Morphologically-Driven Vowel Hiatus and its Phonological Realizations*

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Lee, Jae-Young. 1999. Morphologically-Driven Vowel Hiatus and its Phonological Realizations. *Studies in Phonetics, Phonology and Morphology* 5 171-191. This paper examines a variety of morphologically-driven vowel concatenation in SiSwati. The language SiSwati, a member of Nguni language, is spoken in Swaziland and in the eastern part of the Republic of South Africa. The vowel hiatus from morphological operation is resolved by three kinds of phonological processes: glide formation, vowel deletion, and vowel coalescence. The goal of this paper is to claim that the apparently independent phenomena are accounted for in a unified, principled way within the framework of Optimality Theory. It is shown that a single, well-motivated constraint hierarchy is responsible for the seemingly independent phonological phenomena. **(Chonnam National University)**

Keywords: vowel, hiatus, coalescence, deletion, glide

1. Introduction

Vowel sequences resulting from morphological juxtaposition are resolved in various ways in languages. Some languages like Igede (Bergman 1971) avoid potential VV hiatus by deleting one of two vowels. In other languages like the Bizcayan dialect of Basque (Kenstowicz 1994), Malay/Indonesia (McCarthy and Prince 1993b) and Madurese (McCarthy and Prince 1995), potential VV hiatus is resolved by glide formation. Many other languages like Kikamba (Roberts-Kohno 1995) invoke vowel coalescence to avoid a sequence of vowels. However, it is uncommon to discover a single language in which the three resolutions are employed in a nearly identical context. Thus, it is

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worthwhile to do an in-depth study of a single language with the three phonological processes observed in the same or similar conditioning environment, since the study can lead to a better understanding of the nature of vowel hiatus and the dynamics of a variety of hiatus-resolving methods.

In this paper I examine a variety of morphologically-driven vowel concatenation in SiSwati, which is a language spoken in Swaziland and in the eastern part of the Republic of South Africa. SiSwati employs three hiatus-avoiding strategies such as glide formation, vowel deletion, and vowel coalescence in nearly identical conditioning contexts. The goal of this paper is to argue that the three phonological processes are explained in a unified, principled way within the framework of Optimality Theory (Prince and Smolensky 1993, McCarthy and Prince 1995), and that the occurrence of each phonological phenomenon results from a single, well-motivated constraint hierarchy. It is also shown that motivating forces of the processes are the syllabic requirement of prohibiting onsetless syllables and the markedness principle favoring unmarked segments over marked alternatives.

In analyzing the SiSwati vowel hiatus, I explore several types of morphological processes, which yield a juxtapositon of two vowels. Among them are included word formation of diminutive forms, possessive forms, infinitive forms, demonstrative forms, and locative forms.

Section 2 provides background knowledge for SiSwati phonology. Section 3 contains detailed discussion of the morphological processes in SiSwati which yield hiatus contexts. Section 4 offers an Optimality-Theoretic account of the SiSwati vowel hiatus. Section 5 includes a summary and conclusion of this paper.

2. The Consonant and Vowel System of SiSwati

The consonant system of SiSwati consists of a very rich, unusual inventory of segments, as shown in (1) below. Pulmonic stops and velaric clicks show a three-way contrast in laryngeal specification: aspirated, unaspirated, and voiced. Pulmonic voiced stops show an asymmetry with respect to place of articulation. Only voiced velar stop

[g] surfaces in modern SiSwati. Voiced alveolar click is represented as [$ʇ^{g}$] in (1). Unlike pulmonic stops and clicks, pulmonic affricates show a two-way distinction in laryngeal contrast: aspirated vs. unaspirated or voiceless vs. voiced. Laterals are classified as sonorant vs. fricative. Fricative laterals can be either voiceless [ɬ] or voiced [ɮ]. In SiSwati, there is only one implosive stop, i.e. [ɓ].

