Satisfying minimality in Ndebele*

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1 Introduction

Work on minimality (McCarthy & Prince 1986, 1993a; Crowhurst 1992; etc.) has mainly focussed on two types of morphological constituents, Word and RED. Little work has explored the role of minimality in constraining other morpho-prosodic domains or the variety of strategies a single language might use to satisfy minimality in different morphological contexts. In this paper, I discuss four different verb forms in Ndebele (a Nguni Bantu language spoken mainly in Zimbabwe) – the imperative, reduplicated, future and participial. I show that while all four are subject to minimality restrictions, minimality is satisfied differently in each of these morphological contexts. To account for this, I argue that in Ndebele (as in other Bantu languages) Word and RED are not the only constituents which must satisfy minimality: the Stem is also subject to minimality conditions in some morphological contexts. This paper, then, provides additional arguments for the proposal that Phonological Word is not the only sub-lexical morpho-prosodic constituent. Further, I argue that, although Word, RED and Stem are all subject to the same minimality constraint – they must all be minimally bisyllabic – this does not follow from a single 'generalized' constraint. Instead, I argue, *contra* recent work within Generalized Template Theory (see, e.g., McCarthy & Prince 1994, 1995a, 1999; Urbanczyk 1995, 1996; and Walker 2000; etc.) that a distinct minimality constraint must be formalized for each of these morpho-prosodic constituents.

2 Background

2.1 Bantu verb structure

As background to the analyses presented below, it is important to note that I am assuming the verb word structure shown in (1). This structure has been argued for for other Bantu languages in work by Barrett-Keach (1986), Hyman (1993), Hyman & Mtenje (1999), Mchombo (1993), Myers (1987, 1998) and Mutaka (1994), among others, who show there is both phonological and morphological evidence that Bantu verb words consist of two distinct constituents: the inflectional prefixes (INFL) and the Stem (Inflected Stem). (This is also the traditional view of Bantu verb structure presented in work like that of Doke (1943, 1954) and Meeussen (1967).) Subject prefixes (SP) and tense/aspect prefixes are daughters of INFL. Stems consist minimally of the Root (or Minimal D(erivational) Stem) and an Inflectional

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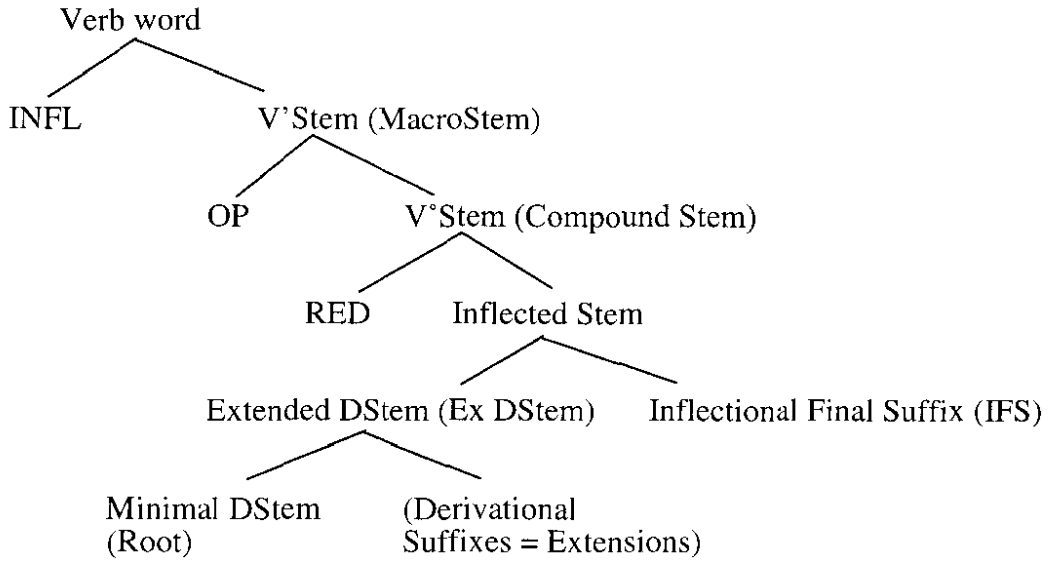
Final Suffix (IFS), separated by optional derivational suffixes (or extensions). As shown, the object prefixes (OP) and RED are often arguably dependents of a larger MacroStem constituent. In this paper, the terms „Stem“ and „MStem“ are used interchangeably to refer to the constituent labelled „Inflected Stem“ in the structure in (1).

