Chapter 2

Metrically conditioned vowel length in Dagaare

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There is little evidence for stress in Dagaare, but vowel length alternations in nominal and verbal morphology reveal the presence of a word-initial metrical foot. New evidence for the foot hypothesis comes from action nominals formed with the suffix /-UU/: if the root is CV, the root lengthens and the suffix shortens; if the root is CVV the suffix shortens; if the root ends in C nothing happens. Similar length alternations appear more idiosyncratically with number and aspect suffixes. A metrical analysis provides a simple account of these vowel length alternations.

1 Introduction

Dagaare (Gur, Mabia; Naden 1989, Bodomo 1997) is a two-tone language of north-western Ghana.[1] There is little direct evidence for metrical stress, but vowel alternations in nominal and verbal morphology suggest the presence of a word-initial metrical foot (Anttila & Bodomo 2009). New evidence for the foot hypothesis comes from vowel length alternations in action nominals, the topic of the present paper.

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[1] The data represent the Jirapa district dialect of which the second author is a native speaker. Most of the data are previously unpublished; some can be found in (Kennedy 1966; Bodomo 1997; Anttila & Bodomo 2009), which are referred to in the text. The examples are given in Bodomo's (1997: 37) orthography. The digraphs <ky>, <gy>, <ny> stand for IPA [tʃ], [dʒ], [ɲ], respectively.

Kennedy (1966: 9) gives the vowel inventory for Dagaare word-medial syllables shown in Table 1.

Table 1: Dagaare vowels (Kennedy 1966)

| | −round | | +round | |
	+ATR	−ATR	+ATR	−ATR
+high, −low	i, ii	ɪ, ɪɪ	u, uu	ʊ, ʊʊ
−high, −low	e, ie	ɛ, ɪɛ	o, uo	ɔ, ʊɔ
−high, +low		a, aa		

Vowel length is contrastive in Dagaare. High and low vowels can be short or long, but there is a striking gap in Kennedy's inventory: long mid vowels are missing. Kennedy (1966: 8) notes that word-medially "there are high and low long vowels, but no mid long vowels" and suggests that in terms of the phonological system the diphthongs [ie], [ɪɛ], [uo], [ʊɔ] are in fact the missing long vowels /ee/, /εε/, /oo/, /ɔɔ/. This is an attractive interpretation because it makes the long vowel pattern symmetrical.

The problem is that long mid vowels do exist on the surface. There are even near-minimal pairs that demonstrate a phonemic contrast between a long mid vowel and the corresponding diphthong: *béé* 'or' vs. *bié* 'child.sg', *gɔ̀ɔ́* 'left' vs. *gúɔ̀* 'thorn.sg'. Examples of long mid vowels are shown in Table 2. /E/ stands for a [−high, −low, −round] vowel and /I/ for a [+high, −low, −round] vowel, both underspecified for ±ATR]; /V/ stands for a [−high] vowel underspecified for [±back], [±round], and [±ATR].[2]

However, Kennedy's insight is nevertheless well founded: long mid vowels are phonologically special. The long mid vowels in Table 2 are either underlying or result from the concatenation of two underlying short mid vowels; phonologically derived long mid vowels are systematically missing. In particular, the process of vowel lengthening stops short of creating long mid vowels as shown in Table 3.

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[2]Tone does not figure into the vowel length alternations, but a brief note is warranted. Underlyingly there is a three-way contrast between H, L, and toneless; on the surface there is a three-way contrast H, ꜜH, and L. Toneless morphemes surface as H or L depending on the context. We mark downstep as a raised exclamation point before a H toned syllable. Downstep seems analyzable as a floating L and contour tones as combinations of H and L. The underlying tone marking reflects our work in progress. For more details, see Kennedy (1966: 42-49) and Anttila & Bodomo (2000).

Table 2: Long mid vowels

Underlying	Surface		Underlying	Surface	
/béé/	béé	'or'	/bóò/	bóò	'which'
/pɔg-léé/	pɔ̀gléé	'woman-DIM'	/tòò-rÍ/	tòòrí	'ear-SG'
/gbɛ́-É/	gbɛ́ɛ̀	'leg-PL'	/dɔɔ-´/	dɔ́ɔ́	'man-SG'
/bar-ÈÉ/	bàrɛ̀ɛ́	'leave-PERF'	/ɔɔ-rV́ /	ɔ̀ɔrɔ́	'chew-IMPF'
/téésì /	téésì	'test.SG'	/lɔ́ɔ́-rÍ/	lɔ́ɔrì	'lorry-SG'

Table 3: Vowel lengthening in suffixed nouns

	Root	Suffixed form		N + A Compound	
(a)	/bi-/	bíí-rí	'child-PL'	bì-fáá	'bad child'
	/pì-/	pìì-rí	'rock-SG'	pì -fáá	'bad rock'
	/kù-/	kùù-rí	'hoe-SG'	kù-fáá	'bad hoe'
	/gṹ-/	gṹṹ-rì	'thorn-PL'	gṹ-ˈfáá	'bad thorn'
(b)	/pò-/	pùò-rí	'back-SG'	pò-fáá	'bad back'
	/nɔ́-/	nɔ̃́ɔ́-rì	'mouth-SG'	nɔ́-ˈfáá	'bad mouth'
	/dò-/	dò-rí	'pig-PL'	dò-fáá	'bad pig'
	/dè-/	dè-rí	'room-PL'	dè-fáá	'bad room'
	/lè-/	lè-rí	'bead-SG'	lè-fáá	'bad bead'
	/gbɛ́-/	gbɛ́-rì	'leg-SG'	gbɛ́-ˈfáá	'bad leg'