(1)

Pulmonic airstream

	Labial	Alveolar	Prepalatal	Velar	Glottal
Stops	p^h	t^h		k^h	
	p	t		k	
				g	
Fricatives	f	s	ʃ		h
	v	z			
Affricates	$tʃ^h$	ts^h			
	tʃ	ts	ʧ		
			ʤ		
Nasals	m	n	ɲ	ŋ	
Laterals		l			
		ɬ			
		ɮ			
Glides	w		y		

Glottalic airstream

	Labial	Alveolar	Prepalatal	Velar	Glottal
Stops	p'	t'		k'	
	ɓ				
Affricate		ʧ'			

Velaric airstream

$ʇ^{h}$	(aspirated)	
ʇ	(unaspirated)	
$ʇ^{g}$	(voiced)	

SiSwati has a five vowel system: two high vowels, i, u, and three low vowels, e[ɛ], a, o[ɔ].

3. Details on Vowel Hiatus in SiSwati

This section considers five types of word formation in SiSwati, the ones that yield vowel concatenation. The morphological forms considered here include diminutive forms, possessive forms, infinitive forms, demonstrative forms, and locative forms.

First, diminutive forms consist of a noun and a suffix *-ana*, as exemplifed in (2).

(2)

Noun	Diminutive Form	Gloss
sandla	sandlana	'hand'
sive	sivana	'nation'
emasi	emasana	'sour milk'

The juxtaposition of a vowel-final noun and the suffix *-ana* yields vowel hiatus: ...V+*ana*. The morphologically-driven vowel hiatus is resolved by either glide formation or by vowel deletion.

Glide formation is seen when stem-final vowels are round, as shown in (3) below. Stem-final vowels *u* and *o* change into the labial glide *w* before the vowel *a*. The glide *w* is homorganic to the stem-final vowels.

(3)

	Noun	Diminutive Form	Gloss
a.	lisusu	lisus**w**ana	'type of squash'
	indvuku	indvuk**w**ana[1]	'stick'
b.	liso	lis**w**-ana	'eye'
	lihloko	lihlok**w**-ana	'head'

Vowels other than *u* and *o* in nouns, on the other hand, are deleted before the suffix *-ana*, as seen in (4). Stem-final vowels *i*, *e*, and *a* are elided before the vowel *a*.

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[1]This paper adopts the traditional orthography used in SiSwati phonology. The orthographic forms like *dv*, *b*, *hl*, *d*, *t*, *dl*, *tj*, *j*, c, *g*, *k*, and *nk*, for example, represent phonetic values [tf], [ɓ], [ɬ], [t], [t'], [ɮ], [ʧ], [ʤ], [ɟ], [k], [k'], and [ŋk], respectively.

(4) a.

Noun	Diminutive Form	Gloss
emanti	emant-ana	'water'
sijingi	sijing-ana	'kind of soft porridge'

b.

Noun	Diminutive Form	Gloss
umlente	umlent-ana	'leg'
inceke	incek-ana	'cooked pumpkin'

c.

Noun	Diminutive Form	Gloss
litsafa	litsaf-ana	'plateau'
umlata	umlat-ana	'whey'
busika	busik-ana	'winter'

Some cases, however, do not follow the pattern seen in (3) above. The back vowels *u* and *o* are deleted before *-ana*, unlike those in (3), where glide formation takes place. Deletion of back vowels is employed in the context where they are preceded by a labial consonant like *f* and *m*, as shown in (5) below. The stem-final vowels *u* and *o* do not become the glide *w*, which suggests that labial consonants do not allow the neighboring labial glide *w*.

(5)

sitofu	sitof-ana	'stove'
inkhomo	inkhonj-ana	'beast'[2]

Based on the observation of diminutive forms, we can make several generalizations. First, the round vowels *u* and *o* change into the glide *w* before a vowel. Second, the front vowels *i* and *e* do not change into the glide y before a vowel: *Cy. Third, the suffix-initial vowel *-a* remains intact while stem-final vowels change. Next, stem-final vowels including *a* delete if they cannot trigger a glide. Last, a complex segment with [labial] is not allowed: e.g. *fw.

The next morphological process to investigate is to make infinitive

[2]The diminutive morpheme *-ana* triggers palatalization for the preceding consonants such as *m*, *mb*, *mph*, *b*, *bh*, *ph*, *l* and *n*. Palatalization in SiSwati is very complex. Analysis of SiSwati palatalization is beyond the scope of this paper.

forms, which are composed of the prefix *ku-* and a verb stem, as exemplified in (6) below.[3] Verbal stems end with *-a*.

