

Prosodic Morphology in Dagaare

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1. Introduction

Gur languages are tonal and there is little evidence for stress.¹ However, segmental alternations can nevertheless provide evidence for metrical structure. In this paper, we present such evidence from Dagaare (Gur, Niger-Congo; Kennedy 1966, Hall 1977, Bodomo 1997, Anttila and Bodomo 2007) where vowel length alternations in number morphology reveal the presence of a bimoraic foot $(\mu\mu)_\phi$.

Dagaare nominals can be divided into classes based on how they form singular and plural, a characteristic property of Gur languages (Naden 1989, Bodomo 1997, Bodomo and Marfo 2007). This results in the appearance of “polarity morphology” where one and the same suffix, e.g. *-ri*, may denote either singular or plural, depending on the stem. This is illustrated in (1) for two sets of nouns. We will use the orthographical conventions of Kennedy 1966 and Bodomo 1997.

(1) “Polarity morphology” in Dagaare

	STEM	SINGULAR	PLURAL	
(a)	bì-	bíé	bíírí	‘child’
	tì-	tíé	tíírí	‘tree’
	dè-	dié	dèrí	‘room’
	wè -	wíé	wèrí	‘farm’
(b)	pì-	píírí	pié	‘rock’
	bí-	bíírí	bíè	‘seed’
	yí-	yíírí	yíè	‘house’
	mí-	míírí	míè	‘rope’

In (1a), the singular is marked by a vowel, in this case a final /e/ or /ɛ/, depending on ATR-harmony. The plural is marked by /ri/ or /rɪ/, depending on ATR-harmony, possibly accompanied by lexically conditioned stem vowel lengthening. In (1b), we have the reverse pattern. Such apparent mismatches of morphology and semantics may be unusual, but they are characteristic of Dagaare nominals. The specific point we set out to demonstrate in this paper is a phonological one. We will argue that the additional vowels—either singular or plural—have two distinct sources: sometimes they are actual suffixes; sometimes they arise from phonological epenthesis that adjusts the stem to make up a bimoraic foot $(\mu\mu)_\phi$.

The leftmost column in (1) shows the underlying form of the noun without number marking. This underlying stem can be established by combining the noun with an adjective, e.g. *fáá* ‘bad’, or with a *wh*-question word, e.g. *boó* ‘which’, *wúó* ‘what’, what kind’, and *bónó* ‘what, what thing’. In both cases, the noun appears in its stem form. Examples are given in (2). As we will see shortly, the shape of the stem plays an important role in identifying the Dagaare foot template.

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- (2) (a) bíé ‘child-SG’ bì-fáá ‘bad child’
 dié ‘room-SG’ dè-fáá ‘bad room’
 (b) bíé ‘child-SG’ bì-bóò ‘which child?’
 dié ‘room-SG’ dè-wúló ‘what (kind of) room?’

2. The morphophonology of number marking

2.1. Zero singulars

First, we note that singular marking may be absent under certain phonological circumstances:

- (3) Generalization 1: If the stem is at least bimoraic and ends in a vowel
 (a) The singular is marked by zero.
 (b) The plural is marked by /-ri, -rɪ/.

In the examples in (4), the singular is morphologically unmarked, the plural is morphologically marked. The examples in (4b) show that this group of words includes recent loans.

(4) Zero singulars

	STEM	SINGULAR	PLURAL	
(a)	tù-	túú	túúrí	‘forest’
	kyú-	kyúù	kyúúrí	‘moon’
	kù-	kùù	kùúrí	‘cradle’
	kù-	kùú	kùúrí	‘death’
(b)	bìrìgyì-	bìrìgyì	bìrìgyìrí	‘bridge’
	pòlísì-	pòlísì	pòlísìrí	‘police’

As is evident from these examples, both singular and plural involve a suffixal H tone (Anttila and Bodomo 2000, 2007; Kenstowicz et al. 1988). A reviewer suggests that this potentially undermines the claim that singulars are morphologically unmarked. However, note that the H tone marks neither singular nor plural: it occurs on all inflected words irrespective of number. These suffixal tones thus in no way undermine the singular/plural asymmetry: the plural equals the singular plus /-ri, -rɪ/.

