [nd]

c. Swahili: /N-ʧi/ → [ɲ̩ʧi] ‘9/10-country’



/N+ʧ/ → [ɲʧ]

d. Swahili: /N-goma/ → [ŋgoma] ‘9/10-drum’



/N+g/ → [ŋg]

In (22a), nasal place assimilation is represented by linking the labial place element |U| of /b/ to the stop manner element |ʔ| of the nasal while in (22b), the alveolar place element |I| of /d/ is linked to |ʔ| of the nasal. In (22c-d), the alveo-palatal elements |A, I| and velar element |A| are linked to the manner element |ʔ| of the nasal to represent nasal place assimilation at these places.

The deletion of /N/ was observed before nasals and voiceless obstruents. /N/ deletion before nasals may be analyzed as nasal degemination. Studies on geminate sonorants show that these segments are disfavored across languages (Taylor 1985; Podesva 2002; Kahawara 2005). Geminate sonorants are marked segments because they are confusable with their corresponding singletons. This situation arises since it is more difficult to perceive the segmental length of sonorous segments. Besides, it is more demanding to articulate voiced geminate consonants. This is so because sustaining sonorant length requires that vocal cords be drawn close together for a longer duration in order to maintain voicing throughout the articulation period. This difficulty is eased in word-initial position where it is possible to break the geminate nasal into two prosodic parts, namely a syllabic first half and an onset second half (see Hayes 1989). This prosodic division explains why geminate nasals involving /N/ tend to appear initially but not medially.

The deletion of /N/ before voiceless obstruents also appears to be motivated by articulatory factors. /N/ effacement in this context gets rid of a sequence of a homorganic nasal followed by a voiceless obstruent especially in languages that disallow nasal devoicing. This sequence is taxing to articulate since it involves a gesture for voicing and another for voicelessness with concomitant occlusion at the same point of articulation. Thus, nasal deletion before voiceless obstruents circumvents articulatory difficulties. Alternative strategies may include nasal devoicing, postnasal debuccalization and aspiration, postnasal voicing, and nasalization; all these typological alternations are attested in Bantu. Nasal deletion may be formalized in EBD as in (23) where /N/ deletion occurs before /p/ (23a), /s/ (23b), and /ɲ/ (23c):

(23) EBD representation of /N/ deletion

a. Swahili: /N-paɲa/ → [p^{h}aɲa] '9/10-rat'

(PFX)			(STEM)		(STEM)	
O			O		O	
L	L	+	ʔ	→	ʔ	H
ʔ			U		U	

/N + p/ → [p^h]

b. Yao: /N-saadi-il-l-e/→ [saadiil-e] ‘told me’ (Ngunga 2000:61)

```
(PRX)          (STEM)            (STEM)
  |              |                  |
  O              O                  O
  |\             |                  |
  L   L   +      H        →         H
  |              |                  |
  ʔ              I                  I
```

/N + s/ → [s]

c. Yao: /N-ɲaku-il-l-e/ → [ɲakwiil-e] ‘lifted me’ (Ngunga 2000:60)

```
(PFX)          (STEM)                 (STEM)
  |              |                      |
  O              O                      O
  |\             |\                     |\
  L   L   +      L   L      →           L   L
  |              |                      |
  ʔ              ʔ                      ʔ
                 |\                     |\
                 I  A                   I  A
```

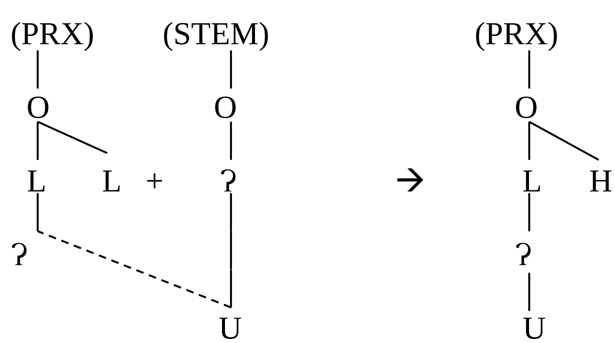
/N + ɲ/ → [ɲ]

In (23a), /N/ deletion is accompanied by the change of /p/ to [p^h], that is, aspiration. Aspiration is represented by the phonation element |H|, the same element that represents fricative manner (23b). In (23b), /N/ is deleted before /s/ which has |H| as the sole manner element. The representations in (23a-b) indicate that nasals disfavor |H| segments after them, be they characterized by manner or laryngeal properties. We propose that languages that allow nasal effacement in this context do not tolerate aspirated or devoiced nasals in their phonological systems. The facts in (23a-b) support the EBD idea of using the same elements for manner and laryngeal contrasts since |H| of fricative manner and |H| of laryngeal specification have the same effect on the nasal. In (23c), /N/ deletes before /ɲ/, implying that Yao disallows geminate nasals.

EBD treats laryngeal contrasts aspiration, breathy voice, and voicelessness as different phonetic interpretations of the same phonological segment represented by the phonation element |H|. The Bantu data we examined in the previous sections showed that /N/ undergoes both devoicing and aspiration. EBD treats the two alternations as variants the same phonological segment represented by the phonation element |H|. In the literature, voiceless nasals and other voiceless sonorants have been analyzed as aspirated (e.g. Anderson & Ewen 1987; Lombardi 1991). In traditional phonological theories, the feature [spread glottis] was used to characterize voiceless sonorants and voiceless stops (Halle & Stevens 1971; Lombardi 1991). EBD follows the same view by denoting aspiration, breathy voice, and voicelessness with a single phonation element |H|. In EBD, a laryngeal segment does not contrast with a corresponding laryngeal modification within a subsyllabic category such as an onset (in EBD, laryngeal elements contrast at the subsyllabic position, and are thus dominated by that position). This means that an aspirated nasal and a sequence of a nasal and a glottal fricative are not contrastive within a subsyllabic category. Therefore, the units [m^h, mh] are not contrastive and may be interpreted as a voiceless or aspirated or breathy bilabial nasal, and is formalized as a single segment as in (24):

(24) Nasal aspiration/devoicing

Shona: /N-pasa/ → [**mh**asa] '10-mat' (Fortune 1955:83)



/N + p/ → [m^h], [mh]

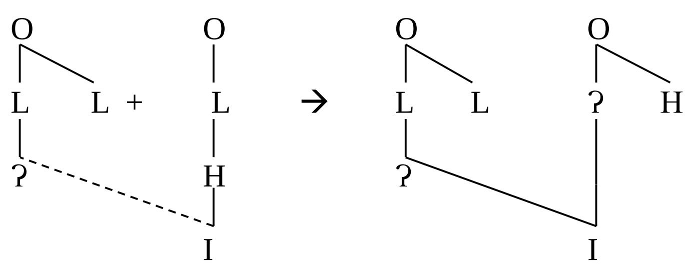
In (24), postnasal debuccalization of /p/ to a laryngeal fricative [h] gives rise to the aspirated bilabial nasal that may be transcribed as [m^h] or [mh]. Note that in EBD, this segment may be represented as a single aspirated nasal as in (24) or a nasal followed by a laryngeal fricative. Phonetically, this nasal may be interpreted as a voiceless or aspirated or breathy voiced, depending on the language. In (24), [m^h, mh] is represented by the dependent element |H| of nasal manner. This is achieved by substituting dependent |L| of nasal manner with |H|.

The realization of /N/ as a syllabic nasal is not consistent; it surfaces syllabic in monosyllabic stems and when it occurs in a geminate nasal. Elsewhere, it is non-syllabic. In EBD, syllabicity alternation of /N/ may be represented by varying the subsyllabic category that dominates nasal manner. In EBD, the structure of nasal manner consists of a vocalic element |L| dominated by a subsyllabic category and a consonantal element |ʔ| dominated by the vocalic element |L|. When /N/ surfaces non-syllabic, this means that its sonorant element |L| is dominated by the onset (O) (25a) but when it surfaces syllabic its sonorant element |L| is dominated by the nucleus (N) (25b):

(25) Syllabicity alternation of /N/

a. Non-syllabic /N/

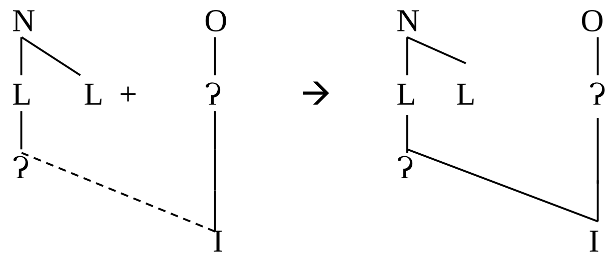
Tswana: /N-rata/ →[nt^hata] ‘love me’ (Cole 1955:41)



/N + r/ → [nt^h]

b. Syllabic /N/

Tswana: /N-twa/ → [n̩twa] ‘war’ (Cole 1955:41)



/N + t/ → [n̩t]

In (25a-b), the realization of /N/ as an alveolar nasal [n] is represented by linking the place element |I| to the stop manner element |ʔ| of the nasal. In (25a), /N/ is dominated by an onset, meaning that it is non-syllabic. Aspiration of the postnasal alveolar stop is represented by the dependent element |H|. In (25b), /N/ is dominated by a nucleus, interpreted that it is syllabic.

4.8 Summary

In this chapter, we set out to describe and formalize alternations that occur in /N/ when it interacts with stem-initial segments. The changes observed in /N/ when it interacts with stem-initial segments include nasal place assimilation, aspiration, devoicing, effacement, and syllabicity alternation. Besides, when /N/ is placed before vowel-initial stems it surfaces as a dorsal nasal (i.e. [ɲ, ŋ]). These changes raised a number of questions: (a) why does /N/ assimilate to the place of articulation of the stem-initial segment? (b) Why does /N/ become a dorsal nasal before vowel-initial stems? (c) Why do some languages allow nasal devoicing, aspiration and effacement in some contexts while others do not? (d) What are the implications of syllabicity alternations of /N/?

(d) How can the changes of /N/ be formalized in phonological theory? We did not raise answers to all the questions, but the EBD approach revealed that some of the changes that occur in /N/ are expected in nasals generally but crosslinguistic variations abound. As stops, nasals are expected to share place features with oral stops, that is, be articulated at labial, alveolar, palatal, and velar places. Since nasals consist of vocalic and consonantal properties, they may function as onset or syllable nucleus, hence the syllabicity alternations of /N/. Owing to their vowel-like phonetic features that derive from their dorsal place feature, palatal and velar nasals are preferred before vowel-initial stems in Bantu. Nasal devoicing and nasal aspiration are different phonetic implementations of the same phonological segment represented in EBD by the phonation element |H|. The (non-)occurrence of nasal effacement, devoicing, and aspiration depend on the language. The next chapter explores postnasal alternations associated with /N/.