(6)

Imperative form	Infinitive form	Gloss
babáta	kú-babáta	'admire'
téka	kú-téka	'take a wife'
khánga	kú-khánga	'attract'
físa	kû-físa	'desire'
sebénta	kú-sebénta	'work (for)'
nakékela	ku-nakekéla	'take care of'
lála	kû-lála	'lie down'
wungá	ku-wunga	'entice'
yáma	kú-yáma	'lean on'

Infinitive forms yield a sequence of vowels when the prefix *ku-* is juxtaposed with vowel-initial verb stems, as illustrated in (7).

(7) a. kw-ákha 'to build, construct'
kw-elekélela 'to help'

b. k-ôkha 'to light, to provoke'
k-ókhéla 'to transfer fire'
k-ôma 'to become dry or thirsty'

Vowel hiatus resulting from morphology is resolved by either glide formation (7a) or by vowel deletion (7b). Examples in (7a) show that the prefix-final vowel *u* changes into *w* before non-rounded vowels. The data seen in (7b) exemplify the case in which the final vowel *u* deletes before a round vowel. This is a result of avoidance of labiality in a row, i.e.,-wo-, as in the case of a sequence of a labial consonant plus a labial glide. For reference, other possibilities of vowel hiatus like

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[3]SiSwati, like other southern Bantu languages, shows tonal contrast. The acute accent (´) marks high tone in (6) and below. Low tones are not represented by any symbols. The circumflex (^) indicates falling tone. I do not tackle tonal patterns in this paper, and thus omit tonal specifications with no explanation from time to time.

ku-i or *ku-u* in infinitive forms are not found in SiSwati, for there are no *i* or *u* initial verb stems in this language.

A third type of morphological operation, which brings about hiatal vowels, is to make possessive forms. This type of word formation contains a more complex sequence of vowels. Possessive forms are composed of a noun stem plus a subject concord and a possessive pronoun. The subject concord (SC) in SiSwati is fixed and predictable from noun classes, as illustrated in (8).

(8)	SC	Noun Class	e.g.	Gloss
	u	1	úmfâti	'woman'
	ba	2	bántfu	'people'
	u	3	úmúti	'village'
	i	4	ímifula	'rivers'
	li	5	lítje	'stone'
	a	6	émânti	'water'
	si	7	sándla	'hand'
	ti	8	tísébénti	'workers'
	i	9	ímbúti	'goat'

The paradigm of possessives in SiSwati includes the following:

(9)		
	am	'my'
	etfu	'our
	akho	'your'
	akhe	'his'

Possessive forms, like diminutive and infinitive forms, yield vowel hiatus, which is resolved by either glide formation or by vowel deletion, as seen in (10) below.

(10)		Input	Output	Gloss
	a.	umfati-u-ami	umfati**w**ami	'my woman'
		litje-li-ami	litjelØami	'my stone'
	b.	umfati-u-etfu	umfati**w**eftu	'our woman'
		litje-li-etfu	litjelØetfu	'our stone'

c.	umfati-u-akho	umfati**w**akho	'your woman'
	litje-li-akho	litjelØakho	'your stone'
d.	umfati-u-akhe	umfati**w**akhe	'his woman'
	litje-li-akhe	litjelØakhe	'his stone'

The first of each set in (10) contains a combination of three vowels, and the second shows a juxtaposition of two vowels. The former undergoes glide formation, while the second invokes vowel deletion. The vowel *u* changes into the glide *w* in the former, while the vowel *i* is elided in the latter. The change of *u* to *w* in a three-vowel sequence causes a minimal modification of the input representation derived from morphological operation:

(11) a. umfat**iwa**mi Glide Formation
b. *umfa**twa**mi Vowel Deletion and Glide Formation

The same is true of a ViV sequence, as seen in (12) below. The front high vowel *i* becomes the glide *y* in the middle position of the three-vowel sequence. Minimal change in input material is observed.

(12)

Input	Output	Gloss
imiti-i-ami	imitiyami	'my villages'
imiti-i-etfu	imitiyetfu	'our villages'
imiti-i-akho	imitiyakho	'your villages'
imiti-i-akhe	imitiyakhe	'his villages'

What about the situation in which a non-high vowel is in the middle of a three-vowel sequence? This case occurs when noun stems are categorized as class 6, in which the subject concord is *-a-*. The VaV sequence undergoes vowel deletion, as seen in (13). In this case, a homorganic glide cannot be obtained. The vowel *a* cannot be changed into either *y* or into *w*, so it is just deleted.