A similar case is shown in (5). The suffix /-nɛ/ forms plurals based on mass nouns:

(5) Plurals of mass nouns

STEM	SINGULAR	PLURAL	
tù-	túú	túúnɛ	‘(types of) medicine’
zì-	zìí	zìínɛ	‘(types of) blood’
bì-	bìí	bìínɛ	‘(types of) broth’
dá-	dáá	dáánɛ	‘(types of) alcoholic drink’

In addition to zero singular suffixes, Dagaare also has overt singular suffixes, among them the suffix /-ri, -rɪ/ which we already saw in (1):

(6) Overt singulars

STEM	SINGULAR	PLURAL	GLOSS
pì-	pìrì	pié	'rock'
bí-	bírì	biè	'seed'
yí-	yírì	yìè	'house'
mí-	mírì	mìè	'rope'

2.2. Consonant-final stems

If the stem ends in a consonant, two morphophonological processes apply: consonant deletion/assimilation and vowel insertion.

(7) Generalization 2: If the stem ends in a consonant

- (a) One number value is marked with /-ri, -rì/ which undergoes consonant deletion and/or assimilation depending on the preceding consonant.
- (b) The other number value is marked by an additional vowel which is a copy of the preceding stem vowel, except if this vowel is [+high] (/i, ɪ, u, ʊ/), in which case the added vowel is mid.

We now consider some examples. In (8), the stem-final consonant is /g/. Consonant deletion does not apply to /-ri, -rì/ because [gr] is a possible phonotactic sequence in Dagaare. In these examples, the additional vowel is a copy of the stem vowel.

(8) No consonant deletion after a stem-final /g/

	STEM	SINGULAR	PLURAL	GLOSS
(a)	wég-	wégè	wégrì	'log'
	bòg-	bògɔ́	bògrì	'shoulder'
(b)	gbàg-	gbàgrì	gbàgá	'container'
	nyàg-	nyàgrì	nyàgá	'intestine, root'
(c)	lùg-	lùgrì	lùgó	'pillar'

In (9), the stem-final consonant is /l/. In the /-ri, -rì/ form (= singular) the suffixal /r/ is deleted. The additional vowel (= plural) is a copy of the last stem vowel, except if the vowel is high, in which case the added vowel is mid.

(9) Consonant deletion after a stem-final /l/

	STEM	SINGULAR	PLURAL	GLOSS
(a)	gbààl-	gbàálí (← / gbààl+rì/)	gbàálá	'container'
	pél-	pélí	pélé	'sheet'
	vààl-	vaálí	vaálá	'rubbish'
(b)	gyíl-	gyílí (← /gyil+rì/)	gyilé	'xylophone'
	ííl-	íílí	íílé	'horn'

The examples in (8c) and (9b) illustrate the ban on word-final high vowels. This ban only appears to hold on phonologically derived environments. Non-derived environments are exempt, e.g. /tùù-/ 'forest-SG', /tùù-rí/ 'forest-PL', /birígyì-/ 'bridge', /birígyì/ 'bridge-SG', /birígyì-rí/ 'bridge-PL'. Here the stem-final high vowels (/tùù-/ /birígyì-/) and the suffix-final high vowels (/rì, -rì/) survive because they are underlyingly [+high].

In (10), the stem-final consonant is /n/. In the /-ri, -rɪ/ form (= singular) the suffixal /r/ is deleted. The additional vowel (= plural) is a copy of the last stem vowel and the nasal surfaces as [m].²

(10) Consonant deletion after a stem-final /n/

gán-	gání (← gan+rɪ/)	gámà	‘book’
sán-	sáni	sámà	‘debt’
ngmàn-	ngmání	ngmámá	‘calabash’
lièn-	liéni	liémé	(kind of fruit)

In (11), the stem-final consonant is /ŋ/ (orthographically *ng*). In the /-ri, -rɪ/ form (= plural) the /r/ undergoes total assimilation that results in a geminate, e.g. /ŋ+r/ → [nn]. The additional vowel (= singular) is a copy of the last stem vowel, except if the vowel is high, in which case the additional vowel is mid.³

(11) Total assimilation after /ŋ/

STEM	SINGULAR	PLURAL	
(a) tàng-	tángá	tánní (← /tang+rɪ/)	‘mountain’
yèng-	yèngé	yènní	‘outside’
bòng-	bòngó	bònní	‘donkey’
wòng-	wòngó	wònní	‘deaf’
kòng-	kòngó	kònní	‘leper’
lòng-	lòngó	lònní	‘frog’
bòng-	bòngó	bònní	‘lizard’
(b) bìng-	bìngé	bìnní	‘pen’

2.3. CV-stems

The crucial evidence for foot structure comes from stems with a short vowel. Such stems cannot surface as words, but are systematically lengthened.⁴

(12) Generalization 3: If the stem is monomoraic and ends in a vowel

- (a) One number value is marked with /-ri, -rɪ/.
- (b) The other number value is marked by an additional vowel whose quality and position depend on the number (singular vs. plural).