CHAPTER 5

5. POSTNASAL ALTERNATIONS

5.1 Introduction

In this chapter we examine the influence /N/ exerts on stem-initial consonants, and the postnasal patterns that emerge from this influence. The realization of /N/ in consonant-initial stems yields a wide range of postnasal alternations. The postnasal processes induced by /N/ tend to vary within and across languages. Yet, in some languages /N/ does not affect certain stem-initial consonants. This chapter investigates the range of postnasal patterns associated with /N/. The main goal of the chapter is to assemble postnasal alternations triggered by /N/ and account for them within Element-based Dependency (EBD) (Botma 2004). Since manner is an essential property of segments, this chapter is organized around manner types as follows: nasal-stop interaction (§5.1), nasal-affricate interaction (5.2), nasal-fricative interaction (§5.3), and nasal-sonorant interaction (§5.4). The analysis and discussion appears in §5.5 and the summary §5.6.

5.2 Nasal-stop interaction

There are at least five kinds of stops observed in Bantu languages, namely voiced, voiceless, aspirated, implosive, and ejective stops. The interaction between /N/ and stem-initial stops shows that some stops undergo change when preceded by /N/ while others do not. We will examine the interaction between /N/ and each of the stop types, starting with voiceless stops. When /N/ occurs before voiceless stops the latter may surface unchanged or undergo a variety of alternations. The most common of such alternations are nasal substitution, voicing, and aspiration. Bantu languages in which voiceless stops remain unchanged after /N/ include Gusii (Cammenga 2002; Nash 2011), Lamba (Doke 1922), Lungu (Bickmore 2007), Ganda (Ashton at al. 1954), and

Tswana (Cole 1955). In Lamba, the voiceless stops /p, t, c, k/ surface unaltered when preceded by /N/, as illustratedin (1). In (1), 1SG /N/ in Lamba, as in other Bantu languages, assimilates to the place of articulation of the stem-initial stop (Doke 1922):

(1) Unchanged postnasal voiceless stops in Lamba

f.	/N-pape/	→	[m**p**ape]	'let me carry a pick'
g.	/N-tinte/	→	[n**t**inte]	'let me tug'
h.	/N-cite/	→	[ɲ**c**ite]	'let me do'
i.	/N-kake/	→	[ŋ**k**ake]	'bind me'

The examples in (1) demonstrate that the realization of Lamba /N/ does not affect in any way stem-initial voiceless stops /p/ (1a), /t/ (1b), /c/ (1c) and /k/ (1d).

However, in a number of languages, /N/ triggers postnasal voicing in stem-initial voiceless stops. This process is attested in languages such as Kikuyu (Barlaw 1951), Konde (Meinhof 1932), and Yao (Ngunga 2000). The data in (2) illustrate postnasal stop voicing in the aforementioned languages in which /k/ surfaces as [g] (2a, f), /t/ as [d] (2b, e), and /p/ as [b] (2d):

(2) Postnasal stop voicing in Konde, Kikuyu, and Yao

a.	Konde:	/iN-kuku/	→	[iŋ**g**uku]	'9-fowl'
b.	Kikuyu:	/N-tem-e/	→	[n**d**eme]	'Am I to cut?'
c.	Kikuyu:	/N-ken-e/	→	[ŋ**g**ene]	'Am I to rejoice?'
d.	Yao:	/ju-N-pat-il-e/	→	[juum**b**atile]	's/he got me'
e.	Yao:	/ju-N-tiis-il-e/	→	[juun**d**iisile]	's/he ran away from me'
f.	Yao:	/ju-N-kam-il-e/	→	[juuŋ**g**amile]	's/he milked me'

In addition to voicing, voiceless stops may undergo postnasal aspiration after /N/. This alternation is observed in some languages including Shona (Fortune 1955), Pokomo (Hinnebusch

1975), Rwanda (Kimenyi 1979), and Nyamwezi (Maganga & Schadeberg 1992). The examples in (3) demonstrate postnasal aspiration of voiceless stops in Shona (Fortune 1955) and Nyamwezi (Maganga & Schadeberg 1992). In (3), stem-initial voiceless stops /p, t, k/ are subject to postnasal debuccalization (or aspiration) to surface as a glottal fricative [h] in Shona (3a-c) and Nyamwezi (3d-e). In (3c) the nasal undergoes effacement before /k/, but /k/ surfaces as [h]:

(3) Postnasal aspiration of voiceless stops in Shona and Nyamwezi

a.	Shona:	/N-p̲asa/	→	[m**h**asa]	'10-mat'
b.	Shona:	/N-t̲iʋi/	→	[n**h**iʋi]	'10-side'
c.	Shona:	/N-k̲uni/	→	[**h**uni]	'10-log'
d.	Nyamwezi:	/N-p̲aáŋá/	→	[m**h**aáŋá]	'10-healthy'
e.	Nyamwezi:	/N-t̲uußú/	→	[n**h**uußú]	'10-misery'

In some Bantu languages, for example, Hehe (Odden & Odden 1985) and Luyana (Gívón 1970b), /N/ substitutes stem-initial voiceless stops but retains their place specifications. This alternation is known as "nasal substitution" in the literature.[20] The effect of nasal substitution in these languages is that an NÇ̥ input in which Ç̥ is a voiceless stop is realized as a short homorganic nasal. The data in (4) show nasal substitution in Hehe (4a-b) (Odden & Odden 1985) and Luyana (4c-e) (Gívón 1970b). The target stops in Hehe are /t/ (4a) and /k/ (4b) and in Luyana the target stops are /p/ (4c), /t/ (4d), and /k/ (4e):

[20] Nasal substitution refers to the replacement of a root-initial voiceless obstruent by a homorganic nasal (Pater 1996). Similar to Austronesian languages (Halle & Clements 1983:125; Pater 1996), nasal substitution in Bantu languages appears to target voiceless stops.

(4) Nasal substitution in Hehe and Luyana

a. Hehe: /N-<u>t</u>eefu/ → [**n**eefu] ‘red mats’

b. Hehe: /N-<u>k</u>aanzi/ → [**ŋ**aanzi] ‘walls’

c. Luyana: /N-<u>p</u>oko/ → [**m**oko] ‘arm, knife’

d. Luyana: /N-<u>t</u>abi/ → [**n**abi] ‘prince’

e. Luyana: /N-<u>k</u>uku/ → [**ŋ**uku] ‘chicken’

In (4), [n] replaces /t/ (4a, d), [ŋ] replaces /k/ (4b, e), and [m] replaces /p/ (4c).

The interaction between /N/ and stem-initial voiced stops also leads to different postnasal patterns. The voiced stop may remain unaltered or undergo two alternations, namely devoicing and nasalization. Languages in which voiced stops surface unaltered after /N/ include Shona (Fortune 1955), Swahili (Meinhof 1932), Rwanda (Kimenyi 1979), Lungu (Bickmore 2007), Gusii (Cammenga 2002; Nash 2011), and Ganda (Ashton et al. 1954). In (5), stem-initial voiced stops /b, d, g/ surface unaltered in Shona (5a-b), Ganda (5c-d), and Rwanda (5e-f):

(5) Unaffected postnasal voiced stops in Shona, Ganda and Rwanda

a. Shona: /N-<u>b</u>anje/ → [m**b**anje] ‘wild’

b. Shona: /N-<u>d</u>arama/ → [n**d**arama] ‘gold’

c. Ganda: /N-<u>g</u>aba/ → [ŋ**g**aba] ‘I divide’

d. Ganda: /N-<u>d</u>uuma/ → [n**d**uuma] ‘I command’

e. Rwanda: /i-N-<u>b</u>wá / → [ím**b**wa] ‘dog’

f. Rwanda: /i-N-<u>g</u>we/ → [iŋ**g**we] ‘leopard’

In some languages, /N/ may cause postnasal devoicing, a process common in the Sotho-Tswana subgroup of Bantu that includes Tswana, Kgalagari, and Sotho. In (6), Tswana stem-initial voiced stop /b/ becomes [p] (6a-b) (Cole 1955:41) while Kgalagari stem-initial voiced stops /b, d, g, ɟ/ surface as [p, t, k, c] (6c-f) when preceded by /N/ (Solé et al. 2009:303):

(6) Postnasal stop devoicing in Tswana and Kgalagari

a.	Tswana:	/N-b̲ôna/	→	[m**p**óna]	'see me'
b.	Tswana:	/iN-b̲ôna/	→	[goi**p**óna]	'to see oneself'
c.	Kgalagari:	/χʊ-N-b̲ón-á/	→	[χʊm**p**óná]	'to see me'
d.	Kgalagari:	/χʊ-N-d̲uʒ-a/	→	[χʊn**t**uʒa]	'to anoint me'
e.	Kgalagari:	/χʊ-N-g̲át-a/	→	[χʊŋ**k**ata]	'to like me'
f.	Kgalagari:	/χʊ-N-ɟ̲ís-a/	→	[χʊɲ**c**ísa]	'to feed me'

In both Tswana and Kgalagari, plosives and affricates are contrastive at three laryngeal specifications, that is, voiceless aspirated, voiceless unaspirated, and voiced. Thus, postnasal devoicing in these languages neutralizes laryngeal specification postnasally in addition to producing a segment type attested in their phonemic inventories. Note that postnasal devoicing in these languages also affects other segment types such as liquids and fricatives but devoicing in approximants is always accompanied by postnasal hardening.

Postnasal nasalization is observed in some languages especially in the context of Meinhof's Law (ML). We saw in chapter 3 that in ML, generally /N/ conditions nasalization in stem-initial voiced consonants if the onset of the second syllable is an NÇ̬ or plain nasal. Nasalization of stem-initial voiced consonants ensures that no oral consonant intervenes between /N/ and the stem-internal nasal or NÇ̬. The nasalization of voiced stops due to ML is observed in languages such as Ganda (Ashton et al. 1954), Kikuyu (Barlaw 1951), Nyamwezi (Maganga & Schadeberg 1992), Lamba (Cole 1922), and Bemba (Kula 2000). However, nasalization in stem-initial voiced stops is not limited to ML languages only. In languages such as Yao (Ngunga 2000), the nasalization of voiced consonants mayoccur in the absence of ML. The data in (7) illustrate nasalization of voiced stops after /N/ whereby in (7a-d) nasalization of voiced stops is conditioned by ML in Ganda (7a-b) (Ashton et al. 1954) and Nyamwezi (7c-d) (Maganga & Schadeberg 1992). In (7e-f), Yao nasalization of voiced stops is not due to ML (Ngunga 2000):

(7) Postnasal nasalization of voiced stops

a.	Ganda:	/N-<u>g</u>e:nd-a/	→	[ŋ**ŋ**e:nda]	‘I go
b.	Ganda:	/N-<u>b</u>u:mb-a/	→	[m**m**u:mba]	‘I mould’
c.	Nyamwezi:	/N-<u>g</u>oma/	→	[**ŋ**oma]	‘10-drum’
d.	Nyamwezi:	/N-<u>g</u>eendo/	→	[**ŋ**eendo]	‘10-travels’
e.	Yao:	/ju-N-<u>b</u>edud-i-il-l-e/	→	[juu**m**edudiile]	‘s/he broke off for me’
f.	Yao:	/ju-N-<u>g</u>av-il-e/	→	[juu**ŋ**avile]	‘s/he cut me’

Ganda stem-initial voiced stops /g, b/ become [ŋ, m] (7a-b) and Nyamwezi /g/ becomes [ŋ] (7c-d) after 1SG /N/ in the context of ML. In Ganda, nasalization produces geminate nasals [ŋŋ] (7a) and [mm] (7b), but in Nyamwezi, nasalization results in a short nasal [ŋ] (7c-d). In Yao nasalization, stem-initial voiced stops /b, g/ are replaced with homorganic nasals [m, ŋ] (7fe-f).