(13)

Input	Output	Gloss
emanti-a-ami	emantami	'my water'
emanti-a-etfu	emantetfu	'our water'

emanti-a-akho	emantakho	'your water'
emanti-a-akhe	emantakhe	'his water'

In addition to glide formation and vowel deletion explored so far, coalescence is also employed to avoid vowel sequences in SiSwati. Vowel coalescence takes place in demonstrative forms, which comprise the demonstrative formative *le-* and a noun stem:

(14)	Noun	Demonstrative Form	Gloss
	likhaya	le-likhaya	'this home'
	tisebenti	le-tisebenti	'these workers'
	sivakashi	le-sivakashi	'this guest'

Vowel hiatus seen in demonstrative forms is resolved by coalescence, as illustrated in (15):

(15)	Noun	Input	Output	Gloss
	umfati	le-umfati	lomfati	'this woman'
	imbuti	le-imbuti	lembuti	'this goat'

Vowel coalescence also occurs in locative forms, which consist of three components: *e-* plus noun stem plus *-ini*. Vowel coalescence in locative forms takes place both between noun stems and *-ini* and between the prefix *e-* and noun stems, as seen in (16a) and (16b) respectively.

(16)	a.	Noun	Input	Output	Gloss
		kúdla	e-kudla-ini	ekudleni	'food'
		lítje	e-litje-ini	elitjeni	'stone'
		ínkomó	e-inkomo-ini	énkóméni	'beast'
	b.	Noun	Input	Output	Gloss
		ínkhôsi	e-inkhosi-ini	enkhosini	'king'
		îmvú	e-imvu-ini	émvîni	'sheep'
		índlu	e-indlu-ini	endlini	'house'

In (16a), stem-final vowels *a, e,* and *o* are not deleted before the suffix-initial vowel *-i*. This case is different from the one in diminutive and possessive forms, where stem-final vowels are deleted. In (16b), the prefix *e* does not get lost before vowels initiating stems, unlike the case in infinitive forms.

Here, we have to take into account the sonority distinction between vowels. If suffix-initial vowels are more sonorous than stem-final vowels, then the latter undergo modifications, through either deletion or through glide formation. Likewise, if stem-initial vowels are more sonorous than prefix-final vowels, then the latter are changed via glide formation or deletion. On the other hand, if stems-final vowels are more sonorous than suffix-initial ones and prefix-final vowels are more sonorous than stem-initial ones, vowel coalescence takes place rather than vowel deletion or glide formation.

To sum up this section, we have shown that vowel hiatus driven from morphological juxtaposition is resolved by deletion, glide formation, and coalescence. The three phonological phenomena is a result of satisfying a phonological demand of avoiding onsetless syllables. Based on careful investigation of five morphological processes which show vowel concatenation, we can make several broad generalizations. First, the preceding vowel changes in a VV sequence. Second, labial vowels *o* and *u* change into *w* before a vowel. Third, the front vowels *e* and *i* do not change into *y* before a vowel. Instead, they are deleted, unlike labial vowels. Third, labial sounds must not be in neighborhood. Fourth, more sonorous vowels in a preceding position are fused with following, less sonorous vowels. This fact is claimed in the next section to be the result of a compromise between the directional priority of preceding vowels over following vowels and the sonority-based priority of more sonorous vowels to less sonorous ones.

4. An Optimality-Theoretic Analysis

This section provides an analysis of the SiSwati vowel hiatus within Optimality Theory, by formalizing the generalizations discussed in section 3.

First, we have to explain the fact that all potential vowel hiatus is disallowed in SiSwati. This fact is explained by invoking the constraint Onset (17), which is responsible for unfaithful analysis of the input with V+V hiatus. A potential VV sequence, which derives from a morphological combination, violates this requirement, e.g., /liso+ana/ 'eye (dim.)'.

(17) Onset: Syllables must have an onset.

Satisfaction of the onset requirement can be achieved by several options including vowel deletion, glide formation, and coalescence. In SiSwati, an insertion option is not adopted, which implies that the constraint Dep-IO is undominated.[4] According to Dep-IO, every segment of the output must have a correspondent in the input. The illustrative example, /liso+ana/, does not show a segment-inserted form like **lisowana* or **liso?ana*.