(1) The representation of verb words in Bantu (adapted Myers 1987; Hyman & Mtenje 1999)



2.2. Morpho-prosodic domains

The analyses presented below assume that phonological processes only take morpho-prosodic constituents as their domains. As Inkelas (1989, 1993) argues, this assumption follows if we take seriously Selkirk's (1986) proposal that all phonological rules apply within morpho-prosodic domains, rather than domains defined directly on morpho-syntactic structure. This is because, in prosodic domains theory, neither sub-lexical morphological constituents nor super-lexical morpho-syntactic ones directly define the domain for phonological rules. Instead, every morphological constituent (M-constituent) which serves as a domain for phonological or prosodic rules must have a corresponding morpho-prosodic constituent (Ph-constituent), and it is this Ph-constituent which interacts with the phonology. In the default case, the Ph-constituent is coextensive with the corresponding M-constituent. However, the two may be misaligned, for example, to improve the prosodic well-formedness of the Ph-constituent as in the analyses argued for below. Following work like that of Czaykowska-Higgins (1996, 1998), Downing (1999b) and Inkelas (1989, 1993), I assume that sublexical morphological constituents like Stem and Root have corresponding Ph-constituents. Evidence for a distinction between PhWord and PhStem in Ndebele will be presented in section 5, below.

2.3 Phonological background

All of the Ndebele data is cited in the orthography (except where clearly indicated otherwise). It is important to note that all consonant sequences in Ndebele orthography are phonetically single sounds - eg., 'kh' = [k^h]; 'hl' = [•]; 'dl' = [•]; mb= [^{m}b]; etc. - and syllable structure is strictly (C)V. Also, in Ndebele orthography 'y' is the palatal glide; 'j' is a palatal affricate and 'c', 'q', 'x' are the dental, retroflex and lateral clicks, respectively. Note that acute accents indicate high tone (unaccented vowels have a low tone) in the data below, while a colon following a vowel indicates length. (As will be discussed in more detail below, penultimate syllables are always lengthened.)

3 Imperatives

Work like Brandon (1975), Herman (1995), Mutaka (1994) and Myers (1987, 1995) has established the importance of PhWord as a phonological domain in many Bantu languages. The motivation for the PhWord as a constituent in much of this work comes from examining the imperative form of verb stems, since the imperative is the only context where verb stems may occur unprefixed in most Bantu languages. As shown in (2a), Ndebele follows this general pattern: the imperative form of most verbs consists of the bare verb stem. But in (2b) we see that monosyllabic stems are augmented by epenthesizing a syllable in the imperative. And in (2c) we see that vowel-initial stems are (optionally) augmented by epenthesizing an onset in the imperative.

(2) Imperative verbs in Ndebele (Downing field notes; Rycroft (1983); source of the H tone is underlined; '=' indicates the INFL=MacroStem juncture)

	Infinitive	Imperative	Gloss
(a) *Multisyllabic, C-initial*	úkú=do:nsa	do:nsa	to pull
	úkú=bhukú:tsha	bhukú:tsha	to swim
	úkú=khi:pha	khi:pha	to put out
	úkú=búthéle:la	buthelé:la	to heap up
(b) *Monosyllabic*			
	úkú:=lwa	yí:-lwa	to fight
	úku:=phá	yi:-phá	to give
	úku:-zwá	yí:-zwa	to hear
	úkú:=fa	yi:-fa	to die
(c) *V-initial*			
	úkw=á:la	y-á:la	to refuse
	úkw=éla:pha	y-elá:pha	to cure
	úkw=éthú:la	y-ethú:la	to go down
	úkw=ábi:sa	y-abí:sa	to help divide

Epenthesis in the vowel-initial stems can be motivated by the requirement that imperative forms must be prosodically optimal by satisfying the Onset Principle (Itô 1986; Downing

1998a,b). As argued by Myers (1987) for Shona, another Bantu language, the best motivation for syllable epenthesis in the imperative form of monosyllabic stems is that, cross-linguistically, PhWords are required to be minimally bisyllabic. As work like McCarthy & Prince (1986, 1994, 1995b) and Selkirk (1995) has argued, this follows from the prosodic hierarchy. PhWord dominates Foot in the hierarchy, so by the Headedness Principle of the Strict Layer Hypothesis (Selkirk 1984, 1995; Nespor & Vogel 1986), PhWord must dominate a Foot. Since Feet are minimally bisyllabic then PhWords must be, too. As we can see in the data in (2), Ndebele words are, in fact, stressed on the penultimate syllable (this is indicated by lengthening the penult vowel), as is typical in Southern Bantu languages (Doke 1954; Myers 1987). It is plausible, then, to propose that in Ndebele, too, the minimality requirement on PhWords falls out from a requirement that they dominate a bisyllabic foot. The minimality and Onset conditions on PhWord can be formalized by the following constraints:

(3) (a) **Headedness** (adapted Selkirk 1995, fig (4ii)): A PhWord must dominate a metrical Foot.[1]
(b) **FtMin:** Feet are minimally bisyllabic.
(c) **Onset:** *AlignL(σ, μ_s)
OUTRANK
(d) **PhWord≈MWord:** PhWord is coextensive with MWord
(e) **DEP-IO**: Output segments must have input correspondents.

These constraints and ranking optimize misaligning the MWord (in this case the bare verb stem) with PhWord by epenthesis in order to satisfy minimality and Onset. The analysis is exemplified in (4).[2] Note that in this tableau, '[' indicates a PhWord edge; '(' indicates a foot parse, and '{' indicates an MWord edge:

[1] By metrical foot, I mean a foot that has a head which is more prominent than the other elements of the foot (through stress, length, pitch).
[2] To complete the analysis, one must explain why [yi] is the epenthesized syllable, rather than some other. It is actually not surprising that [yi] should be epenthesized since [i] is a common epenthetic vowel, probably due to its inherent shortness and resulting inherent lack of sonority (Steriade 1995; Pulleyblank 1998). This generalization can be formalized, following Pulleyblank (1998), by a harmonic ranking placing DEP[+hi,-back] below other featural faithfulness constraints. To account for why only a single trochaic foot is parsed at the right edge of the word in Ndebele, I propose that **AllFtR** (a constraint requiring all feet to be aligned at the right edge of the word) outranks **Parse σ** (a constraint requiring all syllables to be parsed into feet). Since none of these constraints are ever violated, they will not be included in the tableaux.

(4)

	Headedness	FtMin	Onset	PhWord≈MWord	DEP-IO
/donsa/					
√(a) [({do:nsa})]					
* (b) [YI{(do:nsa})]				*!	**
/lwa/					
√ (c) [(YI:{lwa})]				*	**
* (d) [({lwa})]		*!			
/ala/					
√ (e) [(Y{a:la})]				*	*
* (f) [({a:la})]			*!		

As shown in this tableau, it is not optimal to misalign MWord and PWord by epenthesis when MWord satisfies prosodic well-formedness (compare (4a) with (4b)). However, when MWord is subminimal (as in (4d)) or lacks an onset (as in (4g), it is optimal to misalign MWord and PWord by epenthesizing enough material to satisfy prosodic wellformedness constraints, but no more (as shown in (4h)).

To sum up this section, imperatives provide our first evidence that morpho-prosodic constituents in Ndebele are subject to a bisyllabic minimality constraint. Imperatives are arguably PhWords. Since PhWord is the domain for stress assignment in Ndebele, the minimality requirement on imperatives falls out from the requirement that PhWord dominate a stress foot. For comparison with cases to be discussed later, it is also important to note that epenthesis of phonologically unmarked material before the morphological base is the strategy used to satisfy minimality in the imperative.

4 Reduplication

In Ndebele, as in many other Bantu languages (see Downing 2000 and references cited therein), verb stems can be reduplicated to indicate that the action of the verb is done for a short period of time or in a careless fashion. As shown by the data in (5a), RED is maximally bisyllabic: no matter how long the Base verb stem is, RED never exceeds two syllables. The data in (5b) shows that RED is also minimally bisyllabic. Monosyllabic stems are augmented by [yi], just as in the imperatives. The only difference is that [yi] follows the RED segments corresponding to the Base stem, while in the imperative [yi] preceded the segments corresponding to the input stem.[3] The vowel-initial stems in (5c) show that minimality in the RED is achieved by epenthesizing [y] between the RED and the Base.

[3] Evidence that the /yi/ is epenthesized into RED, not the Base stem, comes from the fact that /yi/ appears in RED even when the Base contains suffixes making it longer than monosyllabic: e.g., <u>si=dl-íle</u> 'we ate' reduplicates <u>si=**dlayi**-dlíle</u>. I assume high-ranked AnchorL-BR accounts for the position of the epenthesized material.