Aspirated stops are also influenced by /N/ as is evident in at least two alternations, namely postnasal voicing and deaspiration. Languages that allow postnasal voicing of aspirated stops include Tswana (Cole 1955) and Konde (Meinhof 1932). In these languages, postnasal voicing affects all kinds of obstruents. The examples in (8) demonstrate postnasal voicing of aspirated stops in Konde. In (8), Konde /N/ occurs as the prefix for 9/10 (8a-b) and 1SG (8c-e) (the augment /i/ occurs in (8a-b) (adapted from Meinhof 1932:136):

(8) Postnasal voicing of aspirated stops in Konde

a.	/iN-$\underline{t}^h$eko/	→	[in**d**eko]	‘9-pot’
b.	/i-N-$\underline{p}^h$imba/	→	[im**b**imba]	‘9/10-short’
c.	/N-$\underline{p}^h$on-il-e/	→	[m**b**onile]	‘I have gotten well’
d.	/N-$\underline{t}^h$um-il-e/	→	[n**d**umile]	‘I have sent’
e.	/N-$\underline{k}^h$am-il-e/	→	[ŋ**g**amile]	‘I have milked’

In (8), stem-initial aspirated stops /t^h, p^h, k^h/ undergo postnasal deaspiration and voicing after /N/ to become voiced stops [d, b, g], respectively. Konde postnasal voicing of aspirated stops thus neutralizes the aspirated/voiced contrast postnasally.

Aspirated stops may be subject to deaspiration before /N/ in some languages. Languages that allow postnasal deaspiration include Zulu and Xhosa. In both languages, plosives and affricates have a three-way contrast in laryngeal features, namely voiceless aspirated, ejective, and voiced. In these languages, when /N/ occurs before voiceless aspirated stops /p^h, t^h, k^h/ they undergo deaspiration and surface as ejective stops [p’, t’, k’]. The data in (9) shows postnasal deaspiration in Zulu (Doke 1926:66-71) and Xhosa (Podile 2002:105). The examples in (9) contain /N/ of class 9/10 (the augment /i/ occurs before /N/):

(9) Postnasal deaspiration after /N/ in Zulu and Xhosa

a.	Zulu:	/izi-N-$\underline{t}^h$i/	→	[ízin**t’**i]	‘10-stick’
b.	Zulu:	/ìzi-N-$\underline{p}^h$á:p^{h}ɛ/	→	[ìzim**p’**á:p^{h}ɛ]	‘10-feather’
c.	Zulu:	/ì-N-$\underline{k}^h$at^{h}á:zɔ/	→	[ìŋ**k’**at’á:zɔ]	‘9-trouble’
d.	Xhosa:	/iN-$\underline{t}^h$et^{h}o/	→	[in**t’**et^{h}o]	‘9-speech’
e.	Xhosa:	/iN-$\underline{p}^h$azamo/	→	[im**p’**azamo]	‘9-mistake’
f.	Xhosa:	/iN-$\underline{k}^h$ut^{h}alo/	→	[iŋ**k’**ut^{h}alo]	‘9-diligence’

In languages that have implosive stops in their inventories, the interaction between /N/ and implosive stops results in de-implosion that produces plosive stops. The most common implosive stops in Bantu languages are bilabial /ɓ/ and alveolar /ɗ/. Implosive stops are attested in some languages such as Zulu, Ndebele, Shona, and Xhosa. When preceded by /N/ implosive stops /ɓ, ɗ / undergo de-implosion and surface as plosive stops [b, d], but in Xhosa de-implosion produces breathy voiced stops. The data in (10) show postnasal de-implosion induced by /N/ of class 9/10 /N/ in Zulu (Doke 1926:66), Shona (Fortune 1955), and Xhosa Podile 2002:109):

(10) Postnasal de-implosion after /N/ in Zulu, Xhosa, and Shona

a.	Zulu:	/iN-ɓ̲ú:zi /	→	[im**b**ú:zi]	‘9-goat’
b.	Zulu:	/ezi-N-ɓ̲í:li/	→	[èzim**b**í:li]	‘9-two’
c.	Xhosa:	/iN-ɓ̲eko/	→	[im**b̤**eko]	‘9-reverence’
d.	Xhosa:	/iN-ɓ̲ali/	→	[im**b̤**ali]	‘9-story, history’
e.	Shona:	/N-ɓ̲erek/	→	[m**b**ereko]	‘9-cradle skin’
f.	Shona:	/N-ɗ̲iki/	→	[n**d**iki]	‘9-small’

In (10), the Zulu implosive stop /ɓ/ becomes a plosive stop [b](10a-b), parallel to Shona /ɓ/ that changes to [b] after /N/ (10e). The Shona alveolar implosive /ɗ/ becomes a plosive stop [d] after /N/ (10f) while in Xhosa the bilabial implosive stop /ɓ/ changes to a breathy voiced stop [b̤] after /N/ (10c-d). The data in (10) shows that the implosive/plosive contrast in Zulu, Xhosa, and Shona is neutralized postnasally where only the plosive allophones are allowed.

Ejective stops seem to surface unaffected by /N/ in languages where they occur, for example, Zulu (Doke 1926) and Tswana (Cole 1955). In both Zulu and Tswana, stem-initial ejective stops remain unchanged when preceded by /N/. The Zulu examples in (11) indicate that

/N/ has no effect on ejective stops. In (11), Zulu ejective stops /p’, t’, k’/ surface unaltered after /N/ of class 9/10 /N/ (Adapted from Doke 1926):

(11) Unaffected ejective stops after /N/ in Zulu

a.	/i-N-p’ɔ̀t’emp’ɔ:t’ɛ/	→	[im**p’**ɔ̀t’emp’ɔ:t’ɛ]	‘9-mashy food’
b.	/izi-N-p’á:ɬa/	→	[izim**p’**á:ɬa]	‘10-good’
c.	/i-zi-N-t’unú:nu/	→	[izin**t’**unú:nu]	‘10-person with large buttocks’
d.	/izi-N-k’ɔ̀bɔ/	→	[iziŋ**k’**ɔ̀bɔ]	‘10-wristlet wire’

In Table 1 below we summarize the influence /N/ exerts on stem-initial stops:

Table 7: Summary of the effect of /N/ on stem-initial stops

Stop type	**Postnasal alternations**
Voiced stops	unaffected, devoicing, nasalization
Voiceless stops	unaffected, voicing, aspiration, nasal substitution
Aspirated stops	voicing, deaspiration
Implosive stops	de-implosion/plosivization
Ejective stops	Unaffected

The observed facts about the effect of /N/ on stem-initial stops raise a number of questions. (a) What determines the crosslinguistic variations in the processes triggered when /N/ interacts with a given type of stop? (b) Why are some stops unaffected by /N/? (c) What enables /N/ to induce a large number of postnasal alternations in stops? These questions will be addressed in §5.5. In the next section we examine the influence /N/ has on stem-initial affricates.

5.3 Nasal-affricate interaction

The interaction between /N/ and stem-initial affricates yields few postnasal changes. In a number of languages, affricates remain unaltered when preceded by /N/. However, postnasal deaffrication in voiceless affricates is observed in Rwanda (Kimenyi 1979). Bantu languages whose affricates surface unaffected after /N/ include Lungu (Bickmore 2007), Zulu (Doke 1926), Shona (Fortune 1955), and Swahili (Meinhof 1932). The data in (12) show that in Shona both voiced and voiceless affricates surface unaltered after /N/ of class 9/10. Note that in Shona /N/ undergoes effacement before affricates. In (12), Shona stem-initial affricates that surface unaffected include /pf/ (12a), /ts/ (12b), /tʂ/ (12c), /bv/ (12d), and /dz/ (12e) (Fortune 1955):

(12) Unaltered stem-initial affricates in Shona

a.	/N-pfuta /	→	[pfuta]	‘9/10-castor-oil’
b.	/N-tsara/	→	[tsara]	‘9/10-row’
c.	/N-tʂuku/	→	[tʂuku]	‘9/1010-red’
d.	/N-bvumirano/	→	[bvumirano]	‘9/10-agreement’
e.	/N-dziʋiso/	→	[dziʋiso]	‘9/10-obstacle’

In Rwanda, /N/ conditions stem-initial affricates to undergo deaffrication and surface as fricatives (Kimenyi 1979). Rwanda has three underlying voiceless affricates /pf, ts, tš/ that become fricatives [f, s, š] when preceded by /N/. The data in (13) illustrate Rwanda postnasal deaffrication of /pf/ (13a), /ts/ (13b-c), and /tš/ (13d) to fricatives [f, s, š] (Adapted from Kimenyi 1979):

(13) Postnasal deaffrication in Rwanda

a.	/iN-<u>pf</u>úra/	→	[íɱ**f**ura]	‘noble’
b.	/iN-<u>ts</u>ina/	→	[íɲ**s**ina]	‘banana tree’
c.	/iN-<u>ts</u>iβika/	→	[iɲ**s**iβika]	‘time’

d. /iN-t̲š̲uro/ → [iɲšuro] 'wild dog'

The table below gives a summary of the effect /N/ has on stem-initial affricates:

Table 8: Summary of the effect of /N/ on stem-initial affricates

Affricative type	**Postnasal alternation**
Voiced affricates	Unaffected
Voiceless affricates	unaffected, deaffrication

The interaction between /N/ and stem-initial affricates raise two main questions: (a) why are voiced affricates not subject to deaffrication parallel to voiceless affricates? (b) How do we interpret the failure of /N/ to alter both voiced and voiceless affricates in some languages? The analysis presented in §5.5 will address these issues.The interaction between /N/ and stem-initial fricatives is considered in the following section.