There turn out to be two kinds of additional vowels. Typically, the vowel is epenthetic in the singular (plural) and an actual suffix in the plural (singular). Consider the paradigm in (13) where the additional vowel appears in the singular.

² It is possible that these stems end in an underlying /m/.

³ The stem /sɛng-/ ‘bed’ is an exception to this statement: *sɛngí* ‘bed-SG’, *sɛnní* ‘bed-PL’.

⁴ There are a small number of (C)V nouns that challenge this generalization, e.g. *zû* ‘head-SG’. These nouns remain exceptions to the present analysis.

- (13) Singular: Vowel epenthesis compelled by the bimoraicity requirement;
Plural: /-ri, -rɪ/, possibly accompanied by high vowel lengthening.

	STEM	SINGULAR	PLURAL	
(a)	bì-	bíé	bírí	‘child’
	tì-	tíé	tírí	‘tree’
(b)	kù-	kúó	kúrí	‘wild rat’
	pù-	púó	púrí	‘stomach’
	wù-	wúó	wúrí	‘wallet’
	bù-	búó	búrí	‘goat’

The additional vowel is required to make up a bimoraic foot. The quality of the epenthetic vowel is determined by the generalization in (7): the vowel is a copy of the last stem vowel except if it is high, in which case the epenthetic vowel is mid. The epenthetic vowel also undergoes rounding harmony: if the stem vowel is unrounded, the epenthetic vowel is unrounded; if the stem vowel is rounded, the epenthetic vowel is rounded. The plural is formed by /-ri, -rɪ/, accompanied by lexically conditioned high vowel lengthening.⁵

However, the data in (13) are also compatible with an alternative hypothesis: perhaps the final vowel is not epenthetic, but an underspecified vocalic suffix, e.g. -V[-high]. This hypothesis must be rejected in view of the additional data in (14).

- (14) Singular: Vowel epenthesis compelled by the bimoraicity requirement;
Plural: /-ri, -rɪ/

	STEM	SINGULAR	PLURAL	
	gbè-	gbié	gbèrí	‘forehead’
	dè-	dié	dèrí	‘room’
	pè -	pié	pèrí	‘basket’
	wè -	wié	wèrí	‘farm’
	dò-	dúó	dòrí	‘pig’
	dò-	dúó	dòrí	‘dawadawa’

In these examples, the stem vowel is mid ([-high, -low]). The bimoraicity requirement is satisfied by epenthesis of a high vowel /i, ɪ, u, ʊ/ in the middle of the stem, resulting in alternations like /gbè-/ ‘forehead’ (stem), *gbié* ‘forehead-SG’, *gbèrí* ‘forehead-PL’. Inserting a high vowel at the end of the word is not an option because of the ban on phonologically derived final high vowels (**gbéí*). Inserting a mid vowel is also not an option because of the ban on phonologically derived long mid vowels (**gbéé*).⁶

The crucial point demonstrated by the examples in (14) is that the singular marker cannot be a suffix. Instead, the additional vowel is epenthetic and arises as a response to the minimal word requirement: a word must contain at least two moras. More precisely, vowel epenthesis follows from the interaction of the following independent principles:

⁵ One might speculate that the lexically conditioned high vowel lengthening is also metrically driven: if the suffix /-ri, -rɪ/ suffix were extrametrical, we could explain stem vowel lengthening. However, the extrametricality of /-ri, -rɪ/ would have to depend on the stem since not all stems lengthen.

⁶ We are aware of one word where high vowel epenthesis feeds lengthening: /nó-/ ‘chicken’, *núó* ‘chicken-SG’, *núúrí* ‘chicken-PL’.

- (15) (a) Number inflection converts stems to morphological words.
 (b) Every morphological word is a prosodic word.
 (c) Every prosodic word must contain at least one foot.
 (d) Monomoraic feet are banned.

Next, consider the data in (16). Here the singular is formed by /-ri, -rɪ/, possibly accompanied by lexically conditioned high vowel lengthening, whereas the plural is formed by adding a vowel. As before, the vowel is necessary to satisfy the minimal word requirement. However, unlike the singular vowels in (13) and (14) that serve the same purpose, the plural vowel is fixed in terms of its phonological shape and location: it is always unrounded and always appears after the stem.

