Vowel Hiatus Resolution in Lubukusu Revisited: A Positional Faithfulness Reanalysis

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Abstract: Previous phonological studies have indicated that a sequence of dissimilar hetero-syllabic/morphemic vowels are dispreferred across languages because it creates vowel hiatus. As a result, it may engender multiple repair mechanisms. However, the repair mechanisms do not apply liberally; they may be resisted in certain positions when segmental deletion or featural change fail to take place. Segments in phonetically and psycholinguistically privileged positions invariably resist such repair strategies that may be quite regular in the grammar of the language. In this study, a reanalysis of data from Lubukusu language (Bantu, Kenya) shows that a Positional Faithfulness (PF) account within an Optimality Theory (OT) framework may be felicitous in explaining both the initiation and resistance to the said repair processes. The findings indicate that the positional faithfulness of the vowel in question may determine whether it is deleted, or which features may be changed based on a single constraint hierarchy in an optimal grammar of the language. Preservation of lexical contrast in positions that are critical in language processing is accounted for through positional sensitive constraint domination.

Keywords: Language processing, Markedness, Optimality, Positional faithfulness, Vowel hiatus

How to Cite this Article:

Nandelenga, H. S. (2022). Vowel Hiatus Resolution in Lubukusu Revisited: A Positional Faithfulness Reanalysis. *Journal of Linguistics, Literary, and Communication Studies, 1*(2), pp. 29-43.

Introduction

Languages generally avoid a sequence of dissimilar vowels across morpheme boundaries because they create vowel hiatus that is generally not tolerated. Whenever morpheme concatenation appears to create vowel hiatus, this may be prevented through a number of repair processes mainly glide formation, diphthongization, vowel height coalescence, vowel deletion or consonant epenthesis. Other processes include assimilation and secondary articulation (Kadenge, 2013). Vowel hiatus repair processes are quite pervasive to the extent that they have come to be referred to as Vowel Hiatus Resolution (VHR-Casali & Casali, 1998; Ngunga, 2000; Wasike, 2004; Baković, 2007; Tanner, 2007, Kadenge, 2013, 2014; Simango & Kadenge, 2014; Kadenge & Simango; Vratsanos & Kadenge, 2017, among others). Whichever strategy the language may use to resolve vowel hiatus is largely determined by vowel height features, the vowel inventory, the vowel height system, the position of the vowel in the morphemes (whether V_1 or V_2) and other morphosyntactic factors besides phonology. In most languages, based on the preceding parameters, the vowel to be deleted or transformed in feature values, for instance, may be predictable (Tanner, 2007).

In standard Generative Phonology (GP), the repairs were dubbed 'conspiracies', (Kenstowicz & Kisseberth, 1979) because different processes were set in motion whenever such sequences emerged. In Optimality Theory (hereafter OT-Prince & Smolensky, 2004), they are referred to as 'homogeneity of target and heterogeneity of process' (McCarthy, 2002:93). The problem with the rule-based derivational analysis of GP was that because the rules are blind to outputs, they could freely apply so long as their structural description is met. The consequence is that the repairs could produce non-recurrent forms or worse, the very exact marked structures they were supposed to eliminate. In vowel hiatus resolution in derivational rule formalism perspective, for instance, the choice of the vowel to be deleted could be determined by the relevant rule with no role ascribed to contextual factors or prediction of the possible target vowel. However, Casali and Casali (1998) argue that at the boundary between a minimally CV prefix and root, deletion invariably targets the initial vowel (V_1) due to anticipatory articulation. Another drawback in the generative approach is the requirement on the condition, for instance in coalescence, to be dependent on a 'counterfactual result' as reported by Baković, (2007) in Chicano Spanish. In this language, coalescence and glide formation are possible repairs given a mid + high sequence. However, derivational analysis does not indicate that coalescence is the preferred repair (to preserve the [+High] features of the root V_2) instead relies on counterfactual derivation evidence to arrive at the optimal process in the resolution of vowel hiatus. This is the basis for a recourse to a Positional Faithfulness (hereafter, PF) analysis within OT where repairs are explained purely in terms of positional sensitive faithfulness constraints interacting with some markedness constraints that ban vowel sequences that create hiatus.

In this paper, Positional Faithfulness (Beckman, 2004, 2013) a theory couched within OT, provides an alternative account for the positional resistance to phonological repair processes in some position and not others and why feature change is preferred over total deletion in certain positions. Note that PF is a term that refers to the idea that in some psycholinguistically privileged positions in the phonology of a language, there is a unique attempt to maintain vocalic and featural contrast which is neutralized elsewhere. Vowels remain faithful to their underlying lexical representation in the input-output mapping. Typically, privileged positions are occupied by vowel segments which are root initial, part of the root, in stressed syllables and long vowels.

Phonologically, privileged positions enjoy perceptual privilege over the non-privileged positions in language processing through phonetic or psycholinguistic prominence (Zhang, 2020; Jesney, 2016) as indicated by increased duration or amplitude, pitch extrema and release burst, among others, that enhances perceptual distinctiveness (Flemming, 2006). Phonological asymmetries serve as diagnostic of positional privilege which in a PF account, are positional maintenance of contrast that is neutralized elsewhere, and positional resistance of phonological processes initiated or applying elsewhere (Beckman, 2004; Jesney, 2016; Kaplan, 2018; Zhang, 2020).