Table 3 shows that the number suffix /-rÍ/ triggers vowel lengthening in high vowel stems, but not in mid-vowel stems where the result is either a diphthong or the vowel simply fails to lengthen, depending on the lexical item. The noun-adjective compound is given as a diagnostic for the underlying form of the noun: the nouns in Table 3 all have a short stem vowel. In contrast, the long mid vowel in *dɔ́ɔ́* 'man.SG' given in Table 2 is underlying: *dɔ̀ɔ̀-fáá* 'bad man'. Lengthening is lexically conditioned even in high vowel stems: there are words like *bí-rì* 'seed-SG' and *yí-rì* 'house-SG' where lengthening does not happen. Finally, the data illustrate a characteristic aspect of Dagaare number morphology: /-rÍ/ may mean either singular or plural depending on the stem, an instance of "polarity morphology" that has attracted the attention of semanticists (Grimm 2012).

Vowel lengthening also occurs in singular forms with no overt suffix. Anttila & Bodomo (2009) propose that in such cases the root vowel lengthens in order to satisfy a bimoraic foot template.

Table 4: Vowel lengthening in unsuffixed nouns

	Root	Suffixed form		N + A Compound	
(a)	/bi-/	bíé	'child.SG'	bì-fáá	'bad child'
	/gṹ-/	gṹɔ̀	'thorn.SG'	gṹ-ˈfáá	'bad thorn'
(b)	/dè-/	dìé	'room.SG'	dè-fáá	'bad room'
	/dò-/	dùó	'pig.SG'	dò-fáá	'bad pig'

Here is the reasoning: the singular form is a phonological word; therefore it must contain at least one foot; therefore it must be minimally bimoraic (McCarthy & Prince 1996). In Dagaare this generalization holds for almost all nouns.[3] In contrast, function words, weak forms of pronouns, and citation forms of verbs can be monomoraic. The question is why the vowel does not simply lengthen, yielding *bíí, *gṹɔ̀, *dèè, and *dòó. Anttila & Bodomo (2009) propose that this is due to two constraints: *bíí and *gṹɔ̀ are blocked by a constraint against word-final high vowels; *dèè, and *dòó are blocked by a constraint against long mid vowels. Crucially, both constraints only apply in phonologically derived environments. The optimal outcome is a rising diphthong: bíé, gṹɔ̀, dìé, and dùó.

In sum, we have seen that all the nine vowels of Dagaare can be underlyingly either short or long (Kennedy 1966). There are also underlying diphthongs, such as tìɛ̀ 'shoot', pùòrì 'thank', yíélì 'sing', lṹɔ́r-áá 'lion-SG'. However, long mid vowels [ee], [ɛɛ], [oo], [ɔɔ] are special in that they cannot be the result of lengthening.

This system of vowel length may seem complicated and one can reasonably question whether it has anything to do with foot structure. We will now provide new evidence suggesting that it indeed does. We first show that verbs exhibit parallel length alternations, complete with parallel exceptions. Particularly interesting is the action nominal paradigm where the length alternations are entirely regular and the foot template triggers both vowel lengthening and vowel shortening.

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[3]We are aware of four monomoraic (CV) nouns: bâ 'father.SG', mǎ 'mother.SG', nû 'hand.SG', zû 'head.SG'.

2 Length alternations in verbs

The key alternations in the verbal paradigm are illustrated in Table 5.

Table 5: Vowel length alternations in Dagaare verbs

	Root	Cit. form	Imperf.	Nominal	
(a)	/ba-/	bà	bàà-rá	báá-ʊ́	'stick into the ground'
	/baa-/	bàà	bàà-rá	báá-ʊ́	'grow (of child)'
(b)	/bar-/	bàrì	bà-rá	bár-ʊ́ʊ́	'leave'
	/bár̀r-/	bárrì	bár-ˈrá	bár'r-ʊ́ʊ́	'bargain'
	/báàr-/	báárì	báá-ˈrá	báá'r-ʊ́ʊ́	'finish'

The root and the citation form are identical except that consonant-final roots acquire a final epenthetic vowel in the citation form, either /i/ or /ɪ/ depending on ATR-harmony. This is because a Dagaare word must end in a vowel or in the velar nasal [ŋ]; in the latter case vowel epenthesis seems optional.[4] The imperfective suffix /-rV́/ copies its vowel quality from the root. Our main focus is on the action nominals where both roots and suffixes alternate. We assume that the underlying form of the suffix is /-ÚÚ/, where /U/ stands for a [+high, −low, +round] vowel underspecified for [±ATR]. Here are the key generalizations. First, a short root vowel lengthens before the suffix, e.g., /ba/ 'stick into the ground' becomes *báá-ʊ́* (long root vowel). Second, the suffix vowel is short after vowel-final roots, but long after consonant-final roots, e.g., /ba/ 'stick into the ground' yields *báá-ʊ́* (short suffix vowel), but /bar/ 'leave' yields *bár-ʊ́ʊ́* (long suffix vowel).[5]

Tables 6 and 7 illustrate vowel length alternations in CV verbs. The above generalizations hold without exception in action nominals: the root vowel is always long and the suffix vowel is always short. Vowel height matters to root vowel lengthening: low and high root vowels lengthen (Table 6), e.g., /bà/, *báá-ʊ* 'stick

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[4]This word-final epenthetic /i/ or /ɪ/ is a systematic counterexample to the ban on word-final derived high vowels. It seems that the ban only holds in the lexical phonology and that these epenthetic vowels are postlexical.