5.4 Nasal-fricative interaction

The influence /N/ exerts on stem-initial fricatives is manifested in different postnasal patterns. In some languages, /N/ deletes before fricatives, leaving the fricatives unchanged. In other languages both the nasal and fricative may be retained, and yet the fricative surfaces unchanged. However, in a number of languages, /N/ may cause various changes in stem-initial fricatives. The most frequent of such changes include hardening, affrication, and nasalization. The hardening of fricatives after /N/ is sometimes accompanied by aspiration, devoicing, or voicing. Thus, /N/ affects both the manner and phonation of stem-initial fricatives. The examples in (14) show stem-initial fricatives that surface unaltered after /N/ in Kikuyu (Barlaw 1951:7), Lamba (Doke 1922), Shona (Fortune 1955), Ganda (Ashton et al. 1954), and Yao (Ngunga 2000:61):

(14) Unaltered postnasal fricatives

a.	Kikuyu:	/N-hūre/	→	[**h**ūre]	‘Am I to beat?’
b.	Lamba:	/N-sumine/	→	[ɲ**s**umine]	‘let me agree’
c.	Shona:	/eN-funda/	→	[eɱ**f**unda]	‘narrow’
d.	Shona:	/N-vuto/	→	[ɱ**v**uto]	‘bellows’
e.	Ganda:	/eN-zito/	→	[en**z**ito]	‘heavy’
f.	Yao:	/ju-N-saadi-il-le/	→	[juu**s**aadiile]	‘s/he told me’

In (14), both voiced /v, z/ and voiceless /h, s, f/ fricatives surface unaffected after /N/. This situation obtains whether or not the nasal is realized. In (14a), Kikuyu /N/ is deleted before /h/, leaving the glottal fricative to surface unaffected. In (14b-e), both the nasal and the fricative are realized but the stem-initial fricatives /s, f, v, z/ remain unchanged. In (14f), /s/ surfaces unaltered in Yao, a language that allows postnasal voicing.

In some languages, stem-initial fricatives become affricates when preceded by /N/. Some of the languages that allow postnasal affrication are Kongo (Meinhof 1932; Hyman 2003), Zulu (Doke 1926), Tswana (Cole 1955), and Shona (Fortune 1955). In Zulu, /N/ causes affrication in voiced and voiceless fricatives, as in (15) (the data involves class 9/10 /N/ (Doke 1926:69-70):

(15) Postnasal affrication in Zulu

a.	/izi-N-f̲udu/	→	[izim**ȹf’**ú:du]	‘10-tortoise’
b.	/izi-N-v̲ɛɱȸvá:nɛ/	→	[iziɱ**ȸv**ɛɱȸvá:nɛ]	‘10-butterfly’
c.	/izi-N-s̲izi/	→	[izin**ts’**:izi]	‘10-sorrow’
d.	/izi-N-z̲ime/	→	[isin**dz**í:me]	‘10-walking staff’
e.	/iz-N-ɬ̲ɔ́:ɓɔ/	→	[izin**tɬ’**ɔ́:ɓɔ]	‘10-species’

The data in (15) show that /f/ undergoes affrication to become [φf’] (15a), /v/ to [ȸv] (15b), /s/ to [ts’] (15c), /z/ to [dz] (15d), and /ɬ/ to [tɬ’] (15e). The derived voiceless affricates in Zulu surface as ejectives since ejection is one of three laryngeal contrasts made in Zulu.

Postnasal affrication in Bantu languages is also attested in Tswana where the derived voiceless affricates become aspirated. Postnasal affrication in Tswana changes voiceless fricatives /s, š/to aspirated affricates [ts^h, tš^h]. In (16), Tswana stem-initial voiceless fricatives /s/ (16a, c) and /š/ (16b, d) become affricates after class 9/10 and 1SG object /N/ (Cole 1955:40-41):

(16) Postnasal affrication and aspiration in Tswana

a.	/N-s̲êbo/	→	[**ts**$^{\mathbf{h}}$êbô]	‘9-scandal’
b.	/N-š̲^{h}otlô/	→	[**tš**$^{\mathbf{h}}$otlô]	‘9-derision’
c.	/N-s̲ega/	→	[**nts**$^{\mathbf{h}}$ega]	‘cut me’
d.	/N-š̲apa/	→	[**ntš**$^{\mathbf{h}}$apa]	‘thrash me’

In Tswana, class 9/10 /N/ is omitted in polysyllabic stems (16a-b) but 1SG /N/ is retainedregardless of the size of the stem (16c-d). In (16), affrication occurs whether or not /N/ surfaces.

Stem-initial fricatives may be subject to postnasal hardening after /N/ to become plosives. Postnasal hardening affects both voiced and voiceless fricatives. However, voiced fricatives tend to undergo postnasal hardening more frequently than voiceless fricatives. Postnasal hardening of fricatives is observed in many languages including Gusii (Cammenga 2002; Nash 2011), Shona (Fortune 1955), Kikuyu (Barlaw 1951), Rwanda (Kimenyi 1979), and Ganda (Ashton et al. 1954). The data in (17) show hardening of fricatives after /N/ in four different languages:

(17) Postnasal fricative hardening

a.	Gusii:	/N-ßook-e/	→	[m**b**ooke]	‘I get up’
b.	Gusii:	/N-ɣɔn-ɛ/	→	[ŋ**g**ɔnɛ]	‘I snore’
c.	Tswana:	/ko-iN-fitl^{h}a/	→	[goi**p^{h}**itl^{h}a]	‘to hide oneself
d.	Tswana:	/N-humô/	→	[**k^{h}**umô]	‘10-wealth
e.	Rwanda:	/i-N-ßoga/	→	[im**b**óga]	‘10-vegetable’
f.	Shona:	/N-ßoni/	→	[m**b**oni]	‘9/10-pupil of eye’

In (17), the postnasal bilabial fricative /ß/ becomes [b] in Gusii (17a), Rwanda (17e), and Shona (17f). Gusii /ɣ/ is also realized as a plosive [g] after /N/ (17b). In Tswana, the voiceless fricative /f/ is subject to postnasal hardening with concomitant aspiration to surface as an aspirated plosive [p^{h}] (17c) while the voiceless glottal fricative /h/ becomes an aspirated velar plosive [k^{h}] (17d).

Voiced fricatives in Bantu languages may undergo postnasal nasalization after /N/. Postnasal nasalization is a common phonological process in Bantu languages, and is observed in a number of languages including Lamba (Doke 1922), Ganda (Ashton et al. 1954), Kikuyu (Barlaw 1951), Nyamwezi (Maganga & Schadeberg 1992), Bemba (Kula 2000), and Yao (Ngunga 2000). In these languages, nasalization targets voiced consonants. The examples in (18) demonstrate nasalization of voiced fricatives after /N/. In Yao, /v/ surfaces as [m] (18a), Bemba /ß/ as [m] (18b), Kikuyu /ɣ/ as [ŋ] (18c), and Ganda /ß/ as [m] (18d). Although we demonstrated that nasal substitution affects voiced stops, it is important to show that other segments types undergo this process as we search for what determines alternations in different segments:

(18) Postnasal nasalization of voiced fricatives after /N/

a.	Yao:	/ju-N-v̲ak-i-il-l-e/	→	[juu**m**aciile]	‘s/he built for me’
b.	Kikuyu:	/N-ɣ̲an-eet-ɛ/	→	[**ŋ**aneetɛ]	‘I had recounted’
c.	Bemba:	/N-ß̲ó:mbel-e/	→	[m**m**ó:mbele]	‘I have worked’
d.	Ganda:	/N-ß̲omba/	→	[m**m**omba]	‘I escape’

The nasalization of voiced fricatives in (18) produces short and geminate nasals from NC̬ inputs. In Yao (18a) and Kikuyu (18b) postnasal nasalization results in short homorganic nasals that substitute voiced fricatives /v, ɣ/, respectively. In Bemba (18c) and Ganda (18d) postnasal nasalization of voiced fricatives creates a geminate nasal [mm], respectively.

Postnasal voicing of stem-initial fricatives induced by N/ is observed in Bantu, for instance, in Kikuyu (Barlaw 1951) where the sibilant /ʃ/ changes to [j] after /N/, as in /N-**ʃ**in-e/ → [n**j**ine] ‘Am I to burn (it)?’ (Barlaw1951:7). The changes that /N/ causes in fricatives are summarized in Table 9:

Table 9: Summary of the effect of /N/ on stem-initial fricatives

Fricative type	**Postnasal alternation**
Voiced fricatives	unaffected, affrication, hardening, nasalization
Voiceless fricatives	unaffected, affrication, voicing

Table 9 shows that both voiced and voiceless fricatives may surface unaffected postnasally. In addition, both voiced and voiceless fricatives are subject to postnasal affrication and hardening. However, only voiced fricatives undergo postnasal nasalization. Postnasal fricative voicing is also attested. These facts raise some questions: (a) what is the interpretation of the deaffrication of both voiced and voiceless fricatives? (b) Why are voiced and voiceless fricatives unaffected by

/N/ in some languages? (c) Why do we have postnasal voicing in fricatives and not devoicing? (d) Why do postnasal hardening and nasalization affect voiced fricatives and not voiceless ones? We will attempt to answer these questions in §5.5. In the next section we examine the interaction between /N/ and stem-initial sonorants.

5.5 Nasal-sonorant interaction

This section considers the interaction between /N/ and stem-initial sonorants. The sonorants to be examined include liquids, glides, and nasals. The effect /N/ has on each of these segments will be investigated in turn, starting with stem-initial liquids. The interaction between /N/ and stem-initial glides results in postnasal hardening, nasalization, and deletion. Postnasal hardening of glides changes /w, y/ to voiced stops [b, ɟ]. This alternation is attested in a number of languages, for instance, Gusii (Cammenga 2002; Nash 2011), Swahili (Meinhof 1932), Lamba (Doke 1922), Matuumbi (Odden 1996), Ganda (Ashton et al. 1954), and Shona (Fortune 1955). The data in (24) reveal hardening in stem-initial glides /w, y/ after /N/:

(19) Postnasal hardening of glides

a.	Gusii:	/N-yɛɛng-e/	→	[ɲ**ɟ**ɛːŋgɛ]	‘I dance’
b.	Swahili:	/N-wili/	→	[m**b**ili]	‘9/10-two’
c.	Lamba:	/N-yolewa/	→	[ɲ**ɟ**olewe]	‘I shout’
d.	Matuumbi:	/N-yímá/	→	[ɲ**ɟ**íma]	‘10-pole’
e.	Ganda:	/eN-we/	→	[em**p**e]	‘10-hen perch’
f.	Shona:	/N-ʋon-i/	→	[m**b**oni]	‘9/10-pupil of eye’

In (19), Gusii stem-initial /y/ hardens to [ɟ] (19a), Swahili /w/ to [b] (19b), Lamba /y/ to [ɟ], Matuumbi /y/ to [ɟ] (19d), Ganda /w/ to [p] (19e) and Shona /ʋ/ to [b] (19f).