Lubukusu, similar to a number of languages, does not allow a sequence of dissimilar vowels (i.e., $V_{1\#}V_2$), that are hetero-syllabic at morpheme juncture. Affixation, morpheme concatenation and other morphological operations may, however, create such a marked sequence of adjacent dissimilar vocalic peaks. Vowel Hiatus Resolution (hereafter, VHR) is a common phenomenon in the language as well and a positional faithfulness account can be extended to its analysis. In vowel hiatus resolution, not all vowels are targeted for deletion, glide formation or merger processes. Certain vowels are protected from deletion and featural change and it may be argued that such vowels occupy privileged positions and, are therefore, expected to be faithful to the underlying form for contrast preservation and language processing. The idea of being faithful to the input form means that such vowels will resist feature change or deletion on the surface forms.

In psycholinguistics, the privileged positions are critical in general language processing by providing necessary cues for lexical storage, access/retrieval besides general language processing (Levelt, 2001; Meyer & Belke, 2007). Due to this, vowels in privileged positions are often protected from neutralization processes, featural alteration and or total segmental deletion. Faithfulness constraints that are positional sensitive play a key role in explaining the blocking of vowel hiatus resolution processes targeting vowels in the privileged positions. The PF theory, therefore, may provide the basis for the existence of phonological asymmetries initiated by vowel segments located in perceptually or psycholinguistically prominent positions. In Wasike (2004) and Nandelenga (2013), vowel hiatus resolution in Lubukusu involves vowel deletion, vowel merge, featural change and consonant epenthesis. However, no explanation is offered as to why, for example, syllable or root initial vowels do not undergo feature change nor segmental deletion. This study attempts to provide an account based on positional faithfulness constraints.

This paper is organized as follows; the first section provides data on vowel hiatus and the available repair mechanisms. This is followed by the PF analysis of vowel hiatus resolution using three strategies. The remaining sections looks at deletion strategy, glide formation and vowel height coalescence strategy.

Data on Lubukusu Vowel Hiatus Resolution

In the following data, it is apparent that the three VHR processes are quite pervasive in the language. Note that morpheme boundaries are marked by the # so that vowel one (V1) is to the left and vowel two (V2) is to the right of the boundary as indicated in the data (see input vowels written as (V_1 # V_2). Also, the underlying phonological form is enclosed in slanting lines while the surface phonetic forms are enclosed in square brackets as conventionally done in phonological analysis involving input-output mapping. An English gloss for each output form is indicated and finally the repair mechanism taking place for each paired input-output. Note: dim= diminutive. The data show VHR utilizing glide formation, deletion and coalescence as repair mechanisms. Although the language utilizes four strategies in VHR namely; glide formation, coalescence, deletion and consonant epenthesis, this paper examines the first three processes. This is because epenthesis applies whenever the three repair processes fail, and it is not determined by any positional faithfulness of the adjacent dissimilar vowels. Finally, VHR fails if the initial vowel is an onsetless syllable and also morphemic and, therefore, responsible for lexical contrast as shown in data (2).

(1) VHR via vowel deletion, glide formation and coalescence

	Input Vs	**Input form**	**Output form**	**Gloss**	**Repair**
(i)	/o$_1$ # a$_2$/	/ojo$_{1+}$a$_2$ca/	[o.ja$_2$:.ca]	'that one goes'	deletion
(ii)	/a$_1$#e$_2$/	/ca$_1$+e$_2$jo/	[ce$_2$:.jo]	'go there'	deletion
(iii)	/i$_1$ # a$_2$/	/βiβi$_1$+a$_2$na/	[βi.βj$_1$a$_2$:.na]	'children (dim)'	gliding
(iv)	/u$_1$ # e$_2$/	/omu$_1$+e$_2$ji/	[o.mw$_1$e$_2$:ji]	'a prostitute'	gliding
(v)	/a$_1$ # i$_2$/	/kama$_1$+i$_2$no/	[kame$_{12}$:no]	'teeth'	coalescence
(vi)	/a$_1$ # i$_2$/	/βa$_1$+i$_2$ra/	[βe$_{12}$:ra]	'they kill'	coalescence

(1a) VHR via glide formation

(a) V1 # V2 — Glide formed

/i + a, o, u, e/ → [j] voiced palatal glide

V1 + V2	Input	Output	Gloss
(i) [i + a]	/βiβi + ajo/	[βiβja:jo]	'livestock'
(ii) [i + o]	/kimi + oko/	[kimjo:ko]	'cassava'
(iii) [i + u]	/βiβi + uma/	[βiβju:ma]	'beads'
(iv) [i + e]	/kimi + eɲa/	[kimje:ɲa]	'songs'

(b) V1 # V2 — Glide formed

/u + a, e, i, o/ → [w] voiced labio-velar glide

V1 + V2	Input	Output	Gloss
(i) [u + a]	/lulu + ana/	[lulwa:na]	'childishness'
(ii) [u + e]	/βuβu +eni/	[βuβwe:ni]	'face'
(iii) [u + o]	/βuβu +oni/	[βuβwo:ni]	'sins'
(iv) [u + i]	/lulu + ika/	[lulwi:ka]	'a horn'