[5]There exists another nominalizing suffix /-bÚ/, which results in doublets such as *dííú ~ dííbú* 'eating', *íŋʊ́ʊ́ ~ ímmʊ́* 'putting', *wóŋúú ~ wómmú* 'understanding', and *zíŋʊ́ʊ́ ~ zímmʊ́* 'sitting'. More examples can be found in Durand (1953). We have not conducted a systematic study of this suffix variation, but we speculate that it may depend on dialect and speech rate. The variation is not completely free: some verbs allow /-ÚÚ/, but not /-bÚ/, e.g., *píírʊ́ʊ́/*píríbʊ́* 'sweep', *síírʊ́ʊ́/*síírɪ'bʊ́* 'touch'.

into the ground' and /dì/, *díí-ú* 'eat', whereas mid root vowels diphthongize (Table 7), e.g., /kyɛ/, *kyɪɛ-ʊ* 'cut' and /bɔ/, *bʊɔ-ʊ* 'want, look for'. The verbs are further divided into two sets (a) and (b) based on vowel length in the imperfective. We will return to the imperfective shortly.

The imperfective paradigm is more complicated. The suffix /-rV́/ copies the root vowel except that a high vowel becomes mid, reflecting the constraint against word-final derived high vowels, e.g., /di/, *dì-ré* 'eat-IMPF'. The verbs are further divided into two sets (a) and (b) based on whether the root vowel undergoes lengthening and/or diphthongization. The choice is phonologically unpredictable: we have vowel lengthening in /ba/ *bàà-rá* 'stick into the ground-IMPF',

Table 6: CV verbs, low and high vowel roots

	Root	Cit. form	Imperf.	Nominal	
(a)	/ba-/	bà	bàà-rá	báá-ʊ̌	'stick into the ground'
	/da-/	dà	dàà-rá	dáá-ʊ̌	'buy'
	/wa-/	wà	wàà-ná	wáá-ʊ̌	'come'
	/kpá-/	kpá	kpáá-rà	kpáá-ʊ̀	'boil'
	/la-/	là	làà-rá	láá-ʊ̌	'laugh'
	/mí-/	mí	míí-rè	míí-ù	'rain'
	/bʊ̌-/	bʊ̌	bʊ̌ʊ̌-rɔ̀	bʊ̌ʊ̌-ʊ̀	'come (of rain)'
	/bú-/	bú	búú-rò	búú-ù	'measure, calculate'
	/nyʊ́-/	nyʊ́	nyʊ́ʊ́rɔ̀	nyʊ́ʊ́-ù[a]	'drink'
	/zú -/	zú	zúú-rò	zúú-ù	'steal'
(b)	/tá-/	tá	tá-rà	táá-ʊ̀	'reach'
	/ɪ-/	ì	ì-rɛ́	íí-ʊ̌	'do'
	/dɪ̌-/	dɪ̌	dɪ́-ˈrɛ́	dɪ́í-ˈʊ̌	'take'
	/di-/	dì	dì-ré	díí-ú	'eat'
	/kʊ̀-/	kʊ̀	kʊ̀-rɔ́	kʊ̌ʊ̌-ʊ̌	'give, offer'
	/yí-/	yí	yí-rè	yíí-ù	'divorce a male'

[a]We mark contrastive nasalization with a subscript tilde to avoid clutter. The interpretation of nasalized vowels is controversial. Kennedy (1966: 12) derives them via absolute neutralization from vowel-/m/ sequences, e.g., /fààm/ →*fàa̰* 'fail': "There is a clear hole in the final nasal pattern. Though n and ŋ occur word final, m does not. Therefore nasalized vowels which are not contiguous to nasals are interpreted as vowel-m sequences." Bodomo (1997: 9) assumes that nasalization is phonemic and notes that it is mostly found in long vowels.

but not in /tá/ *tá-rà* 'reach-ɪᴍᴘꜰ' (Table 6); we have diphthongization in /gyɛ́-/ *gyíɛ́-rɛ̀* 'refuse to take', but not in /nyɛ́-/ *nyɛ́-rɛ̀* 'see, understand' (Table 7). This makes the imperfective suffix /-rV́/ look rather similar to the number suffix /-rÍ/ which also exhibits lexically conditioned vowel lengthening.

Table 8 illustrates the same paradigms in CVV verbs. The pattern in action nominals is the same as with CV verbs: the root vowel is long and the suffix vowel is short. In imperfectives the root vowel typically remains long, but there is an interesting minor pattern: some verbs undergo vowel *shortening* in the imperfective, e.g., *tá-ˈrá* 'have-ɪᴍᴘꜰ' and *gè-rɛ́* 'go-ɪᴍᴘꜰ'.[6] These verbs provide evidence for a process of root vowel shortening which was not visible in CV verbs where we could only see root vowel lengthening. The verbs 'be' and 'have' are tonally idiosyncratic and given our uncertainty about the analysis we do not give underlying forms for them.