The insertion option aside, we can consider other options. Careful investigation leads to a claim that glide formation, other things being equal, is employed rather than vowel deletion and coalescence. Glide formation shows a least violation of faithfulness to the input. The change from a vowel to a glide respects correspondence in timing slot between input and output, with only moraicity stripped. The loss of mora incurs a violation of the constraint Max-IO.

(18) Max-IO: Every segment or mora of the input has a correspondent in the output.

A ranking of Onset over Max-IO in constraint hierarchy is responsible for glide formation. The following tableau (19) shows a contrast between an optimal glide-containing candidate and a hiatus-preserving candidate, and gives a parallel evaluation between an optimal glide-containing form and a vowel-deleted one.

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[4]This is the reason why there is no further discussion of Dep-IO with respect to other constraints below.

(19) Onset >> Max-IO

/liso+ana/	Onset	Max-IO
☞a. liswana		*(μ)
b. lisoana	*!	
c. lisana		*!* (Rt,μ)

The winner, (19a), and the vowel-deleted output both satisfy the constraint Onset, while the faithful analysis (19b) violates it. Thus (19b) is immediately ruled out. The decision between (19a) and (19c) goes to the constraint Max-IO. The winner violates Max-IO less severely than a loser (19c) with multiple violation of Max-IO due to a root node loss and a mora loss.[5] The constraint Max-IO is evaluated in a gradient way.[6]

The active role of Max-IO is also seen in a three-vowel sequence in possessive forms, as illustrated in (20) below. Candidate (20a) shows a violation of Max-IO, while the vowel-deleted alternative, (20b), incurs four violations of Max-IO.

(20)

/imiti+i+etfu/	Onset	Max-IO
☞a. imitiyetfu		*(μ)
b. imitetfu		*!***(Rt,Rt,μ,μ)

Candidates (20a,b) all violate the constraint Onset once, since word-intial vowel causes a violation of Onset. The violation is not marked here for explicit presentation. As noted in McCarthy and Prince (1993b, 1995), a purely syllabic analysis predict that deletion or insertion

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[5]Thanks go to an anonymous reviewer for calling my attention to the term root node.

[6]Alternatively, we can redefine the constraint Max-IO by appealing to the notion conjunction. That is, Max-IO requires that every root node and every mora of the input have each correspondent in the output. For Max-IO to be violated, both segmental and moraic correspondence should be mismatched between input and output. Under this interpretation, candidate (19a) show no violation of Max-IO, while (19c) incurs a single violation of it. Either the gradient interpretation or the conjunctive alternative does not influence the main argument advanced here.

will take place to avoid the Onset violation. However, a morphology-prosody alignment constraint, Align(Stem,L; PrWd,L), requires that all stem-initial segments must also be initial in the prosodic word. Or, the constraint Left-Anchor(Input, Output) dictates that any element at the left-edge of input has a correspondent at the left-edge of output. Align(Stem, L; PrWd, L) and Left-Anchor do the same job. Ranking Align(Stem, L; PrWd, L) and Left-Anchor over Onset will favor an analysis with the word-initial vowel. The undominated stem-prosodic word alignment or Left-Anchor bans deletion or insertion. The role of Align(Stem, L; PrWd, L) and Left-Anchor is universally motivated and well documented in OT literature, so it is not explicitly mentioned in a constraint hierarchy and tableaux in this paper.

As discussed in section 3, however, glide formation is not always employed in SiSwati, as a means of resolving the morphologically-driven VV sequence. The SiSwati data show that the [Cy] sequences like *gy* are dispreferred. This fact will be explained by appealing to the segmental markedness constraint *CG, which prohibits a complex segment. The markedness constraint plays an active role in SiSwati phonology.

The *CG constraint, which prohibits a sequence of [Cy], is highly ranked over Max-IO, as evidenced in (21). Output candidates in tableau (21) differ in evaluation against three constraints from each other.

(21)

/emasi+ana/		Onset	*CG	Max-IO
☞ a.	e.ma.sa.na			**(Rt, μ)
b.	e.ma.sya.na		*!	*(μ)
c.	e.ma.si.a.na	*!		