(5) Ndebele reduplication (Downing field notes; RED is bolded; source of the H tone is underlined; '=' indicates the INFL=MacroStem juncture)[4]

	Infinitive	Reduplicated	Gloss
(a) *Multisyllabic, C-initial*			
	úkú=do:nsa	úkú=**donsá**-do:nsa	to pull
	úkú=há:mba	úkú=**hamba**-há:mba	to go
	úkú=hambí:sa	úkú=**hambi**-hambí:sa	to cause to go
	úkú=khanzí:nga	úkú=**khanzi**-khanzí:nga	to fry
	úkú=límísa:na	úkú=**límí**-límísa:na	to help ea. other farm
(b) *Monosyllabic*			
	úkú:=lwa	úkú=**lwáyí**:-lwa	to fight
	úku:=dla	úkú=**dlayí**:-dla	to eat
	úku:=zwá	úkú=**zwayí**:-zwa	to hear
	úkú:=za	úkú=**zayí**:-za	to come
	úkú:=fa	úkú=**fáyi**:-fa	to die
(c) *V-initial*			
	úkw=á:ba	úkw=**ábá**-y-a:ba	to divide up
	úkw=énzi:sa	úkw=**énzi**-y-énzi:sa	to cause to do
	úkw=á:kha	úkw=**ákhá**-y-a:kha	to build
	úkw=éndla:la	úkw=**éndla**-y-éndla:la	to spread

Since REDs, like imperatives, are minimally bisyllabic and minimality is satisfied in the same way for REDs and imperatives, one might assume that they are also PhWords. If this were so, then the minimality condition on REDs could also fall out from the requirement that PhWords must dominate stress feet. However, there a two important arguments why REDs are not PhWords. The first is that, if RED were a separate PhWord, we would expect its penult vowel to be lengthened under stress. However, as is clear from the data in (5), REDs are not assigned stress. Only the penult vowel of the entire reduplicated form (INFL=RED+Base stem) is lengthened, showing that both RED and the Base stem are contained within a single PhWord to which stress is assigned. Another argument comes from the tone pattern of the reduplicated forms. In Ndebele, as in other Nguni languages (see Downing 1990, 1996; Rycroft 1980, 1983 and references cited therein), high tones shift rightwards. The rightmost high tone generally surfaces on the antepenult of the word, even if the syllable which contributes the high tone is several syllables to the left of the antepenult and must cross a MacroStem boundary to reach the antepenult. This is illustrated in (5) where we see the H tone from the infinitive prefix úku- regularly spreads rightward into RED and the Base stem. More examples of low-toned verb stems following other H-toned prefixes (underlined) are given in (6). Note that ya- is the present affirmative focus prefix and –ile is the past tense suffix; both are underlyingly low-toned:

[4] See Hyman, Inkelas & Sibanda (1999) for discussion of reduplication in a different dialect of Ndebele.

(6) (a) ú̲-yá=vódlo:za 's/he is crushing'
(b) bá̲-yá=tshéle:la 'they are slipping'
(c) bá̲=lím-i:le 'they farmed'
(d) ú̲-yá=búthéle:la 's/he is heaping up'
(e) bá̲-yá=phéfúmu:la 'they are breathing'

Notice in this data that the prefixal H tone crosses the morphological stem boundary (=) to reach the antepenult when the stem has no H tone.

However, as shown in the data in (7), H tones do not shift long distance across word boundaries. In this data (taken from Rycroft (1983)), notice that H tones of the first word do not spread to the following word even when it is all low-toned:

(7) akú:kho bantwa:na 'there are no children'
akú:kho zikhwa:ma 'there are no bags'
akú:kho ndlwanya:na 'there is no small house'
ábáfá:na be:thu 'our boys'
ízi:nto za:khe 'his/her things'

I conclude from this that long distance tone spread is word-bound. In terms of the theory adopted here, that means it takes PhWord as its domain. Since H tones clearly shift to RED and its Base from the preceding prefixes, as shown in (5) and (6), they must be within the same PhWord as the prefixes and cannot be separate PhWords themselves.

Since RED is not a PhWord, then the minimality restriction on REDs cannot follow from the same general constraints on stress footing defining PhWord minimality that applied in the imperative. Instead, I propose that RED minimality is accounted for by the constraints in (8):

(8)(a) **RED=Ft**
i. The RED string is coextensive with a foot.
ii. The RED string is associated with the weight-bearing elements of a foot.
(b) **FtBin**
i. FtMin: Feet are minimally bisyllabic
ii. FtMax: Feet are maximally bisyllabic.
(c) **SMAX-BR**: Every segment of the Base (B) has a correspondent in the RED (R).