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[6]The ablaut in *gè-rɛ́* 'go-ɪᴍᴘꜰ' is specific to this lexical item.

Table 7: CV verbs, mid vowel roots

	Root	Cit. form	Imperf.	Nominal	
(a)	/kyɛ-/	kyɛ̀	kyìɛ̀-rɛ́	kyíɛ́-ŏ́	'cut'
	/kpɛ-/	kpɛ̀	kpìɛ̀-rɛ́	kpíɛ́-ŏ́	'enter'
	/gyɛ́-/	gyɛ́	gyíɛ́-rɛ̀	gyíɛ́-ò̆	'refuse to take'
	/ŋmɛ-/	ŋmɛ̀	ŋmìɛ̀-rɛ́	ŋmíɛ́-ŏ́	'beat'
	/gbe-/	gbè	gbìè-ré	gbíé-ú	'grind roughly'
	/bɔ́-/	bɔ́	bŏ́ɔ́-rɔ̀	bŏ́ɔ́-ò̆	'want, look for'
	/kɔ́-/	kɔ́	kŏ́ɔ́-rɔ̀	kŏ́ɔ́-ò̆	'farm'
	/yɔ́-/	yɔ́	yŏ́ɔ́-rɔ̀	yŏ́ɔ́-ò̆	'roam'
(b)	/ko-/	kò	kò-ró	kúó-ú	'dry'
	/kó-/	kó	kó-rò	kúó-ù	'get ready for rain'
	/tɛ́-/	tɛ́	tɛ́-rɛ̀	tíɛ́-ò̆	'display'
	/zo-/	zò	zò-ró	zóó-ú[a]	'run'
	/nyɛ́-/	nyɛ́	nyɛ́-rɛ̀	nyáá-ò̀[b]	'see, understand'

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[a]The action nominalization *zóó-ú* is a counterexample to our generalization that there are no derived long mid vowels. Another such verb is /go-/: *gò, gò-ró, góó-ú* 'wait for, keep watch'.

[b]With this verb, vowel lengthening results in [áá], not in the expected [íɛ́].

Table 8: CVV verbs

	Root	Cit. form	Imperf.	Nominal	
(a)	/baa-/	bàà	bàà-rá	báá-ʊ́	'grow (of child)'
	/fáà-/	fáà	fáá-ˈrá	fáá-ˈʊ̃	'seize'
		wàá	wàà-rá	wáá-ʊ́	'be'
	/tɪɛ-/	tìè	tìè-rɛ́	tíɛ́-ʊ̃	'shoot'
	/fɪɛ-/	fɪ̀ɛ̀	fɪ̀ɛ̀-rɛ́	fɪ́ɛ́-ʊ̃	'whip'
	/dɪɛ-/	dɪ̀ɛ̀	dɪ̀ɛ̀-nɛ́	dɪ́ɛ́-ʊ̃	'play'
	/yuo-/	yùò	yùò-ró	yúó-ú	'open'
(b)		tàá	tá-ˈrá	táá-ʊ̃	'have, own'
	/gaa-/	gàà	gὲ-rɛ́	gáá-ʊ̃	'go'

We now turn to consonant-final roots. Table 9 illustrates the same paradigms in CVC roots. Here the action nominal suffix vowel is always long. The imperfective paradigm shows mixed behavior of the familiar kind: the initial syllable may be heavy (CVC.CV) as in (a) or light (CV.CV) as in (b), depending on the verb. One and the same verb may even allow both forms as in (c): /bal-rV́/ 'be.tired-IMPF' may come out either as *bàl-lá* or *bàl-á*. Minimal pairs like /bɔŋ-rV́/, *bɔ̀n-nɔ́* 'know-IMPF' with a heavy initial syllable and /wòŋ-rV́/ *wò-nó* 'hear-IMPF' with a light initial syllable suggest that the choice between the two is lexical. Note that the suffixal /r/ assimilates in place and/or manner to the root-final consonant; the details will be set aside here.[7]

The same paradigms for CVCC verbs are shown in Table 10. Again, the vowel in the action nominal suffix is always long. This time even the imperfective paradigm is uniform: the initial syllable is always heavy (CVC.CV), with no free or lexical variation.

Finally, Table 11 illustrates CVVC verbs. The action nominal suffix vowel is again always long and the imperfective paradigm is uniformly CVV.CV, with no variation.

Having the overtly vowel-final *sɔ̀ɔ̀* 'spoil' listed among CVVC verbs deserves a comment. The citation form is clearly vowel-final, i.e., CVV, but there is good

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[7]The CVC verb /gbɪr-/ 'sleep' has the exceptional paradigm *gbi rì*, *gbíˈré*, *gɔ́ɔ́ˈʊ̃*. The action nominal is exceptional in having a short suffix vowel, but since it differs segmentally from the root in several ways, including its [ATR] value, we suspect it is probably based on a different lexeme.