Glides may also undergo deletion after /N/ but this alternation appears to be uncommon. This process occurs in Yao where stem-initial /y/ is deleted along with /N/(Ngunga 2000:60):

(20) Postnasal /y/ deletion after /N/ in Yao

a.	/juu-N-yuuy-i-i-i-e/	→	[juu…iic-e]	's/he swung me'
b.	/juu-/N-yi-il-k-e/	→	[juu..uuyiiy-e]	's/he reached me'

The realization of /N/ before glides may cause them to undergo nasalization in some languages. When they are subject to postnasal nasalization, glides surface as homorganic nasals. In some languages the nasalization of stem-initial glides produces initial geminate nasals as in Ganda (Ashton et al. 1954). In other languages,the stem-initial glide undergoes nasal substitution, as in Lamba (Doke 1922). We consider nasal substitution and nasalization to be the same process on that is nasal substitution a short homorganic nasal appears. The forms in (21) demonstrate postnasal nasalization of /y/ in Lamba (21a) (Doke 1922) and Ganda (21b-c) (Ashton et al. 1954):

(21) Nasalization of stem-initial glides after /N/

a.	Lamba:	/N-yundaŋgile/	→	[**ɲ**undaŋgile]	'be last one left'
b.	Ganda:	/N-yimba/	→	[n**ɲ**imba]	'I sing'
c.	Ganda:	/eN-yangu/	→	[en**ɲ**angu]	'10-light'

In both Lamba (21a) and Ganda (21b-c), underlying /y/ is realized as the palatal nasal [ɲ] when preceded by /N/. However, in Lamba (21a) the nasal-glide sequence is realized as a short homorganic nasal while in Ganda (21b-c) a similar sequence surfaces as a geminate nasal.

Liquids that appear after /N/ are subject to two main alternations, namely postnasal hardening and postnasal nasalization. In a number of languages, /N/ causes the hardening of liquids /l, r/ to [d]. Thus, the contrast between the two liquids is neutralized postnasally in those languages. However, in Tswana the contrast between /l/ and /r/ is maintained phonetically after /N/ since /l/

surfaces as [t] and /r/ as [t^{h}] (Cole 1955). The hardening of liquids after /N/ is illustrated in (22) with data from Tswana, Swahili and Gusii. In (22a), postnasal hardening of /l/ is accompanied by devoicing to become [t] (22a). In (22b), /r/ undergoes hardening, devoicing, and aspiration to surface as [t^{h}]. In Swahili, /l/ and /r/ become [d] after /N/ (22c-d) while in Gusii, /r/ becomes [d] after /N/ of 1SG subject:

(22) Postnasal hardening of liquids

a.	Tswana:	/N-l̲oma/	→	[n**t**oma]	‘bite me’
b.	Tswana:	/N-r̲ata/	→	[n**t^{h}**ata]	‘love me’
c.	Swahili:	/N-l̲imi/	→	[n**d**imi]	‘10-tongue’
d.	Swahili:	/N-r̲efu/	→	[n**d**efu]	‘9/10-long, tall’
e.	Gusii:	/N-r̲ome/	→	[n**d**ome]	‘I bite’
f.	Gusii:	/N-r̲ar-ɛ/	→	[n**d**arɛ]	‘I sleep’

In some languages stem-initial liquids /l, r/ undergo nasalization after /N/. Postnasal nasalization of liquids occurs especially in languages that allow Meinhof’s Law (ML). We saw in chapter 3 that in ML, stem-initial voiced consonants undergo nasalization after /N/ when the syllable of the second syllable is an NÇ̬ or plain nasal. The examples in (23) show postnasal liquid nasalization in Lamba (Doke 1922), Kikuyu (Barlaw 1951), and Ganda (Ashton et al. 1954):

(23) Postnasal liquid nasalization after /N/

a.	Lamba:	/iN-l̲embo/	→	[i**n**embo]	‘tattoo’
b.	Lamba:	/iN-l̲umbulula/	→	[i**n**umbulula]	‘yellow fungus’
c.	Yao:	/juu-N-l̲oomb-il-e/	→	[juu**n**oombile]	‘he married me’
d.	Kikuyu:	/N-r̲ũme/	→	[**n**ũme]	‘Am I to bite?’
e.	Kikuyu:	/N-r̲iŋge/	→	[**n**iŋge]	‘Am I to strike?’

f. Ganda: /N-l̲onda/ → [n**n**onda] 'I choose'

The nasalization of liquids in (23) changes the liquids /l, r/ to the alveolar nasal [n]. The nasal-liquid sequence may surface as a short nasal (23a-e) or geminate nasal (23f). The nasalization of liquids after /N/ in (23) occurs in the context of Meinhof's Law (ML).

The realization of /N/ before stem-initial nasals may cause denasalization of stem-initial nasals, as observed in Yaka (Kidima (1991). The data in (24) show that stem initial /m/ (24a) and /n/ (24b) surface as voiced stops [b] and [d], respectively, after /N/ (Kidima 1991:4-5):

(24) Postnasal denasalization in Yaka

a. /N-m̲ak-idi/ → [m**b**akiní] 'I carved'

b. /N-n̲uuk-idi/ → [n**d**uukiní] 'I sniffed'

The effect of /N/ on stem-initial sonorants is summarized in the table below:

Table 10: Summary of the effect on /N/ on stem-initial sonorants

Type of sonorant	**Postnasal alternation**
Glides	Hardening, deletion, nasalization
Liquids	Hardening (with aspiration, devoicing), nasalization
Nasals	Denasalization

The main issues that stem from the interaction between /N/ and sonorants are as follows: (a) Why do some languages allow hardening of glides and liquids while others subject them to deletion and/or nasalization? (b) On what basis do some languages allow denasalization of stem-initial nasals while others do not? These are some of the issues we address in §5.5 below.

5.6 Analysis and discussion

The preceding sections revealed that /N/ causes a series of alternations in stem-initial segments. The main questions that arise from this fact are two: (a) what causes the variations in postnasal alternations? (b) How to we account for the noted postnasal variations? We will address these issues within the Element-based Dependency (EBD) framework (Botma 2004). Most of the alternations induced by /N/ involve changes in manner and laryngeal specification of stem-initial consonants. Postnasal debuccalization is the only alternation that combined a change in the [place] feature and manner of target consonants. We will start our analysis with postnasal patterns that involve a change(s) in laryngeal specification.

Postnasal alternations that affect laryngeal specification include nasalization, voicing, aspiration, de-aspiration, debuccalization, devoicing, and de-implosion. In EBD, nasalization is treated at a par with voicing. We will adopt the EBD account that categorizes laryngeal contrasts into three groups represented by the elements |L|, |ʔ|, |H|(Botma 2004:215):

(25) Laryngeal contrasts in EBD

a. |ʔ|: glottalization, ejection, creaky voice, implosion
b. |H|: aspiration, breathy voice, voicelessness
c. |L|: voice, nasalization

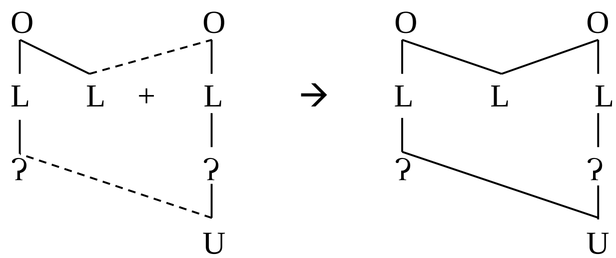
The main claim EBD makes about laryngeal contrasts is that phonological segments represented by the phonation elements |ʔ|, |H|, and |L| have different phonetic interpretations shown in each group. The phonetic realization of a phonological segment depends on differences in phonetic implementation and the manner structure to which a phonation element is associated. Besides, EBD maintains that nasals are subject to two phonation types, namely aspiration and glottalization. These claims predict some of the observed postnasal patterns associated with /N/. Some of the predictions EBD makes include the following: (a) nasalization targets sonorants while voicing targets obstruents. (b) Nasals may undergo aspiration or glottalization. (c) Nasal place assimilation targets places of oral stop articulation, i.e. bilabial, alveolar, palatal, and velar places. (d) A single phonological segment may have different phonetic realizations depending on the language and segment type. (e) Some alternations caused by a nasal will involve its stop property while others will involve its vocalic property.

Let us now consider postnasal alternations that involve the phonation element |L|. In the EBD phonological structure of segments, the phonation element |L| represents nasalization or voicing. Nasalization and voicing are predicted to occur when phonation |L| is linked to sonorant and obstruent manner, respectively. The alternations associated with /N/ that involve phonation |L| include nasalization, nasal substitution, denasalization, and voicing. In nasalization, phonation |L| of the nasal is linked to the dependent position of a sonorant and the place element of the target sonorant linked to the stop element |ʔ| of the nasal to show place assimilation (26a). In nasal substitution, the stop element |ʔ| of the obstruent is delinked and its place element linked to the stop element |ʔ| of the nasal (26b). In denasalization, the sonorant element |L| of the nasal is delinked and the place element of the lexical nasal linked to the stop |ʔ| element of /N/ (26c). In the voicing of an aspirated voiceless stop, the phonation element |ʔ| of the stop is delinked and substituted with |L| which is then linked to the phonation |L| of the nasal. Then, the place element of the oral is linked to the stop element |ʔ| of the nasal. So, all segments that are subjected to nasalization are sonorants in their respective phonological systems. Note that nasalization of sonorants and voicing of obstruents involve less and simpler operations; so, they are preferred. The diagrams in (26) represent these alternations where each derivation shows the structure of segments before and after the derivation. The relevant operations include linking, delinking/deleting, addition, and switching of elements (dotted lines show a linking operation):[21]

(26) Postnasal (de)nasalization, nasal substitution, and voicing

a. Postnasal nasalization

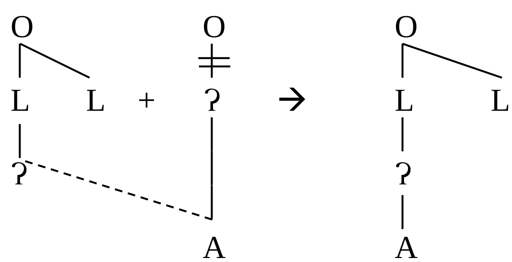
Ganda:/N-**b**o:mb-a/ → [m**m**o:mba] ‘I escape’ (Ashton et al. 1954:156)