(1b) VHR via vowel deletion

(a) V1 # V2 — V1 Deletion

/a + e, o/ → /a/ deleted

V1 + V2	Input	Output	Gloss
(i) [a $_1$# e$_2$]	/ca$_1$+e$_2$jo/	[ce$_2$:.jo]	'go there'
(ii) [a + o]	/xupa + ojo/	[xupo:jo]	'beat that person'

(b) V1 # V2 — V1 Deletion

/o + a, e/ → /o/ deleted

V1 + V2	Input	Output	Gloss
(i) [o + a]	/ojo + aca]	[oja:ca]	'that person goes'
(ii) [o + e]	/ojo + eca]	[oje:ca]	'that person comes'

(c) V1 # V2 — V1 Deletion

/e + a, o/ → /e/ deleted

V1 + V2	Input	Output	Gloss
(i) [e + a]	/oce + ao/	[oca:o]	'you go there'
(ii) [e + o]	/^{m}bone +ojo/	[^{m}bono:jo]	'I saw that person'

(1c) VHR via Vowel Height Coalescence

	V1 + V2	Input	Output	Gloss
(i)	[a + i]	/kama + ino/	[kame:no]	'teeth'
(ii)	[a + i]	/βa + ira/	[βe:ra]	'they kill'
(iii)	[a + i]	/kama + ici/	[kame:ci]	'water'
(iv)	[a + i]	/ka + iβa/	[ke:βa]	's(he) stole'

In vowel hiatus resolution in Lubukusu indicated above, some generalizations can be deduced. Glide formation, which involves feature change, targets the V_1 but not V_2. Deletion is sensitive to positional faithfulness (initial vowel ($V_{2)}$ in the root or stem is preserved). Also, deletion targets the [-high] vowels only. The root vowel is privileged against the prefix vowel but not initial suffix vowel. In addition, in coalescence, [-high] and [-low] features are always preserved.

Data Analysis and Findings

In this section, the VHR data are analyzed using OT formalism by identifying the relevant constraint for each emergent repair, their Lubukusu specific constraint hierarchy and finally, a comparative assessment of the optimal candidate (the true attested output form). The paper assumes some basic understanding of OT architecture especially as regards suitable constraint determination, their ranking, construction of the OT tableaux and evaluation of candidature harmony. In a PF analysis within the OT architecture, the repair processes are explained as driven by the high-ranking anti-hiatus markedness constraint; *HIATUS. This constraint interacts with three faithfulness constraints. First, the anti-deletion PF constraint MAX-IO_{ROOT}, or MAX-STEM (v_1), secondly, a faithfulness constraint that resists featural change of [+High] in glide formation; IDENT-IO (F) and finally, UNIFORMITY-IO, that prohibits coalescence of adjacent vowels into one. Deletion results in the vocalic mora being transferred to the following vowel due to mora preservation requirements. Similarly, in glide formation, the mora (which is autosegmental in nature), spreads to the residual vowel as the host which consequently lengthens in compensatory lengthening. This is driven by another faithfulness constraint IDENT-IO(μ) which demands that the input mora count must be preserved in the correspondent output vowel.

Lubukusu has five phonemic short vowels; /i/, /e/, /a/, /o/, and /u/ which are paired with five long contrastive (distinctive) counterpart vowels; /i:/, /e:/, /a:/, /o:/, and /u:/. The language has a three-height vowel system: high, mid and low. The height feature [+high] is protected so that in gliding, it is not lost. In coalescence, this feature is not actually lost as such, but it is fused with the low feature, resulting in a composite mid vowel. It is apparent that this feature is protected from absolute loss allowing only some feature change. This may explain why the [+high] vowels do not participate in the deletion process in the vowel hiatus resolution processes.

Vowel Deletion

Deletion is a common process in vowel hiatus resolution in which the first vowel (V_1) is deleted leaving the second vowel (V_2) intact. It is the linear order that is critical because the V_2 is often in the word/root initial. Deletion is used to resolve vowel hiatus when both vowels are specified as [-high] in height features. The initial vowel (V_1) must be a low or a mid-vowel followed by a low or mid vowel. The faithfulness constraint against deleting the morpheme initial vowel (MAX-IO (MI)) is important in this regard in preserving morpheme initial vowel. This constraint is a reflex of positional faithfulness which is recast as a positional faithfulness constraint for initial syllable vowels: the MAX-STEM (v_1) constraint. The initial [a] of [a.ca] is in the stem and therefore, protected from deletion based on the following constraint ranking; *HIATUS, MAX-STEM (v_1) ≫ MAX-IO whose interaction is captured in the following comparative tableau.

(2a) /o_1 # a_2/ /$ojo_{1+}a_2ca$/ → [$o.ja_2$:.ca] 'that one goes'

/$ojo_{1+}a_2ca$/	*HIATUS	MAX-STEM (v_1)	MAX-IO
a. ☞[$o.ja_2$:.ca]			*
b. [$o.jo_1$.ca]		*!	
c. [$o.jo_1.a_2$.ca]	*!		

