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Positional Faithfulness and *NC Onset Resolution in Lubukusu: An OT Perspective

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Abstract: Phonological studies have previously shown that a sequence of a nasal plus certain consonants (especially voiceless obstruent) in a syllable onset position is considered marked cross-linguistically. As a result, it may trigger a number of repair mechanisms which have been dubbed *NC effects/resolution. However, what is of interest in this study is that the repair mechanisms are not unconstrained; they seem to target some sound segments for deletion or feature change in certain positions and not others. Segments in psycholinguistically privileged positions invariably resist these repair strategies that are, in fact, expected and regular in the phonology of the language. In this study, data from Lubukusu language (Bantu, Kenya) is used to argue that a Positional Faithfulness (PF) account within an Optimality Theory (OT) framework is required in explaining both the blocking and triggering of such repair processes. The findings indicate that the positional faithfulness of the segments in question determines which one is deleted, merged or which segmental features may be changed in the phonological repairs based on a single constraint hierarchy in an Optimal Grammar of the language.

Key Words: *Markedness, *NC effects, optimality, positional faithfulness, phonotactics.*

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1. Introduction

*NC effects refer to phonological processes that are often triggered whenever a nasal sound is followed by voiceless plosive or fricative (Archangeli, Moll & Ohno, 1998; Pater, 1999, 2001, 2004; Hayes & Stivers, 2000; Hyman, 2001). Such a sequence is considered phonologically marked and may be forced to undergo some repairs to meet syllabic phonotactics or wellformedness requirements. Languages chose different repair strategies for the same markedness in the *NC sequence while other languages may adopt similar repairs for different *NC sequences. This may be determined by the syllable structure of the language in question or the phonemic inventory attested in the language. Some languages have a rich typology of *NC effects to the extent that even voiced sounds are prohibited in the onset of a syllable after an initial nasal stop (Nandelenga, 2014).

Whichever strategy a language may use to resolve *NC effects is largely determined by the phonological features of the phonemes in question, that is, whether the phoneme is in the root word or prefix and its position in the morphemes or prosodic word; whether the phoneme is morpheme/prosodic word final or initial. In a majority of languages, based on the preceding parameters, the phoneme to be deleted or transformed in feature values, for instance, may be predictable. In standard Generative Phonology (GP), because different processes were set in motion whenever such sequences emerged, the repairs were dubbed ‘conspiracies’ (Kenstowicz & Kisseberth, 1979). In the surface-oriented Optimality Theory (hereafter OT-Prince & Smolensky, 2004), they have been referred to as ‘homogeneity of target and heterogeneity of process’ (McCarthy, 2002:93) because of a single constraint hierarchy that is adopted for the multiple repairs.

The problem with the rule-based derivational analysis of standard GP was that because the rules are blind to outputs, they could apply whenever their structural description is met. As a result, they often produced the exact ‘marked’ structures they were supposed to eliminate in the first place. In the same vein, because rules operate based on their structural description, there was no functional unity among them and the different rules are often duplicated in the repair processes. In *NC resolution, for instance, the choice of the phoneme to be deleted may be trivially determined by a rule that carries out the deletion process with no role for the psycholinguistic or phonetic factors or prediction of the targeted phoneme even when they are availed by their positional context.

In an OT grammar, the repairs are explained purely in terms of constraint interaction in which some markedness constraints ban the unacceptable sequences of a nasal and a voiceless obstruent. Specifically, Positional Faithfulness (Beckman, 1997, 1999, 2004) a sub-theory couched within OT, provides an alternative account for the positional triggering of phonological processes while at the same time blocking of processes initiated elsewhere. Positional Faithfulness (PF) is a term that refers to the fact that in certain privileged positions in the phonology of a language, there is a unique attempt to maintain segmental and featural contrast which is neutralized elsewhere. Such segments remain faithful to their underlying representation in the course of the mapping from the input to the surface representation. According to Beckman (1999), the privileged positions are generally occupied by segments which are root initial, syllable onsets, roots, stressed syllables and syllables having long vowels, among other factors.

In psycholinguistics, the privileged positions provide cues for lexical storage, retrieval and processing, as a result, they are protected from neutralization, featural alteration and segmental deletion. In a PF approach, positional faithfulness constraints dominate both the markedness constraints responsible for the repairs and some general faithfulness constraints. Faithfulness constraints that are positional specific play a key role in explaining both the triggering and blocking of phonological processes in such privileged positions. The PF theory, therefore, provides an account of phonological asymmetries initiated by either segments or syllables appearing in perceptually or psycholinguistically prominent positions. This paper is organized as follows; section 2 provides the data on the typology of *NC effects, section 3 provides analysis while the role of PF is explored in three subsections; 3.1 looks at the formation of prenasalized stops, 3.2 examines nasal deletion and 3.3 the formation of syllabic consonants. Section 4 discusses the findings in light of the theory and finally, section 5 provides the summary and conclusion.

2. NC Data and Some Generalization

Lubukusu has a rich typology of *NC effect (cf. Nandelenga, 2014) unlike what is attested in many languages. While most languages have a constraint that bans voiceless obstruents from following a nasal sound, in Lubukusu, this constraint is just one of the many that work in unison with other related constraints that prohibit other sequences of a nasal and a consonant. In essence, a number of voiced obstruents are also banned in the onset sequence besides the voiceless obstruents. In the language, it is also observed that no sonorant sound may follow the initial nasal sound in the onset cluster sequence as the following data clearly depicts.