Ranking: RED=Ft, FtBin >> SMAX-BR, DEP-IO

Note that the Foot defining the RED size cannot be a metrical foot, unlike the foot defining the minimal PhWord, since RED is not stressed. Instead, the foot in (8a) is a purely prosodic, non-headed foot, parsing the RED string into a binary constituent. [5]

The analysis is examplified in (9). Note that parentheses indicate the prosodic foot parse; RED is bolded:

(9)

	RED=Ft	FtMin, FtMax	Onset	SMAX-BR	DEP-IO
/RED-hambisa/					
√(a) (**hambi**)-hambi:sa				**	
* (b) (**hambisa**)-hambi:sa		*! (Max)			
/RED-lwa/					
√ (c) (**lwaYI**:)-lwa					**
* (d) (**lwa:**)-lwa		*! (Min)			
/RED-enzisa/					
√ (e) (**enzi**)-Y-enzi:sa				**	*
* (f) (**enzi**)-enzi:sa			*!	**	
* (g) (**enzi**)s-enzi:sa	*!			*	

As shown in (9a), it is optimal to partially reduplicate longer Base stems in order to satisfy FtMax. It is also optimal to augment monosyllabic Base stems by epenthesis, as shown in (9c), to satisfy FtMin. And, as shown in (4e), epenthesizing /y/ is optimal in V-initial stems as it allows RED to be aligned with a foot while satisfying Onset.

To sum up this section, while REDs, like PhWords, are minimally bisyllabic, this condition cannot be accounted for by parsing REDs as PhWords. The lack of stress on REDs and their ability to be a target for prefixal H tones shows that they are not separate PhWords, but rather subconstituents of the PhWord containing the prefixes and following Base stem. In the next section, we will see that two other morphological verb forms, the future and participial, are subject to a bisyllabic minimality condition on their output base. However, in these cases, morphology, not phonology, determines the form of the segments which occur to satisfy minimality. Further, we shall see that in the participial, as in RED, the minimality requirement on the base cannot be accounted for by defining the base as PhWord.

[5] See Downing (2000) for detailed arguments in favor of this approach. Crowhurst (1992) and Mutaka & Hyman (1990) present other arguments for distinguishing prosodic feet (like those used to define RED size) from stress feet, showing that minimality effects cannot always be derived from independently motivated footing in other languages.

The analysis given here does not explain why the epenthentic /y/ that separates the RED and the Base of V-initial stems is not copied, as predicted by work like that of McCarthy & Prince (1993a). Downing (1998b) accounts for this by proposing that the RED in these words corresponds to the input base, not the output (by high ranking DEP-IR). This problem becomes moot in Pulleyblank's (to appear) approach which eliminates BR correspondence in favor of IR correspondence.

5 Future and participial

As shown in (10a), the future prefix in Ndebele is –<u>za</u>-. The data in (10b, c) shows that when monosyllabic verbs and V-initial stems occur in the future tense, they are augmented by /ku/ (which alternates with [k^w] before non-round vowels and [k] before round vowels). However, /ku/ does not occur with these same verb stems if they are preceded by an object prefix (OP), as shown in (10d).[6]

(10) Future verb forms in Ndebele (Downing field notes)

(a) *Multisyllabic, C-initial*

si:-za=thí:ya	'we will fish'
bá:-za=phendu:lwa	'they are being turned around'
bá:-za=tshele:la	'they will slip'
si:-za=khanzí:nga	'we will fry'

(b) *Monosyllabic*

si:-za=ku:-lwa	'we will fight'
b<u>á:</u>-za=ku:-zwa	'they will hear'
b<u>a:</u>-za=ku:-pha	'they will give'

(c) *V-initial*

si:-za=kw-ehli:sa	'we will bring down'
b<u>á:</u>-za=kw-e:qa	'they will jump'
b<u>á:</u>-za=kw-a:kha	'they will build'
ngi:-za=k-o:ndla	'I will raise; rear
b<u>á:</u>-za=kw-abela:na	'they will divide for each other'

(d) *Monosyllabic and V-initial + OP*

b<u>á:</u>-za=m-<u>é</u>qi:sa	'they will make him/her jump'
si:-za=m-<u>e</u>sabí:sa	'we will frighten him/her'
si:-za=b<u>á:</u>-pha	'we will give them'