Table 9: CVC verbs

	Root	Cit. form	Imperf.	Nominal	
(a)	/bɔŋ-/	bɔ̀ŋì	bɔ̀n-nɔ́	bɔ́ŋ-ɵ̋ɵ̋	'know'
	/dŏg-/	dŏgí	dŏg-rɔ̀	dŏg-ʊ̀ʊ̀	'boil, brew'
	/ɪŋ-/	ìŋì	ìŋ-né	íŋ-ɵ̋ɵ̋	'put'
	/biŋ-/	bìŋì	bìn-né~bìŋ-né	bíŋ-úú	'put down'
	/sîŋ-/	síŋì	síŋ-ˈné	síˈŋ-ɵ̋ɵ̋	'equal'
	/pɔg-/	pɔ̀gì	pɔ̀g-rɔ́	pɔ́g-ɵ̋ɵ̋	'(en)close'
	/sag-/	sàgì	sàg-rá	ság-ɵ̋ɵ̋	'answer'
	/sέg-/	sέgí	sέg-rὲ	sέg-ʊ̀ʊ̀	'write'
	/sʊŋ-/	sʊ̀ŋì	sʊ̀ŋ-nɔ́	sʊ̆ŋ-ɵ̋ɵ̋	'help'
(b)	/bar-/	bàrì	bà-rá	bár-ɵ̋ɵ̋	'leave'
	/bur-/	bùrì	bù-ró	búr-úú	'soak'
	/êr-/	έrì	έ-ˈrέ	έˈr-ɵ̋ɵ̋	'grind'
	/mar-/	màrì	mà-rá	már-ɵ̋ɵ̋	'paste'
	/sar-/	sàrì	sà-rá	sár-ɵ̋ɵ̋	'slip'
	/sɔ́r-/	sɔ́rí	sɔ́-rɔ̀	sɔ́r-ʊ̀ʊ̀	'count'
	/woŋ-/	wòŋì	wò-nó	wóŋ-úú	'understand'
	/yel-/	yèlì	yè-lé	yél-úú	'speak'
	/zɪŋ-/	zìŋì	zì-né	zíŋ-ɵ̋ɵ̋	'sit'
(c)	/bal-/	bàlì	bàl-lá~bàl-á	bál-ɵ̋ɵ̋	'be tired'

evidence that the root is underlyingly /saaŋ/: the velar nasal surfaces in the action nominal *sá̰á̰ŋ-ɵ̋ɵ̋*. It is as if the root-final /ŋ/ were present when the suffix vowel length is determined and then deleted leaving its nasal component behind, resulting in *sà̰à̰*. The coronal nasal in the imperfective *sà̰à̰-ná̰* results from place assimilation with the initial coronal consonant of the imperfective suffix /-rV́/. Parallel examples from nouns include *kɔ̀ɔ́* 'water', underlyingly /kɔ̀ŋ-/, as in *kɔ̀ŋ-fáá* 'bad water'. In the free form the velar stop deletes leaving nasalization behind and the mid vowel diphthongizes to fill the foot template, resulting in (*kɔ̀ɔ́*).

Not all verbs with nasal vowels behave in the same way. Compare *sà̰à̰* 'spoil' to *dḭ̀ḛ̀* 'play' and *fḭ̀ḛ̀* 'whip'. Unlike *sà̰à̰*, the latter two must be underlyingly vowel-final since the corresponding action nominals are *dḭ́ḛ́-ɵ̰́* and *fḭ́ḛ́-ɵ̰́*, with a short suffix vowel. However, the two differ in the imperfective: in *dḭ̀ḛ̀- nɛ́* the coronal

Table 10: CVCC verbs

Root	Cit. form	Imperf.	Nominal	
/bárr-/	bárrì	bár-ˈrá	bárˈr-ʊ́ʊ́	'bargain'
/bɛll-/	bɛ̀llì	bɛ̀l-lɛ́	bɛ́ll-ʊ́ʊ́	'deceive'
/gɔll-/	gɔ̀llì	gɔ̀l-lɔ́	gɔ́ll-ʊ́ʊ́	'go around'
/kann-/	kànnì	kàn-ná	kánn-ʊ́ʊ́	'learn'
/kyɛll-/	kyɛ̀llì	kyɛ̀l-lɛ́	kyɛ́ll-ʊ́ʊ́	'listen'
/mánn-/	mánnì	mán-ˈná	mánˈn-ʊ́ʊ́	'measure'
/nyunn-/	nyùnnì	nyùn-nó	nyúnn-úú	'smell'
/pɛgl-/	pɛ̀glì	pɛ̀g-lɛ́	pɛ́gl-ʊ́ʊ́	'carry'
/pɛnn-/	pɛ̀nnì	pɛ̀n-nɛ́	pɛ́nn-ʊ́ʊ́	'rest'
/síll-/	síllì	síl-ˈlɛ́	sílˈl-ʊ́ʊ́	'tell stories'
/tall-/	tàllì	tàl-lá	táll-ʊ́ʊ́	'walk fast'