/N + b/ → [mm]

b. Nasal substitution

Luyana: /N-k̲uku/ → [**ŋ**uku] ‘chicken’ (Gívón 1970b)

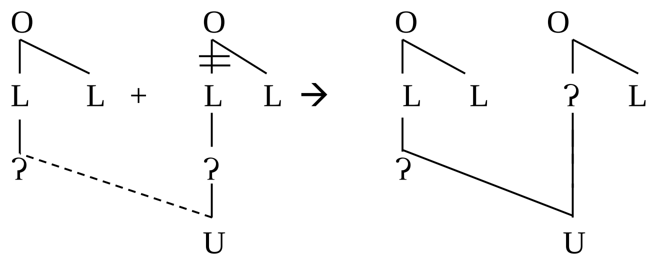


/N + k/ → [ŋ]

[21] In this study, nasals and oral consonants are dominated by onset (O) unless indicated otherwise.

c. Postnasal denasalization

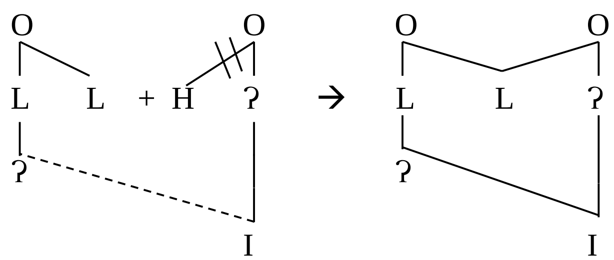
Yaka: /N-**m**ak-idi/ → [m**b**akiní] ‘I carved’ (Kidima 1991:4)



/N + m/ → [mb]

d. Postnasal voicing and deaspiration

Konde: /iN-**t^h**eko/ → [in**d**eko] ‘9-pot’ (Meinhof 1932:136)



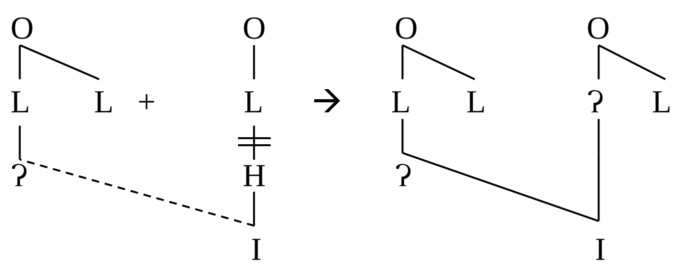
/N + t^h/ → [nd]

The choice to subject a segment to change(s) that affect manner and/or laryngeal contrast are a language-specific matter. Thus, languages may allow or disallow the alternations sketched in (26). However, alternations that involve less complex operations are preferred. The postnasal alternations represented in (26) indicate that nasalization affects sonorants while voicing affects obstruents. Nasal substitution may target both sonorants and obstruents. Postnasal denasalization is rare in Bantu, but it seems to avoid nasal deletion and geminate nasals in favor of NÇs. This alternation is achieved by delinking the vocalic element |L| of nasal manner. In postnasal voicing of an aspirated stop /t^h/, the presence of dependent |H| in the structure blocks the spreading of dependent |L| of the nasal to cause voicing. This linking is made possible by replacing dependent |H| with |L|, and this changes [t^h] to [d].

The representations in (27) show postnasal hardening and the realization of voiceless obstruents postnasally. In (27a), the place element of /r/ is linked to the stop element |ʔ| of the nasal to show place assimilation. The phonation element |H| of /r/ is delinked while its sonorant element |L| is replaced with the stop element |ʔ|. The phonation element |L| is added to indicate voicing. In (27b), the voiceless postnasal stop is realized unchanged, so the only operation here is the linking of the velar place element |A| of the stop to the consonantal element |ʔ| of the nasal to show nasal place assimilation.

(27) a. Postnasal hardening

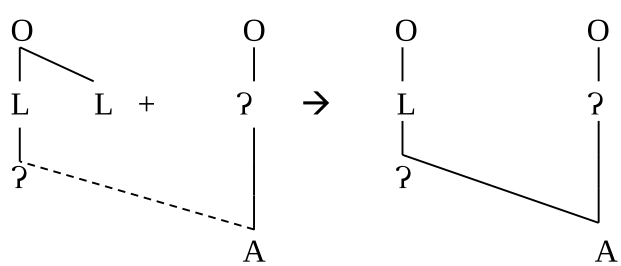
Shona: /N-**r**imi/ → [n**d**imi] ‘10-tongue’ (Fortune 1955)



/N + r/ → [nd]

b. Realization of a postnasal voiceless stop

Lamba: /N-**k**ake/ → [ŋ**k**ake] ‘bind me’ (Doke 1922)



/N + k/ → [ŋk]

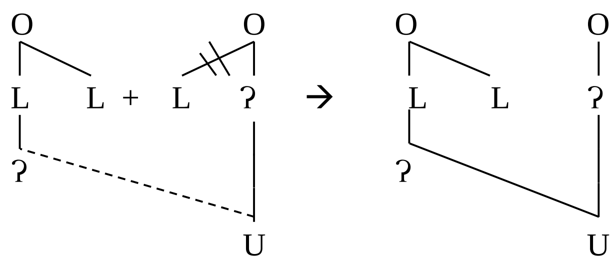
In (27a), Shona /r/ (although a sonorant) does not undergo nasalization but is instead subject to postnasal hardening to become [d]. The lack of nasalization in (27a) must be attributed to language-specific phonology. In (27b), the velar voiceless stop /k/ surfaces unaffected after /N/ in Lamba, also due to the phonology of this language. In other languages, /k/ would undergo nasal substitution or voicing, or the nasal would undergo deletion. A nasal followed by a voiceless obstruent is likely to be aspirated or devoiced (NÇ̥ sequences like (27b) need experimental verification).

The next cluster of postnasal patterns we will consider involves the phonation element |H|. In EBD, the phonation element |H| subsumes aspiration, breathy voice, and voicelessness. These alternations are represented in (28). In (28), /N/ becomes a homorganic nasal when the place element of the obstruent is linked to the stop element |ʔ| of the nasal. In (28a), postnasal devoicing of /b/ to [p] is represented by the substitution of dependent |L| with |H|. In (28b), postnasal deaspiration involves the replacement of dependent |H| with |ʔ|, thus changing the aspirated stop /k^h/ to an ejective stop [k']. Note that the Xhosa phonemic inventory has contrasts aspirated, ejective, and voiced obstruents. In postnasal aspiration (28c), the phonation element |H| is added to the dependent position of /p/, changing it to [p^h]. In debuccalization (28d), /p/ loses the stop element |ʔ| and takes up the phonation element |H|, thus becoming [h] that may surface as either a separate segment after the nasal (i.e. [mh]) or as aspiration on the nasal (i.e. [m^h]) (the diagram shows [m^h]). Note that the phonation element |H| has different phonetic realizations, that is, voicelessness (28a), aspiration (28b), and debuccalization (28d). The various realizations of |H| postnasally stem from crosslinguistic differences in phonetic implementation. The substitution of |H| with |ʔ| in (28c) is determined by the phonemic system of Xhosa that excludes |H| consonants in its inventory.

(28) Postnasal devoicing, (de)aspiration, and debuccalization

a. Postnasal devoicing

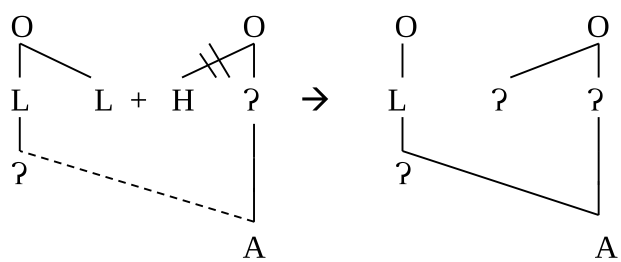
Tswana: /N-**b**ôna/ → [m**p**óna] ‘see me’ (Cole 1955:41)



/N + b/ → [mp]

b. Postnasal deaspiration

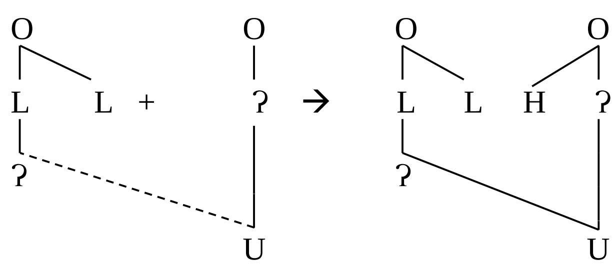
Xhosa: /iN-**k$^{\mathbf{h}}$**ut^{h}alo/ → [iŋ**k’**ut^{h}alo] ‘9-diligence’ (Podile 2002:105)



/N + k^{h}/ → [ŋk’]

c. Postnasal aspiration

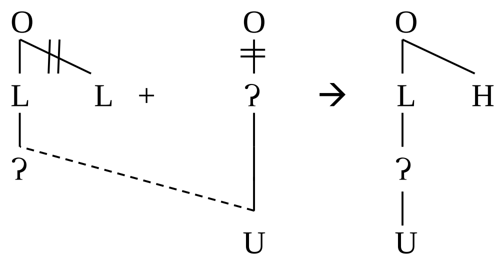
Pokomo: /N-paɲa/ → [mp^{h}aɲa] ‘9/10-rat’ (Huffman & Hinnebusch 1998:9)



/N + p/ → [mp^{h}]

d. Postnasal debuccalization

Shona: /N-p̱asa/ → [m**h**asa] ‘10-mat’ (Cole 1955)



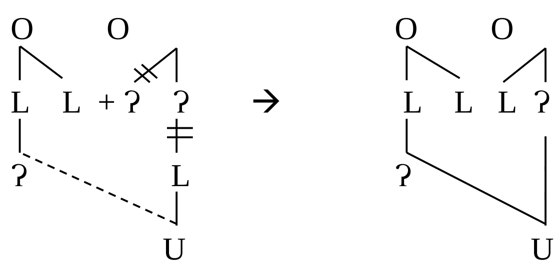
/N + p/ → [m^h]

The postnasal patterns observed in Bantu languages indicate that some of the patterns involve the phonation element |ʔ| that in EBD includes glottalization, ejection, creaky voice, and implosion. It was observed in the previous section that implosive stops undergo de-implosion and become voiced plosive stops or breathy voiced stops while ejective stops surface unchanged. However, glottalization and creaky voice were not observed after /N/. Breathy voice is represented by a combination of dominated |L| in the head manner component and dependent |H|. The diagrams in (29) show postnasal ejective stops, derived voiced stops, and breathy voiced stops:

(29) Postnasal behavior of ejectiveand implosive stops

a. Postnasal de-implosion

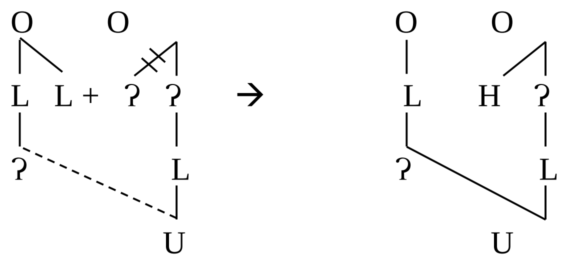
Zulu: /iN-**ɓ**ú:zi / → [im**b**ú:zi] ‘9-goat’ (Doke 1926:66)



/N + ɓ/ → [mb]

b. Postnasal breathy voiced stops

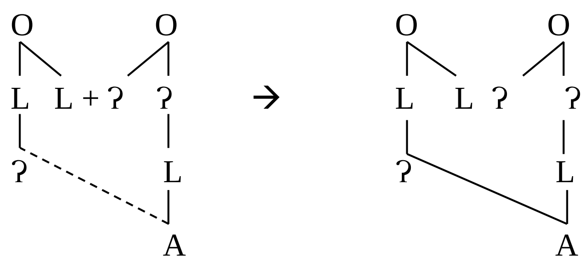
Xhosa: /iN-ɓ̱ali/ → [imb̤ali] ‘9-story, history’ (Podile 2002: 109)



/N + ɓ/ → [mb^h]

c. Postnasal ejective stops

Zulu: /izi-N-k̲’ɔbɔ/ → [iziŋ**k’**ɔbɔ] ‘10-wristlet wire’ (Doke 1926)



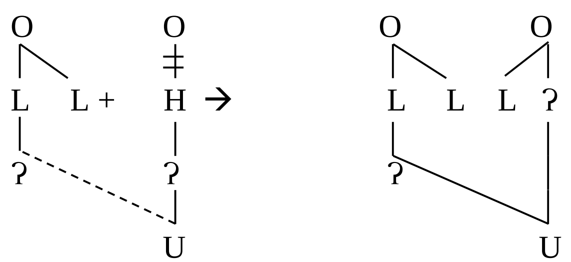
/N + k’/ → [ŋk’]

In postnasal de-implosion (29a), the phonation element |ʔ| that marks implosion is delinked together with the manner element |L|. The phonation element |L| replaces |ʔ| in the derivation of a voiced plosive stop [b] from the underlying implosive stop /ɓ/. The linking of the labial element |U| of /ɓ/ to the stop element of |ʔ| of the nasal changes /N/ to [m]. Thus, the implosive stop /ɓ/ undergoes internal change to surface as a plosive stop postnasally. In (29c), postnasal de-implosion produces a breathy voiced stop [b^h] indicated by the phonation element |ʔ|. In (29c), the ejective stop surfaces unchanged, as its phonation element |ʔ| and the manner elements |ʔ| and |L| remain intact. Apparently, implosive stops are disfavored postnasally while plosives are favored in languages such as Xhosa and Zulu.

A number of postnasal alternations change the manner element(s) of the target segment. Examples of alternations in this category include postnasal hardening and affrication. Postnasal hardening converts lexical glides, liquids, and fricatives to plosives while affrication changes fricatives to affricates. In EBD, postnasal hardening is achieved by deleting the manner element |H| and adding the phonation element |ʔ| to the dependent position of the approximant. In postnasal affrication, the manner elements |ʔ| and |H| swop places; the former dominates the latter in the structure of an affricate, but |H| dominates |ʔ| in a fricative. The EBD derivations in (30) show postnasal hardening of a voiced fricative (30a) and affrication of a voiceless fricative (30b):

(30) Postnasal hardening

a. Gusii: /N-**ß**ook-e/ → [m**b**ooke] 'I get up'



/N + ß / → [mb]

b. Postnasal affrication

/N + f/ → [mpf]

Postnasal hardening and affrication exemplify fortition in that both alternations produce stronger consonants as represented in the dominant manner element |ʔ| in the output postnasal segments.

The different postnasal patterns observed in Bantu languages are explained in EBD in a way that incorporates clearly the manner, place and laryngeal contrasts of segments.

5.7 Summary

This chapter brought together the series of segmental alternations that occur in stem-initial segments at the influence of /N/. The processes examined include postnasal (de)nasalization, (de)voicing, (de)aspiration, (de)affrication, hardening, de-implosion, nasal substitution, and consonant insertion. These alternations were analyzed within EBD. The various postnasal processes show the range of choices available to different languages in the adaptation of NC or NN sequences. However, it emerged that within the EBD model, languages resort to "less expensive" alternations. By "less expensive" we mean processes that involve the least number of operations and less complex operations. Linking, delinking, and addition of elements to represent an alternation are some of the most favored operations. Switching of elements is more complex, and so processes that involve this operation are less popular. Nasalization targets sonorants because this process involves the fewest and least complex operations similar to the voicing in obstruents. Alternations like denasalization, affrications and deaffrication are less popular because they involve more operations that are also more complex. Nasalization of voiced obstruents is one of the most "expensive" alternations, so it was not attested. The alternative to this process is nasal substitution which is a simpler process. Languages also make options on the phonetic realization of laryngeal contrasts in segments. Nasal devoicing and nasal aspiration are two choices languages have for the same process. Nasal place assimilation is pervasive because it involves a single linking operation. Postnasal debuccalization and postnasal aspiration are similar and simple, and so relatively common. Postnasal hardening is also common because it involves few and less complex operations. The Postnasal de-aspiration changes the phonetic interpretation of the same segment; so, it is easy to implement phonetically and phonologically using the EBD model. Postnasal de-implosion is to make nasals more sonorous before breathy voiced obstruents, and involves few operations as well. Postnasal affrication involves more operations, so it is less popular in Bantu. Deaffrication also involves a more complex operation (i.e. switching operation), thus it is uncommon.

CHAPTER 6

6. SUMMARY AND CONCLUSION

This chapter presents a summary of the preceding chapters and the conclusion of the study. In this chapter we present a unified account of the behavior of /N/ based on the findings presented mainly in chapter 3, 4, and 5. The summary provided here contains the description of the various alternations caused by /N/ and how they were formalized within the two theoretical models adopted in the study, that is, moraic theory and EBD. The chapter also presents answers to the questions that this study set out to answer: (a) what are the segmental alternations associated with /N/? (b) What determines the range of alternations induced by /N/? (c) How can the alternations induced by /N/ be accounted for in phonological theory? Answers to these questions were presented in chapters 3, 4, and 5. In §6.1, we summarize the content of chapters 3, 4, and 5 and in §6.2 we present the main generalizations that aise from the study findings.

6.1 Summary

In chapter 2, we presented the basic phonological and morphological characteristics of Bantu languages. The phonological facts presented in this chapter concern vowel and consonant inventories and phonological processes involving vowels and consonants. Bantu languages have simple vowel inventories, most of which consist of five-to-seven vowels. In some of the languages vowel length is contrastive. Vowels are subject to a variety of phonological processes including lengthening, shortening, deletion or assimilation, coalescence, ATR harmony, and height harmony. In vowel harmony patterns, affixal vowels assimilate the feature(s) of the root vowel(s). Bantu languages have simple consonant inventories although some languages have complex consonant systems. The frequent segmental alternations that affect consonants include palatalization, palatal harmony, dissimilation, spirantization, consonant insertion, consonant deletion, and metathesis. Syllables are generally open, and the basic syllable structure is CV(V). A good number of languages are tonal. The tone bearing unit (TBU) is debatable between a syllable and a mora. The common processes that affect tones in these languages are down-step in Hs, right spreading, and avoidance of both contour tones and successive Hs. The morphology of nominal and verbal stems is complex. Although proper nouns have a simple morphology, common nouns may consist of at most four morphermes. The different morphemes that comprise common noun include the augment (also known as reprefix or initial vowel), class prefix, root, and nominalizing suffix. Bantu nouns are normally categorized into classes, with correspoinding class prefixes. In nominal stems, /N/ occurs as the marker of class 9/10. Verbal roots agglutinate a wide range of prefixes and suffixes that mark different meanings on the verbal stem, for example, negation, tense, aspect, mood, subject, object(s), and relative pronoun. The suffixes that occur on verbal stems may be inflectional or derivational, and express various meanings that range from stative to causative, passive, reversive, and reciprocal. Verbs have a default final vowel /-a/ that may change shape when additional meansing are marked on the verb such as negation or subjunctive. In verbal stems, /N/ may occur as the prefix for 1SG subject and object.

In chapter 3, we distinguished between bilabial syllabic nasal prefix /m̩/ and /N/. The two prefixes are considered to be historical relics of the Pro-Bantu syllables /mo-/ and /ni-/, respectively. We demonstrated that the distribution and phonological properties of /m̩/. We also showed how this nasal prefix differs from /N/ using Yao and Matuumbi examples. The bulky of chapter 3 discussed the behavior of /N/ in relation to its role in prenasal and nonlocal alternations. We showed that three main segmental alternations occur before /N/, namely vowel epenthesis, vowel lengthening, and initial vowel shortening. The data provided in this chapter led to the conclusion that the crosslinguistic variations in vowel epenthesis and vowel lengthening before /N/ correlate with contrastive vowel length. The two prenasal alternations were found to occur in languages with contrastive vowel length, but not in those languages without contrastive vowel length. We also established that languages that treat /N/ as moraic are the ones that allow vowel epenthesis and lengthening before /N/. These languages include Lungu, Gusii, Rwanda, Ganda, and Jita. We concluded that /N/ may not be moraic in languages that disallow prenasal vowel epenthesis and lengthening, for example, Kongo, Konde, and Swahili. We also concluded that vowel epenthesis and lengthening before /N/ must be treated as compensatory processes that arise from the suspended mora vacated by /N/ after it is demorified. We found some parallelism between prenasal CL and postglide CL in Bantu; this situation backed up our conclusion that languages that allow vowel epenthesis, prenasal CL, and postglide CL have contrastive vowel length and their /N/ must be moraic. Vowel epenthesis and CL before /N/ were formalized within the moraic model where the epenthetic vowel and CL arose from the mora set afloat by a demorified /N/. Initial vowel shortening before /N/ was attributed to an overarching Initial Vowel Shortening (IVS) rule. This rule seems to take precedence over prenasal CL. Thus, the absence of prenasal CL word-initially in languages that allow this process was accounted for in terms of the interaction between IVS and CL. IVS overrides CL.