The ranking of the more specific positional faithfulness constraint; MAX-STEM (v_1), above the general MAX-IO ensures the protection of the initial syllable vowel from deletion regardless of the demands of the *HIATUS constraint that is also undominated in the constraint hierarchy. However, there is need for a constraint that specifies that initial vowels of the morphemes are preserved. These must be one of the MAXIMALITY set of constraints (Kager, 1999). This study follows Wasike (2004) in using MAX-V (MI); which demands that the input morpheme initial segment must have a correspondent in the output, the equivalent of Casali and Casali's (1998) MAX-WI (Maximum Word Initial). This constraint should dominate MAX-V (MF), a constraint that demands protection of morpheme final vowels, and the general MAX-IO (V) to ensure that the word initial vowel is protected from deletion in VHR and not any vowel. These three constraints should interact with the constraint that drives hiatus resolution; *HIATUS and should be ranked as follows: *HIATUS, MAX-V (MI) ≫ MAX-V (MF) ≫ MAX-IO (V).

(2b) /o_1 # a_2/ /ojo_1-a_2ca/ → [$o.ja_2$:ca] 'that one goes'

/$juno_1$-a_2ca/	*HIATUS	MAX-V(MI)	MAX-V (MF)	MAX-IO(V)
a. ☞ [$ju.na_2$:ca]			*	*
b. [$ju.no_1$:ca]		*!		
c. [$ju.no_1a._2$:ca]	*!			

Candidate (a) is optimal for having the initial vowel deleted thereby removing the vowel hiatus in spite of the violation of MAX-IO (V). Candidate (b) deletes the second vowel rather than the first, violating MAX-V (MI). Finally, candidate (c) does not remove the vowel hiatus; this is in violation of *HIATUS constraint. Note that the optimal candidate vowel (V_2) undergoes compensatory lengthening once it takes over the mora from the deleted segment, a violation of IDENT-IO (μ) because the input V_2 has one mora while the output has two. The constraint that demands mora correspondence; (IDENT-IOμ), must be dominated. Another constraint penalizes candidates that delete segments without mora preservation; $MAX\text{-}IO_{MORA.}$ Note that diphthongization is not one of the repair strategies in Lubukusu, diphthongs are consistently banned in the language by *DIPH constraint that is also an undominated constraint. This is apparent in the following enriched tableau containing more constraints and candidates.

(2c) /o_1 # a_2/ /$ojo_{1+}a_2ca$/ → [$o.ja_2$:.ca] 'that one goes'

/ojo_1-a_2ca/	*HIATUS	*DIPH	$MAX_{STEM\ (\sigma 1)}$	MAX_{MORA}	IDENT [-L]	MAX(V)	IDENT-IO(μ)	UNIFO-IO

a.☞o.ja$_2$:.ca						*	*	
b.o.jo$_1$.a$_2$.ca	*!							
c. o.jo$_{1.}$ca			*!					
d. o.ja$_{2.}$ca				*!				
e. o.jo$_1$a$_2$.ca		*!						
f. o.ja$_{12.}$ca					*!		*	*

The fact that the second vowel (V_2) is not deleted has been argued to be due to its position in word initial syllable. However, from a phonetic point of view, anticipatory co-articulation is likely to result in elision of V_1 due to gestural overlap (Chotaran et al., 2001). Word initial syllables are important cues for lexical access from a psycholinguistic point of view hence languages tend to protect them from deletion, neutralization and general assimilatory processes. These privileged positions enjoy some perceptual advantage in the processing system because of their prominence phonetically or psycholinguistically over the non-privileged positions.

According to Beckman (2004), psycholinguistically prominent positions are those that carry the most burden in lexical storage, access and processing. However, positional privilege is not determined solely on grounds of perception as it may be manifested in patterns of phonological asymmetry relevant to deletion in vowel hiatus resolution. It may, therefore, be argued that vowel deletion in the root or word initial position may neutralize the contrast that is crucial for lexical distinction. This is a case of resistance to the deletion process due to positional privilege even when deletion of any of the two vowels would actually remove vowel hiatus.

A central claim in OT is that each of these phonological asymmetries arises from constraint interaction in which positional faithfulness constraints crucially dominate context free faithfulness and markedness constraints. In the data on deletion, the V_1 (word final or prefix vowel) is normally deleted due to the higher ranked positional faithfulness constraint against deleting the initial syllable vowel of the following morpheme (V_2). The relevant constraint must specify that initial vowel segments of root morphemes are preserved in deletion such as the maximality family of constraints that demand maximum input-output correspondence during the input-output mapping of the underlying form on to the surface (phonetic) form.

Glide Formation

Glide formation is used in vowel hiatus resolution if the V_1 vowel is specified for the positive height feature [+high] followed by a non-homorganic [+high] or any [-high] vowel. Gliding takes place when the initial vowel is one of the high vowels: the front spread high [i] or the back rounded high [u] followed by any other non-high [-high] vowels or the non-homorganic high. Two homorganic glides are normally formed: the palatal [j] or labio-velar [w]. The front high spread[i] glides into the homorganic voiced palatal glide [j] while the back high rounded vowel [u] glides into the homorganic voiced labio-velar glide [w] as shown in data (1) repeated in (3).

(3) Glide formation

(a) V1 # V2 Glide formed

/i + a, o, u, e/ → [j] voiced palatal glide

V1 + V2 Input Output Gloss

(i) [i + a]	/βiβi + ajo/	[βiβja:jo]	'livestock'
(ii) [i + a]	/βiβi + ana/	[βiβja:na]	'children(diminutive)'

The two Lubukusu glides; /j/ and /w/, are formed from the homorganic vowels; /i/ and /u/ respectively. These glides are homorganic because they share the phonological features of [+high] for both the palatal glide and the front high vowel [i]. The labio-velar glide [w] shares the phonological features [+ round] and [+labial] with the high back rounded vowel [u]. The process of VHR also involves the maintenance of the feature [+high] in the resultant glides. In essence, gliding is a less costly repair in terms of features thus reducing faithfulness violations in feature correspondence. In OT, faithfulness constraints would naturally prefer less violation of input features in the output resulting in the formation of the attested homorganic glides.