(1) *NC Data from Lubukusu

	Input	Output	Gloss	Place/manner of articulation
(a)	/N-texa/	[^{n}de.xa]	‘I boil’	Alveolar stop
	/N-tima/	[^{n}di.ma]	‘I run’	alveolar stop
	/N-cuxa/	[^{ɲ}ɟu.xa]	‘I pour’	palatal stop
	/N-cexa/	[^{ɲ}ɟe.xa]	‘I laugh’	palatal stop
	/N-kula/	[^{ŋ}gu.la]	‘I buy’	velar stop
	/N-kona/	[^{ŋ}go.na]	‘I sleep’	velar stop
	/N-pasa/	[^{m}ba.sa]	‘I iron(cloths)’	bilabial stop
	/N-para/	[^{m}ba.ra]	‘I think’	bilabial stop
(b)	/N-fuka/	[fu.ka]	‘I cook’	labio-dental fricative
	/N-funa/	[fu.na]	‘I break’	labio-dental fricative
	/N-si:xa/	[si:.xa]	‘I burry’	alveolar fricative
	/N-suna/	[su.na]	‘I jumb’	alveolar fricative
	/N-xu:la/	[xu:.la]	‘I uproot’	velar fricative
	/N-xaka/	[xa.ka]	‘I try’	velar fricative
(c)	/N-βala/	[^{m}ba.la]	‘I count’	bilabial fricative
	/N-βeja/	[^{m}be.ja]	‘I marry’	bilabial fricative
(d)	/N-lima/	[^{n}di.ma]	‘I cultivate’	alveolar lateral liquid

	/N-lila/	[^{n}di.la]	'I cry'	alveolar lateral liquid
	/N-rema/	[^{n}de.ma]	'I cut'	alveolar trill liquid
	/N-rura/	[^{n}du.ra]	'I offload'	alveolar trill liquid
(e)	/N-nina/	[n̩.ni.na]	'I climb'	alveolar nasal stop
	/N-nala/	[n̩.na.la]	'I get used to'	alveolar nasal stop
	/N-mila/	[m̩.mi.la]	'I swallow'	bilabial nasal stop
	/N-mala/	[m̩.ma.la]	'I complete	bilabial nasal stop
	/N-ɲala/	[ɲ̩.ɲa.la]	'I can/manage'	palatal nasal stop
	/N-ɲaxa/	[ɲ̩.ɲa.xa]	'I suffer'	palatal nasal stop
	/N-ŋona/	[ŋ̩.ŋo.na]	'I make'	velar nasal stop
	/N-ŋa:/	[ŋ̩.ŋa:]	'I grow thin'	velar nasal stop

Similar to some Eastern Bantu languages, Lubukusu prohibits a Nasal-Consonant sequence unless the nasal is followed by a glide (Nandelenga, 2014). Indeed, while most languages prohibit a nasal plus voiceless obstruent sequence, in Lubukusu, the data show that *NC effects are not limited to such a sequence but involve many other NC sequences some of which have voiced segments after the nasal. Therefore, Lubukusu has a rich typology of *NC effect unlike most languages examined so far (Pater, 1999, 2001, 2004; Hyman, 2001). First, a sequence of a nasal plus a voiceless plosive is phonologically marked and is repaired through post-nasal voicing and formation of prenasalized stops. Secondly, a nasal plus a voiceless fricative sequence is also marked and repaired by the deletion of the nasal prefix. The third type of *NC is a nasal plus a voiced fricative that is repaired by post-nasal hardening of the fricative that results in formation of a voiced prenasalized stop. The fourth type of *NC onset is a nasal-liquid sequence, which universally is marked and repaired through post-nasal hardening in which the liquid sound hardens to a homorganic prenasalized stop. Finally, the nasal-nasal sequence is also banned for violating onset sonority sequencing requirements besides violating OCP and is repaired by promoting the initial nasal into a syllabic nasal.

This typology follows from the fact that they all violate the canonical onset cluster that is admissible in Lubukusu language; the CG (Consonant Glide) sequence only. Based on the syllabic phonotactics of the language, no onset cluster can be optimal except a nasal plus a glide sequence (Nandelenga, 2014). In the following examples, the underlying archiphoneme [N], a first-person morpheme prefix (1st person singular pronoun 'I' of English) is prefixed to various verb roots beginning with any consonant of Lubukusu and the results are as indicated below.

(2a) Lubukusu typology of *NC effects and the resolution mechanisms

	Input	Output	Gloss	Repair mechanism
(a)	/N-texa/	[^{n}dexa]	'I boil'	Place assimilation and post-nasal voicing.
(b)	/N-fuka/	[fuka]	'I cook'	Nasal deletion.
(c)	/N-βala/	[^{m}ba.la]	'I count'	Place assimilation and post-nasal hardening.
(d)	/N-lima/	[^{n}di.ma]	'I cultivate'	Place assimilation and post-nasal hardening.
(e)	/N-nala/	[n̩.na.la]	'I get used'	Formation of syllabic nasals.