The faithful analysis *emasi.a.na* violates the constraint Onset and thus is relegated to a trivial, insignificant position. The period denotes a syllable boundary. Unfaithful output structures in (21a,b) satisfy the constraint Onset with the stem-initial vowel aside. The optimal candidate, (21a), satisfies the higher-ranked markedness constraint *CG and shows more violation of the lower-ranked constraint Max-IO. In contrast, candidate (21b) violates *CG and incurs a minimal violation of

Max-IO. The ranking of *CG over Max-IO correctly predicts the winner (21a). No ranking between Onset and *CG is justified here, which is represented by a dotted line.

Some complex segments like *sw*, however, are allowed, as exemplified in *li.su.swa.na* (/lisusu+ana/). Thus, the markedness constraint *CG need to be exploded into *Cy and *Cw. These two specific members of the markedness constraint rank separately with respect to the faithfulness constraint, Max-IO. The *Cw constraint, unlike *Cy, ranks lower than Max-IO, as illustrated in (22) below. If there were no ranking between *Cw and Max-IO or if the constraint *Cw were in a higher or equal position in a constraint hierarchy, vowel-deleted analyses, *li.su.sa.na* or *li.su.su.na*, would be a winner. The optimal structure in (22a) violates the constraint *Cw, unlike other candidates.

(22)

/lisusu+ana/	Onset	*Cy	Max-IO	*Cw
☞ a. li.su.swa.na			*(μ)	*
b. li.su.sa.na			*!*(Rt, μ)	
c. li.su.su.na			*!*(Rt, μ)	

As claimed in Casali (1996), the distinction between *Cy and *Cw is also justified in many other languages including Chichewa, a Bantu language spoken in Malawi, and other West African languages.[7] Casali (1996) suggests that there may be a universal or near-universal implicational relation between [Cy] and [Cw]. If languages allow the [Cy] sequence, then they also permit the [Cw] sequence, not the other way around.

In addition to the *Cw constraint, we need to appeal to the constraint $*[lab]_{\sigma}^{2}$ (23) which is a locally enhanced markedness constraint. The constraint $*[lab]_{\sigma}^{2}$ serves as a specific member of the Obligatory Contour Principle (OCP), which prohibits adjacent identical elements.[8]

7) More in-depth study is needed to offer a phonetically-based explanation for the reason why *Cy and *Cw function differently in phonology.

8) The OCP with no prosodic domains specified is so unrestricted that it might block optimal surface forms like *sitofana* 'stove (dim.)' and *kufisa* 'desire (inf.)', where the feature [labial] are in neighborhood. Thanks go to an anonymous

(23) $*[lab]_{\sigma}^{2}$: Co-occurrence of [labial] is prohibited within a syllable.

The constraint $*[lab]_{\sigma}^{2}$ has an active role in deciding an optimal candidate. This constraint ranks higher than Max-IO, unlike *Cw, as evidently seen in (24) below.[9]

(24)

/sitofu+ana/	Onset	*Cy	$*[lab]_{\sigma}^{2}$	Max-IO	*Cw
☞a. si.to.fa.na				**(Rt, μ)	
b. si.to.fwa.na			*!	* (μ)	*
c. si.to.fu.a.na	*!		*		

As already discussed in section 3, the SiSwati data show the second vowel in a V+V sequence is much well preserved rather than the preceding one. This fact is explained by exploding the constraint Max-IO into specific members, Max-IO(V1) and Max-IO(V2). Max-IO(V1) requires that the first vowel of the input VV sequence have a correspondent in the output, and Max-IO(V2) dictates that the second vowel of the input VV sequence must have a correspondent in the output.

The ranking of Max-IO(V2) over Max-IO(V1) is responsible for faithfulness of suffix-initial vowels to the input material and for unfaithful analysis of stem-final vowels. The following tableau (25) contrasts a first vowel deleted form (25a) with a second vowel deleted form (25b) and also contains an evaluation between the winner (25a) and a first vowel-glided analysis (25c).

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reviewer for helping to make this point clear.