Vowels are underlyingly moraic in Lubukusu (Mutonyi, 2000) and cross-linguistic studies show that moras are protected from deletion because they are autosegmental in nature (Goldsmith, 1999). They are preserved even when the segments to which they are attached are deleted or merged. It is evident that in glide formation, the high vowel that glides release its mora to the following [V_2] vowel. The V_2 lengthens in compensatory lengthening (CL)]. Consequently, the non moraic [+high] glides; [j] and [w], replace the moraic V_1. These glides are consonantal and form syllable onsets. The moraic vowels are replaced by the non-moraic glides violating the IDENT-IO (μ). This constraint demands that there is no moraic feature change during input to output mapping. When *HIATUS is ranked above IDENT-IO (μ) gliding will take place in violation of IDENT-IO (μ) and UNIFORMITY-IO. The mora of the V_1 is transferred to the V_2 which lengthens in compensation, violating the two constraints as shown in the analysis of the following comparative tableau (4a).

(4a) /i_1 # a_2/ /βiβi_1+$a_2$na/ → [βi.βj_1a_2:.na] 'children (dim)'

/βiβi_1+$a_2$na/	*HIATUS	IDENT-IO(μ)	UNIFORMITY-IO
a.☞ [βi.βj_1a_2:.na]		*	*
b. [βi.βi_1.a_2:.na]	*!		

From tableau (4a), the three constraints yield the optimal candidate in Lubukusu. However, it is possible to remove vowel hiatus in the output form via other repair strategies. One of these strategies is by simply deleting the first vowel instead of homorganic gliding to [j] because the constraint against vowel deletion is ranked below the anti-hiatus constraint. However, such an option leads to an infelicitous output [βi.βa_2:.na]. Deletion is not the acceptable strategy in this context because there are certain faithfulness constraints that are relevant in this position. Gliding is preferred to deletion because [+high] features are preserved. It is, therefore, proposed that MAX-[+H] MF constraint is relevant to protect the high vowel in morpheme final position from being deleted or changing their [+high] feature. This positional faithfulness constraint is responsible for resistance to deletion that may lead to loss of the [+high] feature in this position.

(4b) /i_1 # a_2/ /βiβi_1+$a_2$na/ → [βi.βj_1a_2:.na] 'children (dim)'

/βiβi_1+$a_2$na/	*HIATUS	MAX-[+H]MF	IDENT-IO(μ)	UNIFORMITY-IO
a.☞[βi.βj_1a_2:.na]			*	*

b. [βi.βi$_1$.a$_2$.na]	*!			

The inclusion of MAX-[+H] MF yields the correct output. However, it is proposed that an identity constraint requiring that in a morpheme final vowel, the feature [+high] in the input and the corresponding glide must match. The PF constraint; IDENT-V # [+H] demands that vowels in the final syllable have the same [+high] features in the output as is in the input (Tanner, 2007).

(4c) /i$_1$ # a$_2$/ /βiβi$_1$+a$_2$na/ → [βi.βj$_1$a$_2$:.na] 'children (diminutive)'

/βiβi$_1$+a$_2$na/	*DIPH	*HIATUS	IDENT-σ# (+H)	MAX-V-MI	IDENT-(μ)	UNIFORIO	IDENT (+H,+L)
☞[βi.βj$_1$a$_2$:.na]					*	*	
b. [βi.βi$_1$a$_2$:.na]	*!						
c. [βi.βi$_1$.a$_2$:.na]		*!					
d. [βi.βa$_{12}$:.na]			*!				
e. [βi.βj$_1$:.na]				*!			
f. [βi.βe$_{12}$:.na]			*!			*	**

At this point, it may be assumed that positional faithfulness constraints are crucial in ensuring that vowel segments and features in privileged positions are not deleted or altered respectively. The PF constraints IDENT-V# [+HIGH] and MAX-STEM (v$_1$) in conjunction with other markedness and faithfulness constraints have the effect of protecting these features and vowels in the course of VHR. The fact that PF constraints are relevant in the resolution of the markedness of vowel hiatus implies that it is possible to build a language-particular constraint hierarchy. In the hierarchy, position-sensitive constraints targeting the marked structures are undominated to ensure that the expected repairs take place while preserving privileged features/vowel segments.

Vowel Height Coalescence

Another process in VHR is through coalescence. This involves height feature coalescence in which the features of two vowels are fused into one. Coalescence is used to resolve vowel hiatus if the initial vowel (V$_1$) is specified positively for the height feature [+low] whiles the following vowel (V$_2$) is specified as [+high]. Coalescence results in the merging of two polar opposite height features into a compromise mid feature ([-high, -low = [+mid]). It is crucial that the V$_1$ takes the positive low feature specification, because it might induce gliding if it is [+high] and the second vowel has the [+low] feature, as reported above (see § 3.2). The dual indexed output segment has two input correspondents remaining faithful to the two input segments. This gives rise to the "split the difference" process when a low and a high vowel coalesce into a mid vowel.