- (16) Singular: /-ri, -rɪ/, accompanied by lexically conditioned high vowel lengthening.
 Plural: /-e, -ɛ/

	STEM	SINGULAR	PLURAL	
(a)	bí-	bírì	bíè	‘seed’
	pì-	pìrì	pié	‘rock’
	yí-	yírì	yíè	‘house’
	mí-	mírì	mîè	‘rope’
	kù-	kùrì	kùé	‘hoe’
(b)	nó-	nó̄rì	nóè	‘mouth’
	pò-	pòrì	pòé	‘back’
	yó-	yó̄rì	yóè	‘name’
	yɔ-	yɔ̄rì	yɔé	‘penis’
(c)	gbé-	gbérì	gbéè	‘leg’
	lè-	lérì	lèé	‘bead’
	kpé-	--	kpéè	‘malt’ (mass noun)

The crucial data that demonstrate the presence of an actual plural suffix are (16b) and (16c). Here the stem has a mid vowel, but instead of the medial epenthesis of a high vowel found in the singular, we have a final mid vowel suffix, /-e/ or /-ɛ/ depending on ATR-harmony. Note that this suffix freely creates long mid vowels because it is not epenthetic, but underlying.⁷ For the same reason, the suffix is immune to rounding harmony, showing that it is underlyingly /-V[-round]/. Note that the suffix vowel does not need to be specified as [-high] because of the phonological constraint that bans final high vowels.

The contrast between singular and plural is most clearly seen in examples like (17). In the singular, a high vowel is epenthesized in the middle of the stem, with concomitant rounding harmony. In the plural, an unrounded mid vowel (= the plural suffix) is added to the end.

- (17) A stem without /-ri/

STEM	SINGULAR	PLURAL	
pó-	púò	póé	‘farmland’

We conclude that the vowel alternations in Dagaare number morphology have two distinct sources: phonology and morphology. In the above examples, the singular vowel is a piece of phonology: it is an epenthetic response to word minimality. In contrast, the plural vowel is a piece of morphology: it is a suffix with the underlying form -V[-round]. We have used these facts as evidence for metrical structure: in monomoraic stems an epenthetic vowel is inserted to satisfy the requirement that every phonological word contain at least one foot which in the case of Dagaare is bimoraic ($(\mu\mu)_\phi$).

⁷ We are aware of one word where a long mid vowel is created by the coalescence of a low and mid vowel challenging the present analysis: /pá-/ ‘vagina’, páárì ‘vagina-SG’, páè ‘vagina-PL’. The plural is actually pronounced [péè].

3. Towards an analysis

In this section, we sketch an analysis of the morphophonology of Dagaare number marking in terms of ranked and violable constraints (Prince and Smolensky 1993/2004). The analysis is preliminary, but it captures the major regularities in the data. At the heart of the analysis is word minimality. Dagaare nominal stems must be bimoraic $(\mu\mu)_\sigma$ and end in a vowel. If the stem is monomoraic or ends in a consonant, the result is vowel epenthesis. The main challenge is to spell out the phonological principles that determine the featural content and linear placement of the epenthetic vowel.

3.1. Constraints and rankings

The constraints are summarized in (18). A ranking that consists of four strata was found by the Constraint Demotion Algorithm implemented in OTSoft (Hayes, Tesar, and Zuraw 2003). We assume that all non-compound words satisfy ATR-harmony. For this reason, ATR-harmony constraints are not mentioned.

- (18) Stratum 1 (undominated):
- AGR(rd) Adjacent vowels agree in $[\pm\text{round}]$.
 - *C] No consonant-final words (Excludes [ŋ].)
 - FTBIN Feet are binary (two syllables/moras).
- Stratum 2:
- DEP(V) No vowel insertion.
- Stratum 3:
- *I] No word-final $[\text{+high}]$ vowels.
- Stratum 4:
- *vV(mid) No long mid vowels.

3.2. Illustrative tableaux

We now show how the analysis works for different types of stems. Tone is omitted to keep the tableaux simple. Tableau (19) illustrates Generalization 1 ((3)): If the stem has at least two moras and ends in a vowel (CVV, CVCVCV, etc.), the morphologically unmarked number (= singular) is zero. This motivates the ranking $\text{DEP(V)} \gg *I]$.

- (19) CVV-stem: /tuu/ ‘forest’

/tuu/ = CVV	AGR(rd)	*C]	FTBIN	DEP(V)	*I]	*vV(mid)
(a) →(tuu)					*	
(b) (tuue)	*!			*		
(c) (tuuo)				*!		
(d) (tuu)				*!	*	

Tableaux (20) and (21) illustrate Generalization 2 ((7)): If the stem ends in a consonant, it is augmented by an epenthetic vowel which is a copy of the preceding stem vowel, except if this vowel is $[\text{+high}]$, in which case the added vowel is mid. These facts motivate the ranking $*C] \gg \text{DEP(V)}$.