3. Data Analysis

In this section, we analyze data based on the repair mechanisms adopted to account for the *NC resolution processes and the role of PF in the repairs adopted. We begin by examining repairs that result in the formation of prenasalized stops, nasal deletion and formation of syllabic nasals. In each case, a positional faithfulness constraint is involved to ensure any repairs do not compromise perceptual cues associated with each sound in specific prosodic positions.

3.1 Formation of Prenasalized Stops

In the data above (1a, c, d), the nasals assimilate in place to the following consonant to acquire the place feature specification. In terms of markedness theory, sounds must be specified for the place feature (either [–] or [+]) to meet the surface well-formedness condition. Markedness constraints; HAVE PLACE and $\text{AGREE}_{\text{PLACE}}$ (Padgett, 1995; Lombardi, 1999) demand that the nasals (which are underlyingly unspecified for place of articulation) assimilate to the following consonant to acquire their place feature specification. In (2a) above, repeated below as (2b), the nasal cannot be followed by a voiceless stop because such a sequence is ruled out by the markedness constraint (*NC̥) which is undominated in Lubukusu constraint hierarchy (CON).

(2b) the nasal + voiceless stop sequence

	Input	Output	Gloss	Repair mechanism
(a)	/N-texa/	[^{n}de.xa]	'I boil'	
(b)	/N-cexa/	[ɲɟ.exa]	'I laugh'	Nasal place assimilation, post-nasal voicing and
(c)	/N-kona/	[^{n}go.na]	'I sleep'	formation of prenasalized stops
(d)	/N-para/	[^{m}ba.ra]	'I think'	

Post-nasal voicing is prevalent in world languages (Pater, 1999, 2004; Hayes & Stivers, 2000) driven by the constraint *NC̥. According to Pater (1999, 2001) and Archangeli et al., (1998), the *NC̥ produces a range of effects and post-nasal voicing is one of the resolutions due to the interactions of *NC̥ with other constraints. This constraint demands that no nasal-voiceless obstruent onset sequence can be allowed in the output.

The *NC̥ is an undominated constraint in the constraint hierarchy of Lubukusu phonology such that no onset can emerge with a voiceless plosive following a nasal consonant. In Lubukusu repairs, the voiceless plosive acquires the [+voice] feature of the nasal hence violating the voicing faithfulness correspondence between the input and the output. The stop does not lose its obstruency features but acquires the [+voice] feature of the nasal. This violates the universal constraint, IDENT-IO (voice). The voice specification of the input plosives is [-voice] but it is realized in the output as [+ voice]. Finally, by acquiring the nasal feature from the prefix nasal, the oral voiceless stops also violate the faithfulness constraint IDENT-IO (nasal). In an OT account of Correspondence Theory (McCarthy, 1995), assimilation, does not just violate IDENT-IO (voice) and IDENT –IO (nasal)), but also the correspondence relation between the input and output segments. Assimilation is a form of coalescence in which two input segments /N + t/ are fused and realized in the output as one segment, the voiced alveolar prenasalized stop [^{n}d] a singleton.

Note that the nasal is virtually lost as an independent sound segment because what remains is a voiced prenasalized stop, the [^{n}d]. Only its features; [+voice] and [+nasal] are preserved in the stop. In this study, we adopt the view that a pre-nasalized stop is one segment and not a sequence of consonants. Therefore, two segments in the input are mapped on to one in the output, a violation of a faithfulness and correspondence constraint; UNIFORMITY-IO. This constraint is an anti-coalescence constraint and because it is violated by the optimal candidate, it must be ranked below *NC̥ to induce coalescence. However, what is important for the current study is that the plosive retains its integrity as a stop consonant, it is not deleted because of the positional faithfulness constraint; MAX-IO$_{ROOT}$ that bans deletion of segments in the roots. This constraint is undominated in the constraint hierarchy and every optimal output must satisfy it. These constraints should evaluate the optimality of the voiced prenasalized stops in tableau 3 ranked as follows; *NC̥, MAX-IO$_{ROOT}$ ≫ IDENT-IO$_{VOICE}$, IDENT-IO$_{NASAL}$, UNIFORMITY-IO.

(3) /N_1-$t_2$exa/ → [$^{n}d_{1,2}$ e.xa] 'I boil'

/N_1-$t_2$exa/	*NC̥	MAX-IO$_{ROOT}$	IDENT-IO$_{VOI}$	IDENT-IO$_{NAS}$	UNIFORMITY-IO
a. ☞ [$^{n}d_{12}$ e.xa]			*	*	*
b. [n_1e.xa]		*!			
c. [n_1t_2 e.xa]	*!				