In a three-vowel height system such as Lubukusu, fused vowels yield the mid vowels [e] and [o] asymmetrically. Coalescence does not show positive values for height feature; it is typically specified as [-high, -low]. The language has two high vowels: the [i] and [u], and one low vowel [a]; however, coalescence involves the front vowel [i] but not the back [u]. The front mid vowel [e] is the result of fusion between the low open [a] with the front high [i] but not the back mid [o]. There seems to be some phonological gap that requires some explanation in terms of constraints. The following data show the attested coalescence of [a] and [i] into [e] as the output.

(5) Vowel Height Coalescence

	V1 + V2	Input	Output	Gloss
(i)	[a + i]	/kama + ino/	[kame:no]	'teeth'
(ii)	[a + i]	/βa + ira/	[βe:ra]	'they kill'
(iii)	[a + i]	/kama + ici/	[kame:ci]	'water'
(iv)	[a + i]	/ka + iβa/	[ke:βa]	's(he) stole'

From the data, the two input vowels fuse into one output vowel on the surface. Secondly, the input vowels change their height feature specification from the positive [+low] and [+high] to the negative [-low] and [-high] in the resultant mid vowel [e]. Thirdly, neither deletion of features nor the vowel segment is invoked to avoid hiatus. Finally, the moras present in the input are preserved in the output. Specifically, the single mid vowel takes on the moras of the two vowels as evident through the lengthening of the mid vowel into the long counterpart vowel [e:].

However, there is an interesting gap from the absence of coalescence of [a] and [u] though expected. This is contrary to what is reported in Xitsonga spoken in southern Africa (Vratsanos & Kadenge, 2017) that uses the three strategies and in coalescence /a/ and /u/ merge into the back mid [o]. Key vowel properties might account for the absence of the expected coalescence. Ideally, [a] and [i] can be fused easily because both differ in the height dimension only. However, the [u] has the extra feature of [+ round] apart from the height feature of [+high]. This [+round] feature is not shared with the opposite low open unrounded vowel [a] hence fusion may lead to a more complex vowel contrary to the concept of ease of articulation. In any case, the fact that vowel hiatus of the form /a + u/ results in deletion of the /a/, may lend support to our proposal because deletion is the preferred strategy in simplification of complex sounds in a number of languages (Kaun, 2004).

*HIATUS and *DIPH are the two crucial constraints that drive the resolution of hiatus. Diphthongs do not exist in the vowel inventory of the language; hence the two vowels cannot be merged into one syllable nucleus. Consequently, neither hiatus nor a diphthong is tolerated due to the undominated nature of these two constraints. The tableau that follows indicates that coalescence is the preferred method of avoiding hiatus and not diphthongization. The short vowel [e] lengthens after taking on the two moras of the two vowels that fuse due to MAX-IO (μ) demands. Because [e] is not part of the input but a coalesced result of [a] and [i], IDENT-IO (μ) mora is not relevant in this analysis. Fusion is a violation of correspondence between the two segments of the input mapped onto one output segment: a violation of UNIFORMITY-IO.

(6a) /a$_1$ # i$_2$/ /βa$_1$+i$_2$ra/ → [βe:$_{12}$.ra] 'they kill'

/βa$_1$+i$_2$ra/	*HIATUS	*DIPH	MAX-IO$_{MORA}$	UNIFORMITY-IO
a. ☞[βe:$_{12}$.ra]				*
b. [βa$_1$i$_2$.ra]		*!		
c. [βa$_1$.i$_2$.ra]	*!			
d. [βe$_2$.ra]			*!	

The optimal candidate does violate UNIFORMITY-IO constraint but being a low ranked constraint, the violation is not fatal. Consequently, the general feature faithfulness constraint IDENT-IO (-F) outranks IDENT-IO (+F). On the basis of this observation, we posit IDENT-IO [-Lo] and IDENT-IO [-Hi] dominating IDENT-IO [+Lo] and IDENT-IO [+Hi] ranked as follows: IDENT-IO [-L], IDENT-IO [-H] ≫ IDENT-IO [+L], IDENT-IO [+H]. In the analysis, these pairs of constraints will be represented as IDENT-

IO [-L, -H] ≫ IDENT-IO [+H, +L]. The final ranking is: *HIATUS, *DIPH, MAX_{MORA}, IDENT [-L, -H] ≫ UNIFORMITY-IO, IDENT [+H, +L].

(6b) /a_1 # i_2/ /βa_1+$i_2$ra/ → [βe:$_{12.}$ra] 'they kill'

/βa_1+$i_2$ra/	*HIATUS	*DIPH	MAX_{MORA}	IDENT[-L,-H]	UNIFOR-IO	IDENT[+L,+H]
a. ☞[βe:$_{12.}$ra]					*	**
b. [βa_1i_2.ra]		*!				
c. [β$a_{1.}i_2$.ra]	*!					
d. [β$e_{2.}$ra]			*!			
e. [βa_{12}.ra]				*!	*	
f. [βi_{12}.ra]				*!	*	

Note the violation of IDENT-IO [+L, +H] is due to the mismatch between the input [+high] and [+low] represented as [-high] and [-low] in the output. The three constraints are dominated by the rest of the constraints. Candidate (e) violates IDENT-IO [-L] because the two vowels are supposed to be fused yet the feature [-high] of [i] is represented as [a_{12}]. Candidate (f) violates the opposite identity feature IDENT-IO [-H] because the low vowel is represented as [i_{12}] hence the feature [-high] is lacking in the output. It is observed that the vowel in the second morpheme is also morpheme initial and, therefore, protected from deletion because this is a privileged position. Coalescence, technically, implies that the vowel is present as represented in the indexed features. The constraint that protects this vowel (MAX-V (MI)) is required and it maintains the undominated position in the hierarchy as before (see 4c, above). A candidate deleting morpheme initial vowel cannot be optimal as observed in the following tableau; candidate (g).