A similar pattern of alternations is found in the participial form of the verb, used, for example in subordinate clauses introduced by the complementizer <u>úmá</u> 'if'. As shown in (11a), there is no independent tense/aspect marker in this form of the verb. What makes the participial INFL distinctive is that some of the subject prefixes (<u>bé-</u> 'they'; <u>é-</u> 's/he') are different from those used in other affirmative tenses (<u>bá-</u> 'they'; <u>ú-</u> 's/he'). The data in (11b,c) shows that when monosyllabic and V-initial stems occur in the participial, they are augmented by [s(i)]. However, [s(i)] does not occur with these same verb stems if they are preceded by an object prefix (OP), as shown in (11d).

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[6] An identical alternation pattern in the future tense has been identified in Kirundi, a Bantu language spoken mainly in Burundi. See Aronoff (1988), Downing (1998b), Goldsmith & Sabimana (1986), and Myers (1998) for discussion. And see Cassimjee (1999) for discussion of the participial in Xhosa.

(11) Participial verb forms in Ndebele (Downing field notes)

(a) *Multisyllabic, C-initial*

é̲=qá:nsa	'...s/he is climbing...'	é̲=**qansá**-qa:nsa	'reduplicated'
é̲=nge̲ní:sa	'...s/he is putting in...'		
be̲=bó̲na	'...they see...'		
be̲=líma	'...they are farming...'		

(b) *Monosyllabic*

bé̲=si:-dla	'...they are eating...'
ngi=si:-pha	'...I am giving...'
ngi=sí:-wa	'...I am falling...'

(c) *V-initial*

be̲=s-éhli:sa	'...they are bringing someone down'
be̲=s-**éhlí**-y-éhli:sa	reduplicated form of 'they are bringing s.o. down'
e̲=s-á̲:kha	'...s/he is building...'
u=s-o:ma	'...you are thirsty...'

(d) *Monosyllabic and V-initial + OP*

e̲=b-a̲khé:la	'...s/he is building for them...'
ngi=kú̲:-pha	'...I am giving you...'

Since /ku/ and [s(i)] only surface with monosyllabic and V-initial MacroStems, their occurrence clearly has a prosodic motivation: they allow these MacroStems to be bisyllabic and begin with onsets. What is less clear is their morpho-syntactic status, since these strings are empty morphs with no identifiable morpho-syntactic function.[7] As their occurrence correlates with particular tense/aspects (future or participial), they are arguably daughters of INFL. However, since they cannot co-occur with OPs and occur in order to satisfy prosodic well-formedness constraints on the MacroStem, they are just as plausibly daughters of the MacroStem. To resolve this ambiguity, I propose that [ku~ k^w] and [s(i)] are morpho-syntactically unaffiliated (and so unpositioned in the input). Their surface position and morpho-prosodic parse are determined solely by constraint interaction.[8] The fact that these empty morphs co-occur with a particular tense/aspect can be formalized by the alignment constraints in (12) requiring the empty morphs to be left-aligned with the right edge of the relevant INFL:

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[7] While/ku-/ resembles the infinitive prefix (and historically, the future may well be derived from the verb 'to come' plus an infinitive complement (Nurse & Muzale 1999), synchronically, the future tense forms cited in (10) are single verb words. That /ku/ is distinct from the infinitive prefix can be seen from comparing the data in (10) with true infinitival complements, where /úku-/ is obligatorily present no matter how long the verb is and whether or not the verb has an OP: e.g., si:-za=za:ma úkú=ba-lwí:sa 'we will try to fight them'. Notice the infinitival complement has an OP (bá- 'them') and the stem itself (-lwisa 'cause to fight') is bisyllabic, yet /úku-/ obligatorily occurs on the verb.

[8] See Booij & Lieber (1993) and Downing (1998b) for discussion and analysis of other cases of prosodically positioned morphemes, and reference to other work on this topic.

(12)(a) **Align /ku/**: Align (L, /ku/; R, Future INFL)
Align the left edge of /ku/ with the right edge of the Future INFL constituent.
(b) **Align /si/**: Align (L, /si/; R, Participial INFL)
Align the left edge of /si/ with the right edge of the Participial INFL constituent.