Table 11: CVVC verbs

Root	Cit. form	Imperf.	Nominal	
/báár-/	báárì	báá-ˈrá	bááˈr-ʊ́ʊ́	'finish'
/naan-/	nààní	nàà-ná	náán-ʊ́ʊ́	'get ready, develop'
/saal-/	sààlì	sààl-á	sáál-ʊ́ʊ́	'sharpen'
/saaŋ-/	sà̰à̰	sà̰à̰-ná̰	sá̰á̰ŋ-ʊ̰́ʊ̰́	'spoil'
/piir-/	pìirì	pìi-ré	píír-úú	'discover'
/pɪɪr-/	pɪ̀ɪrì	pɪ̀ɪ-rɛ́	píír-ʊ́ʊ́	'sweep'
/sîɪr-/	síírì	síí-ˈrɛ́	síɪˈr-ʊ́ʊ́	'touch'
/yíɛl-/	yíɛlì	yíɛ-ˈlɛ́	yíɛ́ˈl-úú	'sing'
/gíɛr-/	gíɛrì	gíɛ-ˈrɛ́	gíɛ́ˈr-úú	'belch'
/fúòr-/	fúórì	fúó-ˈró	fúóˈr-úú	'sip'
/puor-/	pùòrì	pùò-ró	púór-úú	'thank, greet, pray'
/kɔɔr-/	kɔ̀ɔrì	kɔ̀ɔ-ró	kɔ́ɔ́r-ʊ́ʊ́	'delay'
/ɔɔr-/	ɔ̀ɛrì	ɔ̀ɔ-ró	ɔ́ɔ́r-ʊ́ʊ́	'chew'

stop of the imperfective suffix /-rV́/ becomes a nasal, whereas in *fɩ̀ɛ̀-rɛ́* it does not. We do not have a satisfactory analysis to offer and must leave the topic with these preliminary remarks.

3 Proposal

Our claim is that these vowel length alternations serve to optimize metrical structure. The key assumption is that the action nominal suffix /ÚÚ/ subcategorizes for a foot: the left edge of /-ÚÚ/ strives to be aligned with the right edge of a foot. This demands a well-formed foot that respects alignment. Vowel length adjustments are a way to achieve this goal: a short root vowel lengthens to make up a minimal foot and a long suffix vowel shortens because it is unstressed.

We illustrate the analysis in Table 12 with two vowel-final verbs: /ba/ 'stick into the ground' and /baa/ 'grow (of child)'. The processes are described in terms of informal ordered rules. Foot boundaries are marked with parentheses and imply syllable boundaries.

Table 12: The derivation of vowel length in V-final roots

Process	/ba-ʊ́ʊ́ /	/baa-ʊ́ʊ́ /	Motivation
Footing	(bá)ʊ́ʊ́	(báá)ʊ́ʊ́	Initial foot needed
V lengthening	(báá)ʊ́ʊ́	–	No degenerate feet
V shortening	(báá)ʊ́	(báá)ʊ́	No unstressed VV
	[bááʊ́]	[bááʊ́]	

/ba-ʊ́ʊ́/ undergoes both root vowel lengthening and suffix vowel shortening; /baa-ʊ́ʊ́/ only undergoes suffix vowel shortening. In both cases, the outcome is (*báá*)*ʊ́*, where the syllable containing the suffix vowel falls outside the foot, i.e., it is extrametrical. Kennedy (1966: 4) calls such word-final light syllables *secondary syllables*. Their prosodic structure is illustrated in (1) below.

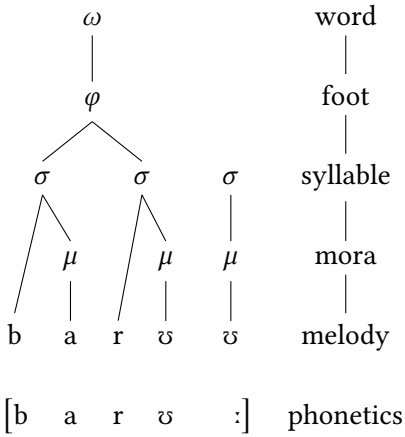(1)   A phonological word with a secondary syllable: (*báá*)ʊ̆

```
    ω                           word
    |                            |
    φ                           foot
    |                            |
    σ            σ              syllable
   ╱│╲           │
  μ   μ    μ              mora
  b    a    ʊ              melody

 [b    aː    ʊ]          phonetics
```
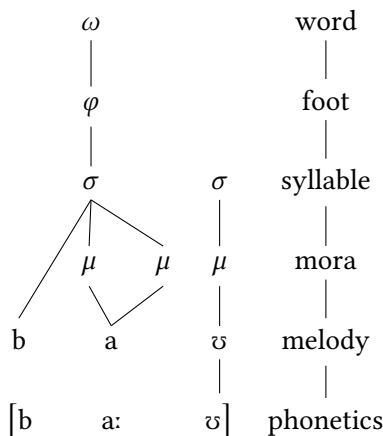
Consonant-final roots are different. Consider /bar/ 'leave': if suffix alignment were all that counts the input /bar-ʊ̆ʊ̆/ should be footed *(*bár*)ʊ̆ʊ̆, but that is not possible because it implies the syllabification **bár.ʊ̆ʊ̆* which is illegal in Dagaare. Suffix alignment and word prosody are driven into conflict and word prosody wins: the solution is (*bá.rʊ̆*)ʊ̆ where the long suffix vowel is split into two light syllables: the first is incorporated into the foot and the second remains extrametrical. This implies the syllabification CV.CV.V which is legal in Dagaare (Kennedy 1966: 3-4). Table 13 illustrates this for the consonant-final verbs /bar/ 'leave', /bár̀r/ 'bargain' and /báàr/ 'finish' in terms of informal ordered rules. The prosodic structure of *bárʊ̆ʊ̆* is shown in (2) below.