[9]The distinction between *Cw and $*[lab]_{\sigma}^{2}$ is motivated by the fact that a non-labial consonant with *w* is allowed, as exemplified in such output forms as *liswana* (/liso+ana/) and *lihlokwana* (/lihloko+ana/). The prohibition of any kinds of *Cy does not allow a parallel distinction. Such complex segments as *vy, *sy, *gy are not allowed, as evidenced in *sivana*, not *sivyana* from /sive+ana/, *emasana*, not *emasyana* from /emasi+ana/, and *sijingana*, not *sijingyana* from /sijingi+ana/, respectively.

(25) Onset, *Cy >> Max-IO(V2) >> Max-IO(V1)

/sive+ana/	Onset	*Cy	Max-IO(V2)	Max-IO(V1)
☞a. si.va.na				**(Rt, μ)
b. si.ve.na			*!	
c. si.vya.na		*!		*(μ)

The ranking of Max-IO(V2) over Max-IO(V1) selects the winner (25a) against the second vowel deleted candidate, (25b). Candidate (25a) is chosen against (25c) as the winner by virtue of the ranking of *Cy over Max-IO(V1).

The constraint *Cw is the lowest-ranked of the relevant constraints discussed so far, as illustrated in (26). Were the constraint *Cw ranked higher than Max-IO(V1), then candidate (26b) would be an optimal output.

(26) Onset, $*[lab]_\sigma^2$ >> Max-IO(V2) >> Max-IO(V1) >> *Cw

/liso+ana/	Onset	$*[lab]_\sigma^2$	Max(V2)	Max(V1)	*Cw
☞a. li.swa.na				* (μ)	*
b. li.sana				*!* (Rt,μ)	
c. li.so.na			*!		

Finally, in addition to glide formation and deletion, SiSwati displays vowel coalescence. Up to this point, we have examined the cases where the preceding vowel is lower in sonority hierarchy than the following vowel. In those cases occur glide formation and vowel deletion. However, coalescence takes place when a first vowel is more sonorous than the following one in a V+V sequence. I claim here that coalescence is the result of compromising a conflict between the directionality-based markedness and the sonority-based markedness.

As well argued in Prince and Smolensky (1993) and other OT literature, sonority hierarchy motivates universally accepted segmental markedness constraints like those in (27) below.[10]

[10]See Ní Chiosáin, M. and J. Padgett (1997) for an attempt to split the markedness constraints depending on sonority-based, articulatory-based, and perceptual-based perspectives.

(27) a. *Pk(i,u): The vowels *i* and *u* should not occupy a syllable peak.

b. *Pk(e,o): The vowels *e* and *o* should not occupy a syllable peak.

c. *Pk(a): The vowel *a* should not occupy a syllable peak.

d. Inherent ranking

*Pk(i,u) >> *Pk(e,o) >> *Pk(a)

Coalescence incurs a violation of the constraint Uniformity-IO due to lack of one-to-one correspondence between input and output. According to Uniformity-IO, no element of the output has multiple correspondents in the input.

Permutation of the markedness constraints in (27) and the constraint Uniformity-IO into the constraints motivated above yields a variety of typological combination, and is responsible for various ways of resolving all potential VV hiatus in languages. The SiSwati data are well explained by adding the universally well motivated markedness constraint ranking in (27d) to the constraint hierarchy justified so far, as seen in (28) below, where some constraints with no immediate relevance are omitted here for expository convenience.

(28) Onset >> Max-IO(V2), *Pk(i,u) >> Uniformity-IO >> Max-IO(V1), *Pk(e,o) >> *Pk(a)

/le$_1$+u$_2$mfati/	Onset	Max(V2)	*Pk(i,u)	Uniform	Max(V1)	*Pk(e,o)	*Pk(a)
☞a. lo$_{1,2}$mfati				*		*	
b. lu$_2$mfati			*!		*		
c. le$_1$mfati		*!					

Candidates (28a,b,c) all satisfy the constraint Onset. However, the optimal vowel-fused structure, (28a), satisfies the faithfulness constraints Max-IO(V2) and Max-IO(V1), and the constraint *Pk(i,u). In contrast, the second vowel preserving candidate (28b) violates *Pk(i,u) and Max-IO(V1). Candidate (28c) with the first vowel preserved violates Max-IO(V2). The dominated constraints *Pk(,e,o) and Uniformity-IO do not block fusion of two vowels. The ranking between

Uniformity and Max-IO(V1) does not seem to be motivated here in tableau (28).[11]

The ranking of Uniformity over *Max(V1), however, is responsible for blocking an unlimited application of coalescence. The constraint ranking, for example, correctly predicts the winner *emasana* /emasi+ana/ over a possible vowel-fused candidate *emase_{1,2}na*, as illustrated in (29).[12]

(29)

/emasi+ana/		*Cy	Max(V2)	*Pk(i,u)	Uniform	*Max(V1)	*Pk(e,o)	*Pk(a)
☞a. emasana						*		*
b. emase$_{1,2}$.na					*!		*	
c. emasyana		*!	*!					