In order to formalize the constraints expressing the prosodic motivation for the occurrence of these empty morphs, we must first determine which morpho-prosodic constituent they are parsed into. Looking first at the future data in (10), we can see that /ku/ arguably begins a distinct PhWord from the preceding Future INFL, so that the words in (10b,c) have the following morpho-prosodic constituency:

(13)(a) [bá:za]$_{\text{PhWd}}$[ku:pha]$_{\text{PhWd}}$ 'they will give'
[bá:za]$_{\text{PhWd}}$[kwa:kha]$_{\text{PhWd}}$ 'they will build'
[bá:za]$_{\text{PhWd}}$[tshele:la]$_{\text{PhWd}}$ 'they will slip'

Evidence that INFL and and the MacroStem are distinct PhWords comes from the two tests for PhWord-hood discussed in the preceding sections. Notice, first, that the penult vowel of both the INFL and the MacroStem are lengthened, as we expect if they are distinct PhWords. Further, notice that the H tone of the SP bá- 'they' does not spread rightwards to the MacroStem. This tone pattern is expected if the INFL and MacroStem are distinct PhWords; it is totally unexpected otherwise.

These same tests show that /si/ does not begin a distinct PhWord from the preceding Participial INFL. Notice in (11) that only a single vowel in the participial verb word is lengthened: the penult V of the MacroStem. Further, the H tone of the SP spreads to the MacroStem. This is expected if the MacroStem and INFL are part of the same PhWord, but totally unexpected if they are distinct PhWords. Finally, notice the participial INFL consists of a single syllable, and so is too short to constitute a distinct PhWord. I propose instead that /si/ is parsed into PhStem, a morpho-prosodic constituent based on the MacroStem but not necessarily coextensive with it. Since PhStem is a subconstituent of PhWord, it correctly is contained within the same tone and stress assignment domain as the Participial INFL.

PhStem must further be subject to a minimality constraint particular to that constituent:

(14) **PhStem Min:** PhStem is minimally bisyllabic.

PhStem minimality cannot fall out from Headedness (3a), since only PhWords, not PhStems, are required to dominate metrical feet. Further, PhStem, unlike RED and PhWord, is only required to satisfy minimality in certain morphological contexts, like the Participial. Monosyllabic and V-initial MacroStems occur unaugmented in other morphological contexts, like the infinitive (see (5), (6), above) and the -ya- tense in the data in (15), below. (Notice that the stress falls outside the MacroStem in the monosyllabic examples.)

(15) (a) *Monosyllabic*

si-ya:=lwa	'we are fighting'
kú̲-ya:=tsha	'it is burning'
bá̲-ya:=dla	'they are eating'
si-ya:=pha	'we are giving'

(b) *V-initial*

si-y=e:hla	'we are going down'
si-y=a:kha	'we are building'
bá̲-yá=m-éhli:sa	'they are making him/her go down'
si-y=o:tha	'we are basking'

(c) *Multisyllabic, C-initial*

si-ya=khwé̲:la	'we are climbing'
si-ya=nge̲ní:sa	'we are putting in'
bá̲-yá=do:nsa	'they are pulling'

As these data show, no material is ever epenthesized to prosodically improve the MacroStem. This means that the constraint on PhStem minimality must rank below DEP-IO, while the other minimality constraints must rank about DEP-IO, since epenthesis is optimal to satisfy minimality in the imperative and RED. Note that this would create a ranking paradox if PhStem minimality were accounted for with the same constraints appealed to for PhWord and RED minimality.

The empty morphs /ku/ and /si/ surface, then, to satisfy minimality conditions on PhWord and PhStem, respectively. To explain why there is a correlation between the form of the base stem and the occurrence of the empty morphs, I propose that the Future and Participial INFLs must be constrained to affix only to prosodically well-formed bases, PhWord and PhStem. This requirement can be formalized with the constraints in (16a,b) which outrank the general alignment constraint (16c) defining the optimal position of INFL as adjacent to the MacroStem:

(16)(a) **AlignPart**: Align(R, Participial INFL; L, PhStem)
Align the right edge of the Participial INFL with the left edge of a PhStem.

(b) **AlignFut**: Align(R, Future INFL; L, PhWord)
Align the right edge of the Future INFL with the left edge of a PhWord.

OUTRANK

(c) **AlignINFL**: Align(R, INFL; L, MacroStem)
Align the right edge of INFL with the left edge of a MacroStem.