Table 13: The derivation of vowel length in C-final roots

Process	/bar-ʊ̆ʊ̆/	/bár̀r-ʊ̆ʊ̆/	/báàr-ʊ̆ʊ̆/	Motivation
Footing	(bá.rʊ̆)ʊ̆	(bár.ˈrʊ̆)ʊ̆	(báá.ˈrʊ̆)ʊ̆	Initial foot needed
V lengthening	–	–	–	No degenerate feet
V shortening	–	–	–	No unstressed VV
	[bárʊ̆ʊ̆]	[bárˈrʊ̆ʊ̆]	[bááˈrʊ̆ʊ̆]	

(2) A phonological word with a secondary syllable: (*bárʊ́*)*ʊ́*

```
  ω                    word

  |

  φ                    foot

 ╱ ╲

σ     σ     σ          syllable

     μ    μ    μ        mora

b   a   r   ʊ   ʊ       melody

[b   a   r   ʊ   :]     phonetics
```

Summarizing, vowel length alternations in Dagaare action nominals can be understood from a metrical perspective. The three key facts, namely vowel lengthening in CV roots, suffix vowel shortening after vowel-final roots and absence of suffix vowel shortening after consonant-final roots receive a unified explanation. In the next section we will outline an optimality-theoretic analysis of action nominals.

4 Analysis

4.1 Constraints

To keep things simple we will make the following assumptions. Dagaare words have an initial trochaic foot; feet are binary under syllabic or moraic analysis; and degenerate feet, e.g., *(ba)*, and ternary feet, e.g., *(ba.rʊ.ʊ)*, are excluded. At most one syllable may be extrametrical: (*baa.ʊ*)*ʊ* is possible, but *(baa)ʊ.ʊ* is not. Candidates that violate these high-ranking constraints will not be mentioned.

Four phonological constraints are needed to express the generalizations informally outlined in earlier sections. These constraints are given in Table 14.

The Weight-to-Stress Principle (WSP, Prince 1990) punishes unstressed heavy syllables. It is satisfied in (*báá*)*ʊ́* where the suffix vowel has shortened and surfaces as the light extrametrical syllable *ʊ́* that lacks an onset. It is also satisfied in (*bár.rʊ́*)*ʊ́* where the long suffix vowel has been parsed into two light syllables: the tail of the foot *rʊ́* and the light extrametrical syllable *ʊ́* that lacks an onset. The

Table 14: Four constraints

Weight-to-Stress Principle	'No unstressed heavy syllables'
Max(V)	'No vowel deletion'
Dep(V)	'No vowel insertion'
Align(Suffix, L, Foot, R)	'The left edge of a suffix coincides with the right edge of a foot'

latter is Kennedy's (1966) "secondary syllable." The WSP is violated in *(*báá*)*ʊ́ʊ́*, *(*bár*)*rʊ́ʊ́* and *(*bár.rʊ́ʊ́*) where the long suffix vowel is parsed as a single heavy syllable.[8]

4.2 Deriving vowel length

The four constraints in Table 14 allow us to derive the vowel length alternations in action nominals. We start with CV stems. Tableau (3) establishes the crucial rankings. To simplify presentation, we have omitted tone and simply assume the correct vowel harmony (ATR, rounding). Candidates with ternary feet, degenerate feet, and multiple extrametrical syllables are systematically omitted.

(3) Vowel length with CV roots

/ba-ʊʊ/			WSP	Align	Dep(V)	Max(V)
(a)	☞	(baa)ʊ			1	1
(b)		(ba.ʊ)ʊ		1!		
(c)		(ba.ʊʊ)	1	1		
(d)		(baa)ʊʊ	1!		1	
(e)		(baa.ʊʊ)	1!	1	1	
(f)		(ba.ʊ)		1		1

The winner (a) exhibits both suffix vowel shortening and root vowel lengthening. The faithful candidate (b) is perfect in every way except that it fatally mis-

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[8]An anonymous reviewer notes that the word /dàgáárì/ 'the Dagaare language' violates the WSP given a left-aligned trochee, i.e., (*dà.gáá*)*rì* and wonders why the vowel does not shorten. Two explanations seem possible. First, this could be an instance of nonderived environment blocking (Kiparsky 1993). Second, the intuitively strong syllable is the penult, suggesting the foot structure *dà*(*gáárì*). It should be pointed out that trisyllabic and longer words in Dagaare are often right-headed compounds with the morphological structure σ+σσ, e.g., *lábírì* 'small axe' from *lárì* + *bírì* 'axe-sg + seed-sg'. It is possible that /dágáárì/ is etymologically a compound, i.e., /dá+gáárì/, although synchronically opaque.

aligns the suffix and foot boundaries. Since Align dominates both faithfulness constraints, Max(V) and Dep(V), the result is a double adjustment of vowel shortening and vowel lengthening. Candidates (c), (e), and (f) are grayed out to show that they are harmonically bounded: they can never win no matter how the constraints are ranked.

We now turn to CVV roots illustrated in Tableau (4). In this case, only suffix vowel shortening is needed in order to satisfy the WSP:

(4) Vowel length with CVV roots

/baa-ʊʊ/			WSP	Align	Dep(V)	Max(V)
(a)	☞	(baa)ʊ				1
(b)		(ba.ʊ)ʊ		1		1
(c)		(ba.ʊʊ)	1	1		1
(d)		(baa)ʊʊ	1!			
(e)		(baa.ʊʊ)	1!	1		
(f)		(ba.ʊ)		1		2

Consonant-final roots behave differently. What sets them apart from vowel-final roots is that they inevitably violate Align when combined with a vowel-initial suffix. Given the input /CVC-VV/ the best-aligned candidate is (*CVC*)*VV* where the suffix boundary is crisply aligned with the foot boundary. But this foot structure entails the syllabification **CVC.VV* which is illegal in Dagaare.[9] We need a better syllabification, but that will inevitably violate Align. This makes alignment irrelevant with consonant-final roots because it will have to be violated no matter what. We illustrate this for CVC roots in Tableau (5). The winner (*ba.rʊ*)*ʊ* has the syllable structure CV.CV.V which is legal in Dagaare.