In the preceding tableau, the optimal candidate is one that avoids the marked *NC̥ onset cluster without deleting the root segment. In an OT analysis, the harmony of candidates is determined strictly by constraint interaction. Two possible output candidates are [t_2e.xa] that deletes the nasal and another one that inserts a vowel between the initial nasal and the following plosive resulting in [n_1i.t_2e.xa]. Apparently, two faithfulness constraints; the general anti-deletion, MAX-IO and the anti-epenthesis, DEP-IO, disqualify them largely because in Lubukusu syllabification, the IDENT-IO families of constraints are consistently violated to satisfy high-ranked markedness and faithfulness constraints. The *NC̥, the PF constraint (MAX-IO$_{ROOT}$), MAX-IO and DEP-IO are ranked above the IDENT-IO constraints as follows; *NC̥, MAX-IO$_{ROOT}$ ≫ MAX-IO, DEP-IO ≫ IDENT-IO$_{NAS}$, IDENT-IO$_{VOI}$, UNIFORMITY-IO. The following tableau incorporates the two proposed candidates and the faithfulness constraints. The interaction of markedness constraints and faithfulness constraints (both positional sensitive and a general one) is shown in the following comparative tableau. It is imperative that MAX-IO and DEP-IO are ranked above the IDENT-IO constraints to ensure that the optimal candidate is the attested form in Lubukusu. This is because these two candidates have exactly one violation against three incurred by the optimal candidate in the tableau 4 as follows;

(4). /N$_1$-t$_2$exa/ → [$^{n}d_{1,2}$ e.xa] 'I boil'

/N$_1$-t$_2$exa/	*NC̥	MAX-IO$_{ROOT}$	MAX-IO	DEP-IO	IDENT-IO (nas)	IDENT-IO(voi)	UNIFORM-IO
a. ☞[$^{n}d_{12}$ e.xa]					*	*	*
b. [n$_1$e.xa]		*!					
c. [n$_1$t$_2$e.xa]	*!						
d. [t$_2$ e.xa]			*!				
e. [n$_1$i.t$_2$ e.xa]				*!			

Note that candidate (4d) and (4e) are suboptimal because they violate MAX-IO and DEP-IO which are satisfied by (4a). In the data below, a sequence of a nasal plus a voiced fricative is also marked and the resolution results in the formation of prenasalized stop as observed in the preceding example.

(5) The nasal + voiced fricative sequence

	Input	Output	Gloss	Repair mechanism
(i)	/N-βala/	[^{m}ba.la]	'I count'	
(ii)	/N-βoa/	[^{m}bo.a]	'I tie'	Place assimilation, post-nasal hardening and
(iii)	/N-βea/	[^{m}be.a]	'I lie'	formation of prenasalized stops
(iv)	/N-βeka/	[^{m}be.ka]	'I shave'	

The input /N- βala/ yields the output [^{m}ba.la] 'I count' resulting from nasal place assimilation and post-nasal hardening. The root consonant is not deleted due to the undominated MAX-IO$_{ROOT}$ a positional faithfulness constraint; instead, it is retained but hardened into a prenasalized stop (based on the strength scale). The data indicate that the input nasal assimilates to the place of articulation of the following voiced bilabial fricative [β]. The fricative hardens to a stop [b], but because the language does not have this voiced stop in its phonemic inventory, the result is a voiced bilabial prenasalized stop [^{m}b], which is part of Lubukusu consonant phonemes. The nasal does not delete because the two sounds share the voicing feature [+voice] and the voiced fricative is weaker than the voiceless stop, the two merge into the near similar voiced prenasalized stop [^{m}b].

Pater (1999, 2001) had proposed *NC̥ markedness constraint that should penalize input onsets having a voiceless obstruent following a nasal. This constraint cannot ban the above sequences based on the ranking adopted for tableau (3) above. The inadequacy of the *NC̥ is quite apparent in the absence of other constraints as shown in the tableau (6). The tableau yields unattested form as optimal because *NC̥ is only relevant in banning the voiceless fricative (the offending candidate is specified as [+voice]). This constraint declares candidate (b) as optimal based on the hierarchy, yet it violates the sonority profile (SSP) required in the onset.

(6) /N$_1$-β$_2$eka/ → [^{m}b$_{12}$e.ka] 'I shave'

/N$_1$-β$_2$eka/	*NC̥	*CODA	MAX-IO ROOT	MAX-IO	IDENT-IO NAS	UNIFORMITY -IO
a.☹[^{m}b$_{12}$e.ka]					*!	*
b.☜[m$_1$β$_2$e.ka]						
c.☜[m$_1$.β$_2$e.ka]						
d. [m$_1$e.ka]			*!			
e. [β$_2$e.ka]				*!		

Lubukusu allows NG sequence only in the onset to ensure a rising sonority hence a nasal plus voiced fricative sequence creates a sonority reversal. It is, therefore, proposed that the Sonority Sequencing Principle (SSP) constraint be included to get the true optimal candidate. Note that candidate 6(c) with a syllabic nasal violates *PEAK-C because the nasal is transformed into a syllabic consonant but the context is not appropriate for the formation of a syllabic nasal (cf. 3.3) as shown in tableau (7).

(7) /N_1-$\beta_2$eka/ → [$^{m}b_{12}$e.ka] 'I shave'

/N-βeka/	SSP	*CODA	MAX-IO ROOT	MAX-IO	*PEAK-C	IDENT-IO	UNIFORM-IO
a.☞ [$^{m}b_{12}$e.ka]						*	*
b. [$m_1\beta_2$e.ka]	*!						
c. [m̩$_1$.β_2e.ka]					*!		
d. [m_1 e.ka]			*!				
e. [β_2e.ka]				*!			