The behavior of /N/ in three nonlocal processes, that is, nasal-consonant harmony (NCH), Dahl's Law (DL), and Meinhof's law (ML) revealed that as a prefix, /N/ cannot trigger NCH. NCH is always triggered by lexical prevovcalic nasals that lie within the stems, the domain of NCH. In ML, /N/ was found to cause nasalization in stem-initial voiced oral consonants when the second syllable of the stem has an NC̬ or plain nasal as onset. Nasalization triggered by /N/ may create initial geminate nasals (as in Ganda and Bemba) or short nasals (as in Kikuyu and Lamba). We concluded that the segments that undergo nasalization due to ML must be sonorants in their respective phonological systems as claimed by EBD. When it comes to DL, we discussed four possible views to account for the behavior of /N/ in this process: (a) coda analysis; (b) prenasalized analysis; (c) nasal devoicing analysis; and (d) prefix anaalysis. We concluded that /N/ is not transparent to DL when it occurs between the trigger and target, but it is part of the trigger onset. This is possible if we analyze /N/ in NÇ̥s as devoiced and/or part of a voiceless prenasalized stop.

In chapter 4, we examined alternations that affect /N/ when it interacts with stem-initial segments. The results obtained indicate that when /N/ occurs before stem-initial vowels it is realized as a dorsal nasal, that is, palatal [ɲ] or velar [ŋ]. The front nasals /m, n/ are excluded from this context. The facts from the sample languages demonstrated that the palatal nasal [ɲ] nasal is the most preferred in this environment. This pattern fits very well with phonetic studies that have established that front nasals [m, n] have strong consonantal properties while dorsal nasals have more vocalic properties in their perception and articulation. On this basis, we concluded that the preference of dorsal nasals in this context is due to their vocalic properties. In other words, vowel-initial stems in Bantu tend to prefer nasals with more vocalic properties before them for harmony reasons. In EBD, this preference is represented using the place elements for dorsal nasals. So, linking their place elements to the consonantal element of nasal manner represents the realization of dorsal nasals before vowel-initial stems.

When /N/ occurs before stem-initial consonants it undergoes a number of alternations. /N/ always assimilates to the place of articulation of a stem-initial consonant. In EBD, this is achieved by linking the place element of the oral to the stop element of the nasal. Thus, this linking operation produces the realizations of /N/ as [ɱ], [m], [n], [ɲ], and [ŋ]. Deletion is another change that occurs in /N/, and it occurs mostly before voiceless obstruents (especially fricatives) and other nasals. The deletion of /N/ before other nasals was attributed to the general marked status of geminate sonorants crosslinguistically. Perceptually, it is hard to distinguish geminate and singleton sonorants. /N/ deletion before voiceless obstruents avoids NC̥s in languages where they are outlawed. NC̥s are marked sequences on articulatory grounds, as the voiceless obstruent may causes devoicing or aspiration in the nasal. In languages that disfavor these types of nasals, /N/ deletion becomes the best option. In EBD, it is easy to represent /N/ deletion than voicing or other options available in the adaptation of NC̥s. /N/ deletion in EBD involves delinking the manner elements of the nasal. Nasal aspiration and devoicing were also observed in /N/. In EBD, these two are treated as crosslinguistic variants of the same phonological segment represented by the phonation element |H|. Nasal aspiration is achieved by substituting dependent |L| of the nasal with |H|. This is a more complex operation than linking, addition, or delinking. Thus, on theoretical grounds alone, postnasal aspiration and devoicing are disfavored alternations. Phonetically, it is difficult to articulate devoiced or aspirated nasals. It was also observed in chapter 4 that /N/ alternates in its syllabicity. In polysyllabic stems, /N/ surfaces as non-syllabic but in monosyllabic stems it becomes syllabic. This alternation is expected because /N/ is a sonorant, and in EBD this is shown by having the vocalic element |L| dominate the consonantal element |ʔ| of nasal manner. When /N/ is non-syllabic, the EBD model will show /N/ dominated by the onset position but when syllabic by the nucleus.

In chapter 5, we addressed the range of alternations that /N/ causes on stem-initial consonants. The interaction of /N/ and stem-initial consonants in this chapter was organized along the manner categories of the postnasal segments, that is, stops, affricates, fricatives, and sonorants (i.e. glides, liquids, and nasals). The effect of /N/ on different obstruents also followed various laryngeal contrasts of segments in each manner category. The interaction between /N/ and stops looked all the five different kinds of stops attested in Bantu, i.e., voiceless, voiced, aspirated, implosive, and ejective stops. When /N/ interacts with voiceless stops the latter may surface unaffected or undergo postnasal voicing, or aspiration, or nasal substitution. Bantu voiced stops may also surface unaffected or be subject to devoicing or nasalization after /N/. Aspirated stops undergo two alternations in Bantu when preceded by /N/; these are voicing and deaspiration. In Bantu, ejective stops surface unaltered after /N/ while implosive stops undergo de-ipmlosion to become plosives. When preceded by /N/, voiced and voiceless affricates may remain unaffected although voicless affricates may undergo deaffrication and become fricatives. The main effects of /N/ on glides and liquids are manifested as postnasal hardening and nasalization although glides may delete postnasally in some languages. Postnasal hardening of liquids may be accompanied by aspiration and devoicing. When /N/ occurs before fricatives, voiceless fricatives may remain unaffected or become voiced or affricates. In Bantu, voiced fricatives may also surface unatered after /N/ but may also undergo nasalization or hardening or affrication.

Postnasal alternations in Bantu were formalized within the EBD model. EBD explains postnasal processes in terms of the interaction between elements of manner, place and and phonation. In EBD, segmental alternations that involve fewer and less complex operations are predicted to be more frequent across languages. Postnasal nasalization targets sonorants because it involves one linking operation (in addition to linking place elements to show nasal place assimilation which is common in all alternations involving /N/). Postnasal voicing of obstruents is also preferred because it involves one linking operation. In a nutshell, alternations that involve fewer and simpler operations (e.g. linking, deletion, addition) are more common than those that involve more and complex operations. Postnasal nasalization and voicing were represented by linking dependent |L| of the nasal to the dependent position of the sonorant and obstrent, respectively. Postnasal devoicing was represented by simply delinking dependent |L| of the obstruent. Nasal substitution was achieved by delinking the manner element of the obstruent and linking its place element to the consonantal element |ʔ| of the nasal. Because it involves more than one operation, nasal substitution is not very common in Bantu. The representaion of postnasal hardening varied depending on the target approximant. Postnasal hardening of liquids and voiced fricatives involved delinking |H| with concomitant linking of the stop element |ʔ| of the nasal to the place element |I| of the approximant being plosivized. In postnasal glide hardening, |ʔ| of the nasal was linked to the place element of the glide. In postnasal de-aspiration, dependent |H| of the input obstruent is delinked while in postnasal aspiration dependent |H| is added to the dependent position of the nasal, with concomitant delinking of |ʔ| of the obstruent. These are many operations, and so postnasal aspiration must be marked alternation. Postnasal de-implosion involved the delinking of dependent |ʔ| of the obstruent. Postnasal affrication and de-affrication were represented by switching the manner elements |ʔ| and |H| of the obstruents. These two are predicted to be uncommon because they involve more and complex operations.

6.2 Conclusion

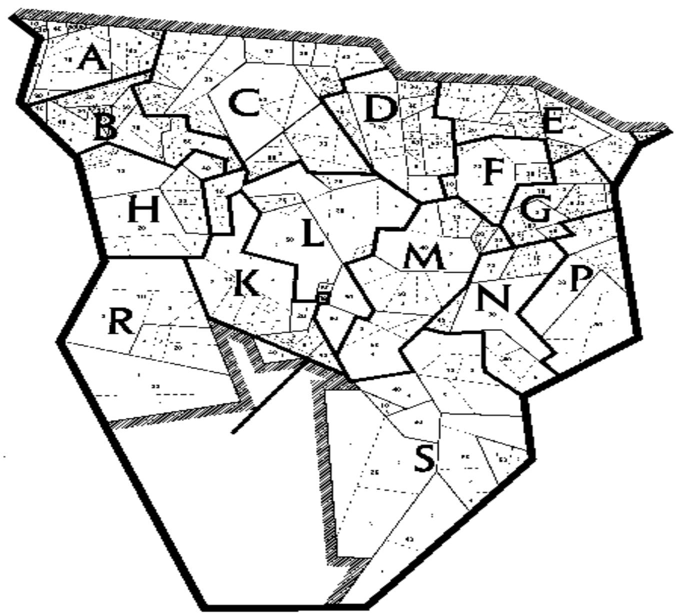
In this section, we present the general conclusion and a number of specific concluding statements about the behavior of /N/. The preceding examination and analysis of /N/ led to one general conclusion that nasal clusters (i.e. NC, NN) are marked phenomena in Bantu because of the multiple repair strategies adopted to alter them. The segmental alternations observed in the realization of /N/ are conditioned by two main factors, namely, language-specific phonology and the phonological properties of /N/ and the segments with which it interacts. Unlike NC and NN, NV sequences appear to be unamarked. Therefore, when /N/ occurs before vowel-initial stems, it is always retained and conditioned to surface as a dorsal nasal. The variations noted in prenasal CL and vowel epenthesis stem from the varying moraic status of /N/ which also depends on whether a language has contrastive length or not. /N/ is moraic in languages with contrastive vowel length; these are the languages that exhibit prenasal CL and prenasal vowel epenthesis. Thus, /N/ must be non-moraic in languages without contrastive vowel length; these do not allow prenasal CL and prenasal vowel epenthesis. These facts align with some basic principles of moraic theory especially the Mora Conservation Hypthesis and the proposal that language-specific phonology conditions CL. The interaction between prenasal CL and the Initial Vowel Shortening (IVS) rule causes the lack of long vowels before /N/ word-initially in some languages.

The inability of /N/ to trigger NCH is due to the fact that it is a prefix while NCH occurs within the stem. In DL, /N/ is not transparent when it intervenes between the trigger and target, but it is part of the voiceless prenasalized stop that triggers DL. That /N/ causes nasalization on stem-initial voiced obstruents under ML implies that the segments that undergo nasalization are all sonorants. The distinction between sonorants and obstruents, thus affects the kind of alternation a consonant will undergo when it interacts with /N/; voiced obstruents will undergo voicing, hardening, and so on while sonorants may undergo nasalization, among other processes. Stops, fricatives, affricates, sonorants (vowels, liquids, and glides) interact with /N/ in different ways but may exhibit similar alternations. Laryngeal contrasts such as voicing, voicelessness, ejection, implosion, breathy voice, glottalization, aspiration interact with nasal manner in different ways. So, the range of processes /N/ is able to trigger is based on the multiple properties of segments in addition to language-specific preferences.

APPENDIX

APPENDIX

Figure 1: Map: This map shows Bantu speaking area and Guthrie's sixteen zones



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