What remains to be explained is why the empty morphs do not surface when not needed to satisfy prosodic well-formedness. I propose this can be accounted for by ranking constraint (16c) above MAX-IO and below the prosodic constraints (Onset, Minimality >> AlignINFL>>MAX-IO). As shown in (17), this optimizes deleting the empty morphs when the morphological MacroStem is prosodically well-formed:

(17)[9]

(i) Future

	Align Fut	Align /ku/	Onset	FtMin	DEP-IO	Align INFL	MAX-IO
/si-za=ku-lwa/							
√ (a) si:za=[ku:-{lwa						*	
* (b) si:za=[{lwa				*!			**
/ba-za=ku-eqa/							
√ (c) ba:za=[kw-{e:qa						*	
* (d) ba:za=[{e:qa			*!				**
/si-za=ku-thiya/							
√ (e) si:za=[{thi:ya							**
* (f) si:za=[ku-{thi:ya						*!	

(ii) Participial

	Align Part	Align /si/	Onset	DEP-IO	PhStem Min	Align INFL	MAX-IO
/be=(si)-pha/							
√ (a) be=[si-{pha						*	
* (b) be=[{pha					*!		**
/be=(si)-akha/							
√ (c) be=[s{akha						*	*
* (d) be=[{akha			*!				**
/be=(si)-bona/							
√ (e) be=[{bona							**
* (f) be=[si-{bona						*!	

As shown in the tableaux in (17), the empty morphs, /ku/ and /si/ optimally surface when the MacroStem is monosyllabic or V-initial. Even though maintaining the morphs in the output violates AlignINFL (16c), deleting them leads to violations of the higher ranked prosodic well-formedness conditions (Onset, Minimality) on PhStem and PhWord. However, as shown in (17ie, iie), when the morphological MacroStem satisfies Onset and Minimality, it is optimal to delete the empty morphs to satisfy AlignINFL (16c).

To sum up this section, I have shown that two INFL stems of Ndebele, the Future and the Participial, take a morpho-prosodic constituent as their base for affixation, as well as their morphological base, the MacroStem. This best explains why the base of both INFLs is

[9] In the tableaux in this section, '=' indicates the INFL=MacroStem juncture, '[' indicates PhWord (future) or PhStem (participial) edge, '{' indicates the MacroStem edge. Even though the empty morphs are shown as ordered in the input for typographic reasons, it is important to remember they are actually ordered only in the output by alignment constraints.

subject to minimality: (morpho-)prosodic constituents are typically required to be prosodically well-formed. I have also shown that the Future and Participial do not take the same morpho-prosodic constituent as their base. Rather, the Future takes the PhWord while the Participial takes the PhStem. Finally, I have shown that the empty morphs which occur to satisfy minimality fail to occur otherwise because these morphs have only a morpho-prosodic affiliation, not a morpho-syntactic one. As a result, they interfere with the proper morpho-syntactic alignment of the INFL and MacroStem within the verb word when they do surface. This misalignment is optimal when it improves prosodic well-formedness. When it does not, the empty morphs are deleted.

6 Conclusion

In sum, I have argued that minimality conditions the surface form of four forms of Ndebele verbs: the imperative, reduplicative, future and participial. While all four are required to be bisyllabic, I have shown that property does not fall out from a single general minimality constraint, as we might expect given Generalized Template Theory (McCarthy & Prince 1994, 1995, 1999; Urbanczyk 1995, 1996; and Walker 2000; etc.). Instead, I have shown that three different constraints are necessary, because three different morpho-prosodic constituents with different properties are motivated by this data. The imperative and the base for the future are parsed into PhWord, as shown by the patterns of tone and length assignment to these forms (and the morpho-syntactic independence of the imperative). These same phonological patterns show that neither RED nor the base of the participial are PhWords even though they, too, are minimally bisyllabic. The base of the participial was shown to be PhStem, a subconstituent of PhWord mostly coextensive with the morphological Macrostem. The RED was argued to be a distinct morpho-prosodic entity since, unlike the others, it is subject to a maximality as well as a minimality constraint. While this property makes RED resemble a metrical foot, the RED is not plausibly parsed into a metrical foot since it is not stressed. Only the bisyllabic minimality of PhWord arguably follows from a general requirement that PhWords contain at least one stress foot. PhStems are subject to a distinct minimality requirement from PhWords, because, like RED, they are not always parsed into a stress foot. Further, unlike the other morpho-prosodic constituents, PhStems do not always satisfy minimality on the surface since epenthesis cannot be appealed to to satisfy minimality. This paper, then, contributes to our understanding of the variety of sublexical morpho-prosodic constituents cross-linguistically, and to our understanding of the variety of ways prosodic constraints on these constituents can be satisfied.

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