Thus far, the tableau yields the correct optimal candidate based on the established ranking. In a PF analysis, it is important that the root segment [β] is not deleted as demanded by the top-ranked PF constraint; MAX-$IO_{ROOT.}$

Finally, we analyze the formation of prenasalized stops from a different sequence. From our data in (1), whenever a nasal is followed by any of the two alveolar liquid sounds, the nasal assimilates to their place of articulation so that it is transformed into a voiced alveolar prenasalized stop. The liquid sounds in Lubukusu are articulated at the alveolar ridge; consequently, this sequence takes on the homorganic voiced alveolar prenasalized stop [^{n}d]. This is because the alveolar ridge is the place of articulation for the two liquids in the language. The weak liquids are realized as a strong stop [^{n}d] on the strength scale as shown in data (8).

(8) Nasal + Liquid Sequence

	Input	Output	Gloss	Repair mechanism
(i)	/N_1-$l_2$ima/	[$^{n}d_{12}$i.ma]	'I dig'	
(ii)	/N_1-$l_2$oma/	[$^{n}d_{12}$o.ma]	'I speak'	Nasal place assimilation, post-nasal
(iii)	/N_1-$r_2$ura/	[$^{n}d_{12}$u.ra]	'I depart'	hardening and formation of prenasa-
(iv)	/N_1-$r_2$ema/	[$^{n}d_{12}$e.ma]	'I cut'	lized stops

Predictably, the NÇ constraint, without other markedness constraint, cannot yield the expected optimal candidate. A specific SSP constraint; $SSP_{PLATEAU}$ (Morelli, 2003), is introduced to rule out such a sequence because it violates the SSP by creating a sonority plateau. Sound segments from the same manner class (sonorants) in an onset cluster form a sonority plateau. The ranking proposed is; NÇ, $SSP_{PLATEAU}$, ≫ IDENT-IO_{NAS}, IDENT-IO_{SON}, UNIFORMITY-IO. By incorporating $SSP_{PLATEAU}$ in the tableau, the correct optimal candidate is predicted in tableau (9).

(9) /N_1-$l_2$ima/ → [$^{n}d_{12}$i.ma] 'I dig'

/N_1-$l_2$ima/	NÇ	$SSP_{PLATEAU}$	MAX-IO ROOT	MAX-IO	*PEAK-C	IDENT-IO_{NAS}	IDENT-IO_{SON}
a.☞[$^{n}d_{12}$i.ma]						*	*
b. [n_1l_2i.ma]		*!					
c. [$n_1$ima]			*!				
d. [l_2i.ma]				*!			
e. [n̩.l_2i.ma]					*!		

In the tableau, it is apparent that the optimal candidate is the one that does not have a sonority plateau in the onset. This is the crucial between candidate (a) and candidate (b). Fortuitous deletion of the root or prefix segment as observed in (c) and (d) leads to unmotivated violations similar to formation of syllabic segment in an environment that is infelicitous as indicated by the violation marks in the sub-optimal candidate (e).

3.2 Nasal Deletion

In the preceding section, the unacceptable *NC syllable onset sequences were repaired through formation of prenasalized stops. However, if the nasal is followed by a voiceless fricative, the nasal deletes; a common cross-linguistic tendency (Padgett, 1995; Ohala, 1995; Pater, 1999; Baković, 2007). What is of interest in PF is the fact that it is the nasal consonant that is deleted and not the fricative because the latter is in a privileged position: syllable onset initial and also it is part of the root (a privileged position as well). On the other hand, the nasal is an affix which in this case is a non-privileged position because it is a prefix and not a root.

(10) *NC̥ resolution through nasal deletion

Prefix		Root		Surface Form	Gloss
(a)	/N	+	sila/	→ [si.la]	'I keep quiet'
(b)	/N	+	funa/	→ [fu.na]	'I break'
(c)	/N	+	xala/	→ [xa.la]	'I cut'

From the analysis adopted in section 3.1 on *NC̥ effects, it may be argued that a positional faithfulness constraint against deletion of segments in the roots/stems is responsible for the deletion of the prefix nasal rather than the fricative onset segment which is in the root. The constraints responsible for the deletion is the markedness constraint *NC̥ and faithfulness constraint against deletion of root segments, MAX-IO_{ROOT}. Both constraints dominate the general MAX-IO thus: *NC̥, MAX-IO_{ROOT} ≫ MAX-IO.

(11) /N_1-$f_2$una/ → [f_2u.na] 'I break'

/N_1-$f_2$una/	*NC̥	MAX-IO_{ROOT}	MAX-IO
a. ☞[f_2u.na]			*
b. [n_1u.na]		*!	
c. [nf_2u.na]	*!		

From the tableau (11), it is apparent that the two undominated constraints engender the violation of the low ranked MAX-IO resulting in the deletion of the prefix nasal thus avoiding the emergence of a syllable with a marked onset (candidate c) or one that deletes the root consonant (candidate b). However, there are potentially more candidate outputs for the given input. Besides, there is need to show that it is not root faithfulness alone that plays a role in the evaluation of the optimal candidate. Similarly, while the result in tableau (11) may be satisfactory in terms of avoiding the marked NC̥ onset cluster, there is no indication as to why the nasal deletes and not the fricative consonant. There are some positional faithfulness constraints working in conjunction with some markedness constraints to ensure the resolution of the *NC̥ does not delete the segment in the root or initial position of the stem.