(5) Vowel length with CVC roots

/bar-ʊʊ/			WSP	Align	Dep(V)	Max(V)
(a)	☞	(ba.rʊ)ʊ		1		
(b)		(ba.rʊʊ)	1	1		
(c)		(baa.rʊ)ʊ		1	1	
(d)		(baa)rʊʊ	1	1	1	
(e)		(ba.rʊ)		1		1

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[9]A full analysis of Dagaare syllable structure cannot be undertaken here. Here we simply assume an undominated locally conjoined constraint Onset & $_L$*Coda that is violated by the syllabification C.V where the first syllable has a coda and the second syllable has no onset. Other analyses are no doubt possible.

The following question raised by a reviewer is best quoted verbatim:

> I see a potential inconsistency between the analyses of /ba-ʊʊ/ and /bar-ʊʊ/. If foot structure can make the suffix split across foot edges, why does /ba-ʊʊ/ need vowel lengthening? The structure (baʊ)ʊ has no degenerate foot and no unstressed VV. It doesn't have -ʊʊ attaching to a foot, but then neither does (ba.rʊ)ʊ.

The answer is characteristically optimality-theoretic: grammaticality is determined by competition. In the case of /ba-ʊʊ/, the candidate *(baʊ)ʊ loses because there is a better candidate available: the winner (baa)ʊ that satisfies ALIGN. In the case of /bar-ʊʊ/ we have no such luxury: all candidates violate ALIGN and therefore we must settle for the suffix-splitting (ba.rʊ)ʊ.

We conclude by showing the tableaux for CVVC and CVCC roots. They behave analogously and present no additional complications.

(6) Vowel length with CVCC roots

/barr-ʊʊ/			WSP	ALIGN	DEP(V)	MAX(V)
(a)	☞	(bar.rʊ)ʊ		1		
(b)		(bar.rʊʊ)	1	1		
(c)		(baar.rʊ)ʊ		1	1	
(d)		(bar.rʊ)		1		1

(7) Vowel length with CVVC roots

/baar-ʊʊ/			WSP	ALIGN	DEP(V)	MAX(V)
(a)	☞	(baa.rʊ)ʊ		1		
(b)		(ba.rʊ)ʊ		1		1
(c)		(baa)rʊʊ	1	1		
(d)		(baa.rʊ)		1		1

4.3 Lexically conditioned length

Our metrical analysis of Dagaare action nominals is relatively straightforward. Much more intriguing are the number and imperfective paradigms. Table 15 below illustrates lexically conditioned length alternations with the imperfective suffix /-rV́/.

In CV-roots the vowel lengthens or stays short; in CVV-roots the vowel stays long or shortens; in CVC-roots the suffix creates a CC cluster /CVC-rV́/ which either survives or shortens, sometimes variably within a single lexical item. Why are length alternations so uniform in the action nominal paradigm, but riddled with lexical exceptions in the number and imperfective paradigms? To answer

Table 15: Lexical conditioning in the imperfective

	Underlying	Imperfective	Alternation	
(a)	/da-rV́/	dàà-rá	lengthening	'buy'
	/tá-rV́/	tá-rà	–	'reach'
(b)	/fáà-rV́/	fáá-ˈrá	–	'seize'
	/gaa-rV́/	gè-rέ	shortening	'go'
(c)	/bɔŋ-rV́/	bɔ̀n-nɔ́ –	'know'	
	/woŋ-rV́/	wò-nó	C-deletion	'understand'
	/bal-rV́/	bàl-lá ~ bàl-á	variation	'be tired'

this question with any degree of confidence would require a deeper understanding of Dagaare morphophonology than we have at the moment. However, one is immediately struck by the observation that it is the *vowel-initial* suffixes that tend to have uniform paradigms. In addition to the action nominal /-ÚÚ/, the perfective /-ÈÉ / and the plural /-V́ / seem fairly regular. It is the *consonant-initial* suffixes that permit exceptions, in particular the number /-rÍ/ and the imperfective /-rV́/.[10] Trying to explain these apparent suffix-related regularities is an interesting project, but must be left for future work.

5 Summary

We have provided new evidence for metrical structure in Dagaare based on vowel length alternations in action nominals. If the root is CV the root lengthens and the suffix shortens; if the root is CVV the suffix shortens; if the root ends in C nothing happens. Similar length alternations appear more idiosyncratically with number and aspect suffixes. We have proposed a metrical analysis that explains the length alternations in action nominals and lends further support to the metrical analysis of vowel length proposed in Anttila & Bodomo 2009 for Dagaare nouns.

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[10]Space does not permit a discussion of the perfective /-ÈÉ/ and the plural /-V́/ here. We hope to return to the topic in a more complete exposition in the future.

Acknowledgements

Abbreviations

DIM	diminutive	PL	plural
IMPF	imperfective aspect	SG	singular
PERF	perfective aspect		

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