(6c) /a_1 # i_2/ /βa_1+$i_2$ra/ → [βe:$_{12.}$ra] 'they kill'

/βa_1+$i_2$ra/	*HIATUS	*DIPH	MAX_{MORA}	MAX-V MI	IDENT[-L,-H]	UNIFOR-IO	IDENT[+L,+H]
a.☞[βe:$_{12.}$ra]						*	**
b. [βa_1i_2.ra]		*!					
c. [β$a_{1.}i_2$.ra]	*!						
d. [β$e_{2.}$ra]			*!				
e. [βa_{12}.ra]					*!	*	
f. [βi_{12}.ra]					*!	*	
g. [βa_1.ra]				*!			

Candidate (g) is suboptimal in deleting the initial vowel of the second morpheme, although it has resolved hiatus. Finally, because the deletion strategy is used to resolve hiatus, the constraint responsible is the specific anti-vowel deletion constraint MAX-IO (V) not the general MAX-IO.

Finally, to show the functional unity of constraints, a single constraint hierarchy is required. A composite *tableau des tableaux* is constructed based on the three inputs examined for each of the three hiatus resolutions strategies. These strategies form a class because they are all based on vowel feature specification. In the tableaux, only the relevant vowels that form hiatus are used rather than the complete words and the same result are obtained as reported earlier for individual tableau. In addition, each input has one unique optimal candidate similar to the previous tableaux. The fact that the unified *tableau des tableaux* adopt the fixed ranking from the individual tableau with no variation in results is significant for the economy principle in evaluation. The following *tableau des tableaux* (7) summarizes all the three VHR processes based on constraints and ranking schema already established up to this point.

(7). The *tableau des tableaux* for Glide Formation, Vowel Coalescence and Deletion.

(i) $/i_1 \# a_2/$ $/\beta i\beta i_1+a_2jo/$ → $[\beta i.\beta j_1a_2\!:.jo]$ 'livestock' (Glide formation)

(ii) $/a_1 \# i_2/$ $/\beta a_1+i_2ra/$ → $[\beta e\!:_{12.}ra]$ 'they kill' (Coalescence)

(iii) $/o_1 \# a_2/$ $/juno_{1+}a_2ca/$ → $[ju.na_2\!:.ca]$ 'this one goes' (deletion)

$/i_1\#a_2/$	*DI	*HI	MAX[+H]MF	MAXV-MI	MAX MORA	IDENT[-L,-H]	MAX-V	IDEN (μ)	UNIF	IDEN+L,+H
a☞$[j_1a\!:_2]$								*		
b.$[i_1a_2]$	*!									
b.$[i_{1.}a_2]$		*!								
d.$[a_2]$			*!		*					
e.$[i_1]$				*!	*					
$/a_1 \# i_2/$										
a.☞$[e\!:_{12}]$								*	*	**
b. $[a_1i_2]$	*!									
c. $[a_{1.}i_2]$		*!								
d. $[a_1]$					*!	*				
e. $[i_2]$					*!	*				
$/o_1 \# a_2/$										
a☞$[a_2\!:]$							*	*		
b $[o_1a_2]$	*!									
c $[o_{1.}a_2]$		*!								
d. $[o_{1:}]$				*!			*	*		
e. $[a_2]$					*!		*			

Discussion

The above analysis indicates that that a PF account of VHR resolution in Lubukusu may adequately be accounted for by recourse to positional privilege of the vowels in question. In an OT grammar, constraints interaction is all that is required to account for the VHR strategies adopted by any language. Indeed, it is a basic tenet of OT that variation in the strategies adopted by languages in resolving vowel hiatus is due to different ranking of universal constraints in a language specific constraint hierarchy (McCarthy, 2002; Prince & Smolensky, 2004). Constraints are not only universal, but they are also phonetically rounded, they mirror the process of speech articulation. In deletion, it is the initial vowel that is deleted mainly because of anticipatory articulation of the following vowel V2. In Articulatory phonology approach (Chotoran et al., 2002; Hall, 2010) for instance, gestural overlap is responsible for what is perceived as deletion in speech due to co-articulation of V1 and V2 or anticipatory articulation of

V2 before the completion of V1. It is, therefore, expected that V1 is deleted as this study has demonstrated if deletion is the preferred repair strategy.

In addition, the very essence of avoiding vowel hiatus is due to the articulatory effort required in producing two adjacent dissimilar vowels. This require substantial gestural coordination and effort, hence the need to repair the hiatus because such a sequence is phonologically marked. It is therefore of interest that it is the top ranked markedness constraint; *HIATUS that is responsible for initiating vowel hiatus resolution in some form to make articulation easier but without compromising vowel perception distinctiveness. This brings in the positional faithfulness constraints that are also top-ranked to guarantee that repairs satisfy the positional privilege of the vowels under repair. Speech perception is paramount and, therefore, any repair that neutralizes phonological contrast will be blocked. The constraint; CONTRAST, remains undominated in the language as a default constraint ranking during the deletion process for the preservation of the expected contrast in the outputs that are optimal.