Note that the fricative consonant forms the onset of the following syllable of the root to which the nasal prefix is attached. This segment is not just part of the root, but it is part of the initial syllable of the root as well; these are two privileged positions in terms of positional faithfulness. In this analysis, the MAX-IO_{ROOT} constraints will ensure no part of the root is deleted for whatever reasons, while a positional faithfulness constraint, MAX-IO_{ROOT} (σ_1), ensures that syllables in the initial position of the roots are protected from deletion. In tandem, these constraints protect the fricative onset of the syllable from deletion, while targeting the nasal. MAX-IO (σ_1) is an undominated PF constraint in the language's constraint hierarchy as ranked in the following tableau.

(12) /N_1-$x_2$ala/ → [x_2a.la] 'I cut'

/N_1-$x_2$ala/	*NC̥	*CODA	MAX (σ_1)	IDENT-IO VOI & NAS	MAX-IO	IDENT VOICE	IDENT-IO_{NAS}	UNIFOR IO
a. ☞[x_2a.la]					*			
b. [n_1x_2a.la]	*!							
c. [$N_{1.}x_2$a.la]		*!						
d. [N_1a.la]			*!					
f. [$^{m}b_{12}$a.la]				*!		*	*	*

The introduction of the constraint that protects initial syllables against deletion obviates the need to use the faithfulness constraints of MAX-IO$_{ROOT}$ and MAX-IO giving the analysis a more uniform account of why roots and initial syllables are privileged positions in phonological repairs. In essence, the fricatives are not deleted in an NÇ onset sequence because they occupy a privileged position that is protected from deletion for the linguistic purpose of contrast maintenance besides providing cues for lexical access and storage (Swinney, Prather & Love, 2000; Levelt, 2001, among others).

3.3 Formation of Syllabic Nasals

In Lubukusu, the nasal is the only consonant that can act as a syllabic peak and no other onset cluster can be optimal except the CG which includes a nasal glide sequence. Given these facts, it follows that a sequence of a nasal-nasal in the onset position will be banned. In morpheme concatenation, any possibility of a nasal-nasal sequence emerging during the mapping process between the input and output will initiate some repair process. In the language, as already illustrated, a nasal-nasal sequence is a possibility because of prefixing the first-person archiphoneme nasal before a nasal root verb to indicate an action by a first-person singular in the present tense. There is need to establish the unity among the constraints if similar constraints and their ranking can account for different manifestations of the *NC resolution to show the 'homogeneity of target and the heterogeneity of process'. The data display the four syllabic nasals in the context of *NC typology effects based on the four places of articulation of Lubukusu nasals.

(13) Syllabic nasals from *NC effects (Nandelenga, 2014).

	Prefix 'N'+ stem	Surface form	English gloss
(a)	/N-nina/	[n̩.ni.na]	'I climb'
(b)	/N-maɲa/	[m̩.ma.ɲa]	'I know'
(c)	/N-ɲala/	[ɲ̩.ɲa.la]	'I can/ am able'
(d)	/N-ŋona/	[ŋ̩.ŋo.na]	'I make'

The data indicate that a nasal-nasal sequence is a marked onset cluster within the broad *NC typology. The marked status of the nasal-nasal sequence induces the syllabic phonotactics of the language to initiate some repairs to ensure this sequence does not occur in the output. From the point of view of sonority, two nasals in the onset position form a sonority plateau because they have the same sonority index, yet ideally, sonority should rise from the initial consonant in the onset cluster to the next up to the peak nucleus. This requirement forces the initial nasal to separate into a distinct syllable thus forming a syllabic segment. The repair strategy entails the promotion of the initial nasal in the sequence into a syllabic nasal that occupies the peak of the new syllable. This process violates the universal constraint against a consonantal nucleus. It is hereby proposed that SSP$_{PLATEAU}$ dominates the anti-consonantal peak constraint; *PEAK-C, as follows;

(14a) /N_1-$n_2$ina/ → [$n̩_1$.n_2i.na] 'I climb'

/N_1-$n_2$ina/	SSP$_{PLATEAU}$	*PEAK-C
a. ☞ [$n̩_1$.n_2i.na]		*
b. [n_1n_2i.na]	*!	

In the tableau, candidate (a) having transformed the initial nasal into syllabic consonant is optimal. However, candidate (b) incurs a fatal violation mark because the two nasals form an unacceptable onset cluster. Similarly, it is possible that the SSP$_{PLATEAU}$ constraint may be operating alongside other constraints against a sequence of two nasal consonants. For instance, OCP (Myers, 2004) as a markedness constraint demands that adjacent segments are not similar in some phonological features; segments in the same syllable onset cannot be of the same type. This may be responsible for the upgrading of the initial nasal into the syllable peak position. In a PF analysis, it is instructive that the prefix nasal is the one that is targeted for feature change from [-syllabic] to [+syllabic] but not the root nasal. Neither segmental epenthesis nor deletion is used as a repair strategy, implying that there are faithfulness constraints ranked above *PEAK-C. The general MAX-IO and DEP-IO should dominate *PEAK-C. The final ranking should therefore be: OCP, MAX-IO$_{ROOT}$ ≫ MAX-IO, DEP-IO ≫ *PEAK-C. Both OCP and MAX-IO$_{ROOT}$ are undominated because they are never violated in the Lubukusu phonology. The SSP$_{PLATEAU}$ constraint is left out to avoid constraint redundancy; it has the same effect as OCP.