The constraint hierarchy also certifies the coalescence in locative forms, as exemplified in tableau (30) below.[13] All candidates in (30) undergo a single violation of Onset because of the word-initial vowel. As discussed above, this violation is ignored here. All candidates also

[11]The tableau does not contain an evaluation between the winner *lo$_{12}$mfati* and a possible candidate *leemfati*. The candidate *leemfati* violates Onset and thus is immediately ruled out in evaluation. The winner satisfies the constraint Onset. There might be an interpretation of *leemfati* as *le:mfati*. However, this interpretation is not legitimate since SiSwati shows no contrast in vowel length. Even though the interpretation would be possible, the candidate could not be a winner since the superheavy syllable *le:m* in *le:mfati* is disallowed. The prohibition of superheavy syllables can be explained in several ways. One possibility is to appeal to the constraint Ft-Bin. When Ft-Bin is assumed to be in higher position in a constraint hierarchy, it can play a crucial role in filtering out *le:mfati*.

[12]I thank an anonymous reader for helping me to make this point clear.

[13]An anonymous reviewer legitimately points out that the constraint hierarchy justified so far cannot select the winner *endlini* over a possible candidate *endlene*, the one which reflects lowering of the suffix-initial and suffix-final *i's* due to the ranking of *Pk(i,u) over *Pk(e,o). I admit that we appeal to a more general and highly-ranked constraint to rule out the possible candidate *endlene*. A possibility is to invoke the constraint No Restructuring Constraint proposed by B.-G. Lee (1997), the constraint reflecting a series of Alternation Condition proposed by Paul Kiparsky in the 1970s and the Strict Cycle Condition in Lexical Phonology in the 1980s. The question raised by an anonymous reviewer is not limited to the SiSwati problem, but is relevant to a general phonological observation that a lot of phonological phenomena take place only when alternations can be tracked.

incur a violation of the constraint *Pk(i,u) due to the word-final vowel, which is not counted here.

(30) Onset >> Max-IO(V2), *Pk(i,u) >> Uniformity-IO >> Max-IO(V1), *Pk(e,o) >> *Pk(a)

/e_1-$i_2$ndlu_3-$i_4$ni/	Onset	Max(V2)	*Pk(i,u)	Uniform	Max(V1)	*Pk(e,o)	*Pk(a)
☞a. $e_{1,2}$ndl$i_4$ni			*	*	*	*	
b. $i_2$ndl$i_4$ni			*!*		**		
c. $i_2$ndl$u_3$ni		*!	**		*		
d. $e_1$ndl$i_4$ni		*!	*		*	*	
e. $e_1$ndl$u_3$ni		*!*	*			*	

In sum, the three independent phonological phenomena in SiSwati, which serve to avoid morphologically-driven vowel hiatus, are accounted for in a unified way by relying on a single constraint hierarchy, the one which reflects a combination of universally justified principles like sonority and markedness. The constraint ranking is given in (31).

(31) Onset, *$[lab]_\sigma^2$, *Cy >> Max-IO(V2), *Pk(i,u) >> Uniformity-IO >> Max-IO(V1), *Pk(e,o) >> *Pk(a),*Cw

5. Conclusion

This paper has proffered an Optimality-Theoretic account of SiSwati vowel hiatus, by appealing to universally motivated constraints. The account covers a variety of phenomena, which take place in apparently identical environments. The phenomena include glide formation, vowel deletion, and vowel coalescence. The OT account demonstrates that the seemingly independent phenomena are explained through a single, well-motivated constraint hierarchy.

This paper shows that the constraint Onset plays a crucial role in resolving all potential VV hiatus. It is also claimed that vowel coalescence is the result of removing a conflict between the positional preference and the sonority-based markedness.

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