Strategies used in VHR seem to be very similar among Bantu languages especially those in east, central and southern Africa (Casali, 1996; Rosenthal 1997; Mtenje, 2007; Sibanda, 2009; Mudzingwa & Kadenge, 2011). Most of the languages share the strategies used in VHR except for a few cases. However, unless the output form after resolution is licit, the strategy fails. For example, Lubukusu does not have complex consonants with secondary articulation except the prenasalized stops, hence secondary articulation as a repair strategy is not used. Similarly, due to a leaner phonemic inventory, the language does not utilize palatalization as repair mechanism in resolving hiatus. This is contrary to languages that have phonemic palatalized consonants such as Nambya (Mudzingwa & Kadenge (2011).

Glide formation is a common strategy in many Bantu languages of east, central and southern Africa whose inventories have the glides /j/ and /w/ (Tanner, 2007; Kadenge, 2013, 2014; Simango & Kadenge, 2014; Vratsanos & Kadenge, 2017). However, we note that gliding is blocked in some languages, e.g., in Xitsonga, Nambja and Karanga, if the vowel is preceded by a consonant because it creates a consonant cluster. This is not the case because in Lubukusu, the CG (consonant Glide) onset cluster is the only legitimate cluster allowed in the syllabic phonotactics of the language. In glide formation, features in the initial (V1) vowels are changed. However, features that are key in lexical identification for purposes of lexical access or retrieval tend to be preserved according to psycholinguistic studies on word retrieval and storage. For example, in languages that have laryngeal neutralization of voicing contrast such as German, neutralization takes place in obstruent final sounds but not in initial sounds because of positional privilege of initial consonants for lexical access and/or recognition. This can be explained by recourse to positional faithfulness (Levelt, 2001; Meyer & Belke, 2007).

In coalescence, the results are in accord with what is reported in other Bantu languages in which the [+high] and [+low] features fuse to the mid [-high, -Low] in the emergent mid vowel. This is what is observed in the data. However, while some languages allow coalescence of [a] and [u] resulting into the mid [o], this is not the case in Lubukusu and this has been argued to be due to feature disparity in /a/ and /u/ with Kaun (1995) proposing a markedness constraint *[-High, +Round] which forbids vowels that are simultaneously rounded but not positively specified for the feature high. This technically forbids the emergence of the [o] from coalesced [a] and [u].

Deletion seems to be the last resort repair strategy, and this is supported by Kadenge (2013, 2014) and Mudzingwa and Kadenge (2011) while glide formation is reported to be the preferred once the vowel features required are satisfied. In Lubukusu, this strategy applies when the initial (V1) is specified phonologically as [-high] but also followed by [-high]. The deletion of the V1 seems to be a Bantu universal as reported by Mudzingwa and Kadenge (2011) for Nambya and Kalanga, Simango and Kadenge (2014) for ciNsenga, Vratsanos and kadenge (2017) in Xitsonga. However, there as some limitations in languages that allow secondary articulation or labialized labial consonants such as ChiNambya and Chizezuru (Kadenge, 2014). In Lubukusu similar to the above Bantu languages, there is interaction of phonological and morpho-syntactic factors in determining which process is the preferred repair strategy. It was observed that the phonological features of the vowels determine all the three repairs while morpheme and or syllable position of the vowels play a significant role.

To account for the role of morphology, for example, Kadenge and Simango (2014) use Alignment constraints in the analysis of VHR in ciNtsenga and chiShona. The protection of V2 in VHR is argued to be due to alignment constraints demanding that the root is aligned with the syllable. This is the reflex of the positional faithfulness constraints (MAX- STEM (V1) and MAX-IO (MI)) adopted in the current study. In PF analysis, therefore, the relevant positional faithfulness constraints dominate both the markedness constraints initiating the repairs and some general faithfulness constraints. However, although PF approach is felicitous in modelling contextual asymmetries, they may engender unwanted predictions whenever positional sensitive faithfulness constraints fail to dominate context free faithfulness constraints. This may lead to opacity that require serialism that demands an intermediate level between input and out not available in standard OT (Jesney, 2009)

Conclusion

In this study, it is apparent that some positional faithfulness constraints responsible for glide formation are also relevant for deletion and coalescence. Furthermore, the ranking from glide formation is maintained in the analysis of deletion and coalescence. This fixed ranking is crucial in OT particularly in hiatus resolution within the same language as part of the functional unity of constraints. The same must be the case for the composite tableaux. It may, therefore, be argued that positional sensitive constraint interaction may be central in accounting for the preservation of vowel features and segments in specific positions of a prosodic word. From a Lubukusu specific constraint hierarchy based on universal markedness and faithfulness constraints, it is possible to account for why, in certain positions, vowel deletion, merger or glide formation may fail in vowel hiatus resolution. Such vowels are faithful to their underlying feature specification in psycholinguistically privileged positions for perceptual and processing reasons. Vowels in prominent positions may consistently resist changes due to the need to maintain phonological contrast because such positions provide critical perceptual/acoustic cues in language processing.

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