(14b) /N$_1$-n$_2$ina/ → [n̩$_1$.n$_2$i.na] ‘I climb’

/N$_1$-n$_2$ina/	OCP	MAX-IO$_{ROOT}$	MAX-IO	DEP-IO	*PEAK-C
a.☞[n̩$_1$.n$_2$i.na]					*
b. [n$_1$n$_2$i.na]	*!				
c. [n$_1$i.na]		*!			
d. [n$_2$i.na]			*!		
e. [n$_1$i.n$_2$i.na]				*!	

The optimal candidate has the least costly violation of the lowest ranked constraint; *PEAK-C. In the grammar of the language, it is better to form a syllabic nasal than map the two nasals into the onset position. Furthermore, neither deletion nor epenthesis can derive an acceptable output.

However, based on Richness of the Base (ROTB) concept, one more possible candidate could be included in the tableau, one that actually merges the two nasals into one (similar to the formation of a prenasalized stop). Note that formation of a prenasal involves coalescence or fusion in which two segments in the input are mapped onto one segment in the output. However, UNIFORMITY-IO forbids such kind of merger. The coalesced nasals have two morphemes merged into one contrary to the constraint requiring that every input morpheme is realized by some phonological output material.

The relevant constraint is REALIZE-MORPHEME, in short, REAL-MORPH (Kurisu, 2001; Trommer, 2008) which is not violated in prenasalized stops. This constraint states that for every morpheme in the input, some phonological element should be present in the output. REAL-MORPH constraint should be ranked either above or together with *PEAK-C. Considering that such a candidate already violates the UNIFORMITY-IO, it will be appropriate to rank REAL-MORPH together with *PEAK-C then the lower ranked constraint will ultimately determine the optimal candidate ranked as follows: OCP, MAX-IO$_{ROOT}$ $\gg$ MAX-IO, DEP-IO $\gg$ REAL-MORPH, *PEAK-C $\gg$ UNIFORMITY-IO whose interaction is shown in tableau 14c.

(14c) /N$_1$-n$_2$ina/ → [n̩$_1$.n$_2$i.na] ‘I climb’

/N$_1$-n$_2$ula/	OCP	MAX-IO$_{ROOT}$	MAX-IO	DEP-IO	REAL-MORPH	*PEAK-C	UNIFORM-IO
a.☞[n̩$_1$.n$_2$i.na]						*	
b. [n$_1$n$_2$i.na]	*!						
c. [n$_1$i.na]		*!					
d. [n$_2$i.na]			*!				
e. [n$_1$i.n$_2$i.na]				*!			
f. [n$_{12}$i.na]					*		*!

From the tableau, it can be inferred that the language prefers the initial nasal (also the 1st person prefix morpheme) to be realized in some form rather than being deleted or merged altogether. The formation of a syllabic nasal maintains the status of this morpheme in some phonological form. This differentiates candidate (a) which is optimal from the candidate (f) that is sub-optimal because of fusing the first-person prefix and root morpheme nasals. This confirms the typology of *NC effects in the language: no onset cluster is licit in Lubukusu onset cluster except a consonant-glide (CG) sequence.

4. Discussion

The analysis and results points to the role of positional faithfulness in ensuring that the marked *NC onset cluster is repaired in a manner that preserves the integrity of the sounds in linguistically prominent positions. In the formation of prenasalized stops, three processes are in operation simultaneously; nasal place assimilation, postnasal voicing and postnasal hardening. Simultaneous process can only be captured in an output-oriented Optimality Theory whose evaluation is global thus avoiding the rule ordering paradoxes of the Generative tradition. Nasals are underlyingly unspecified for place of articulation. In the input-output mapping process during the repairs, the nasal must acquire the place of articulation of the following root consonant. If the root consonant is voiceless, voice assimilation, which is always regressive (Lombardi, 1999), must take place by voicing the obstruent. This is because of anticipatory articulation of the adjacent nasal and obstruent resulting in voicing of the latter because the glottis is in a voicing state when the obstruent is articulated. The natural unmarked status of sonorants is to be voiced hence the sonorant nasal does not lose its voicing. Lubukusu does not have voiced plosives in its phonemic inventory, therefore, the result is a voiced prenasalized stop. This sound is part of the phonemic inventory of the language. However, the root obstruent retains its status as an obstruent with sufficient contrast with other phonemes in the language.

In postnasal hardening, voiced fricatives and liquids, which as typically weak on the strength scale (Lavoie, 2001), they therefore harden or undergo fortition resulting in a prenasalized stop (cf. 3.1above). It is important to note that previous proposals by Pater (2001, 2004) to handle nasal plus voiceless obstruent sequence cannot deal with the rich typology of *NC effects found in Lubukusu. This study proposes an enriched constraint set which includes positional faithfulness constraints to deal with cases where the marked onset cluster involves a voiced sound following the nasal. In such a case, the *NC̥ constraint fails to penalize the cluster. Syllabic wellformedness requirements demands that the resultant output syllable conforms to the attested form in the language. Formation of prenasalized stops becomes the optimal output because the syllable phonotactics of the language does not permit an onset cluster containing a nasal plus a liquid or a voiced fricative [β]. However, in the repair, the prefix nasal is the one targeted for repair losing its status as a phoneme; its presence is only as residual nasality on the stops (a prenasalized stop). This is the essence of MAX-IO_{ROOT} effects that preserves the syllable-initial and root segments.

In segmental deletion, both phonetic factors and positional privilege play part. Nasals delete because they are weak phonetically and secondly, because they occupy the prefix position that is not psycholinguistically and phonetically prominent in language processing. Faithfulness to the root segment ensures that the voiceless fricatives that follow the nasals are preserved. In speech production, articulation of fricatives requires a lot of air to exit through the mouth. Due to the nature of anticipatory speech production that involves substantial overlap, the nasal is denied air with very little left to flow through the nose. The result is deletion of the prefix nasal. OT constraints are phonetically grounded and supplemented by the positional faithfulness constraints, it is possible to account for the resolution of *NC markedness while preserving segments in phonetically prominent positions. Any *NC resolution cannot compromise the perceptual distinctiveness of any sound segments.

Similarly, resolution of *NC may result in promotion of the prefix nasal into an independent syllable. Perceptual reasons may mitigate against feature change in the root nasal because the top-ranked positional faithfulness constraint demands featural preservation in such positions. The constraint against consonantal nucleus must be low-ranked but one that preserves root or root-initial sounds top-ranked to engender the formation of syllabic nasals. The results also point to some crosslinguistic tendencies and has implications for the concept of Universal Grammar (UG) as proposed within the Generative Theory paradigms. First, the study converges with Beckman (1997) study of Shona, a related Bantu language spoken in Zimbabwe in which positional neutralization of vowel contrast is only possible in nonprivileged positions but blocked in psycholinguistically prominent positions. In both cases, the repairs are initiated by markedness constraints but PF constraints may block the repair for purposes of maintaining perceptual contrast in certain privileged positions. Deletion or feature change fails if position sensitive constraints outrank the markedness constraints initiating the repair processes as observed in *NC repairs discussed above.

In addition, the analysis mirror Beckman et al (2009) observation on voicing contrast and neutralization in German. Based on experimental evidence, it is observed that there is indeed no coda devoicing of stops in German as such because all stops emerge unvoiced. However, fricative may be devoiced (because they are specified for the feature [+ voice]) but this is positional sensitive in the sense that constraints ban voicing in the coda position yet preferentially preserves voicing in the presonorant position (Beckman et al, 2009:232). This can only be best accounted for through a PF account adopted in this study in which it is argued that positions that are critical for language processing are protected from any form of neutralization (Levelt, 2001; Swinney et al, 2000). This effect is apparently possible only when there is high-ranking of the PF constraints (Beckman, 1999, 2004; Beckman et al, 2009) suitably ranked in a language specific constraint hierarchy.

5. Summary and Conclusion

In this study, the *NC onset clusters are repaired in a manner that is constrained by positional faithfulness of the root or initial syllable segments. The segment/features of the root initial consonants are crucial in linguistic processing, hence resist deletion and or feature change. In prenasalized stop formation, the place features of the root segments are kept intact in the course of repairing the *NC markedness. The positional faithfulness constraints are responsible for the maintenance of the [+place] specification of all the root initial consonants. In deletion, it is the prefix nasal that deletes but not the voiceless fricative which is in the privileged root position. Similarly, the prefix nasal features changes from [-syllabic] to [+syllabic] but not the root nasal features.

In a nutshell, positional sensitive constraint interaction is all that is needed to account for the preservation of features and segments in specific positions of a prosodic word. Suitably ranked, both markedness and faithfulness constraints are able to account for why, in certain positions, expected deletion of segments or featural change is not tolerated. This is because such sound segments are faithful to their underlying feature specifications in privileged positions due to psycholinguistically relevant perceptual and processing reasons. Segments in prominent positions consistently resist alternations motivated by the need to maintain phonological contrast in prominent positions for language processing and perceptual distinctiveness purposes.

However, literature has some counter examples in the form of positional markedness preserving marked segments in some prominent positions. In Tswana, a Bantu language spoken in Botswana, for example, voiced segments following nasals are actually devoiced (Hyman, 2001; Zsiga et al, 2006) which is contrary to the unmarked status of onset clusters advocated for in this paper. Further studies are required to unravel the phonetic basis of a language preferring a voiceless stop after a nasal, which may also point to the inadequacy of Pater (2001) *NÇ constraints. Indeed, some linguists such as Hyman (2001) are opposed to what they call 'phonetic determinism' in phonology, instead proposing a counter constraint *ND that should penalize voiced obstruents after a nasal stop which is assumed to be active in languages such as Tswana. This requires more investigation on the phonetic grounding of phonological constraints in an OT grammar.

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