- (20) CVC-stem with a low vowel: /gbag/ ‘container’

/gbag/ = CVC	AGR(rd)	*C]	FTBIN	DEP(V)	*I]	*vV(mid)
(a) →(gbaga)				*		
(b) (gbagɔ)	*!			*		
(c) (gbag)		*!				

(21) CVC-stem with a high vowel: /lug/ ‘pillar’

/lug/ = CVC	AGR(rd)	*C]	FTBIN	DEP(V)	*I]	*vv(mid)
(a) →(lugo)				*		
(b) (lugu)				*	*!	
(c) (lug)		*!				

Tableaux (22) and (23) illustrate vowel epenthesis in CV-stems; see Generalization 3 ((12)). If the stem vowel is high, a mid vowel is epenthesized word-finally. If the stem vowel is mid, a high vowel is epenthesized word-medially. Tableau (23) motivates the ranking FTBIN >> DEP(V).

(22) CV-stem with a high vowel: /bi/ ‘child’

/bi/ = CV	AGR(rd)	*C]	FTBIN	DEP(V)	*I]	*vv(mid)
(a) →(bie)				*		
(b) (bii)				*	*!	
(c) (bei)				*	*!	
(d) (bio)	*!			*		
(e) (bi)			*!		*	
(f) (biu)	*!			*	*	

(23) CV-stem with a mid vowel: /pɛ/ ‘basket’

/pɛ/ = CV	AGR(rd)	*C]	FTBIN	DEP(V)	*I]	*vv(mid)
(a) →(pɛɛ)				*		
(b) (pɛɛ)				*		*!
(c) (pɛɔ)	*!			*		*
(d) (pɛ)			*!			
(e) (pɛu)	*!			*		

Tableau (23) shows that vowel epenthesis cannot create long mid vowels. However, such vowels are permitted if they are underlying. This is predicted if we posit the constraint IDENT(V) ‘Input vowel features are faithfully realized on the corresponding output vowel’ and include it in the topmost stratum. This is shown in tableaux (25) and (26). The last tableau motivates the rankings IDENT(V) >> *vv(mid) and *I] >> *vv(mid).

(24)	STEM	SINGULAR	PLURAL	
(a)	dɔ̀ɔ̀	dɔ̀ɔ̀	dɔ̀bɔ̀	‘man’ (singular = /dɔ̀ɔ̀/)
(b)	gbé	gbéɾi	gbéè	‘leg’ (plural = /gbé+ɛ/)

(25) CVV-stem with a mid vowel: /dɔ̀ɔ̀/ ‘man’

/dɔ̀ɔ̀/	IDENT(V)	AGR(rd)	*C]	FTBIN	DEP(V)	*I]	*vv(mid)
(a) →(dɔ̀ɔ̀)							*
(b) (dɔ̀ɔ̀)	*!						
(c) (dɔ̀u)	*!					*	

(26) CV-stem with a vocalic number suffix: /gbɛ+V[-rd]/ ‘leg-PL’

/gbɛ+V[-rd]/	IDENT(V)	AGR(rd)	*C]	FTBIN	DEP(V)	*I]	*VV(mid)
(a) →(gbɛɛ)							*!
(b) (gbɪɛ)	*!						
(c) (gbɛɪ)						*!	

4. Epenthesis or deletion?

Quantity alternations are inherently ambiguous in terms of their direction. It is often not immediately clear whether we have lengthening or shortening, epenthesis or deletion. In this paper, we have argued for epenthesis, but have not explicitly argued against deletion. Fortunately, an anonymous reviewer has proposed a detailed counteranalysis based on vowel deletion. Recall our central claim: the vocalic alternations in Dagaare nominals sometimes involve phonological epenthesis, sometimes morphological suffixation. The counteranalysis denies this claim. Instead, it proposes that both the singular and plural alternations involve morphological suffixation. This would imply that there is no epenthesis and hence no evidence for foot structure. In this section, we will address the counteranalysis in detail, showing that it makes several empirically incorrect predictions and must thus be rejected.

The counteranalysis starts by challenging our assumptions about underlying vowel length. Our analysis was built on the assumption that the underlying form of the stem emerges in the unsuffixed forms, e.g. before an adjective or before a *wh*-question word. By this criterion, words like ‘seed’ and ‘rock’ both have an underlying short vowel (CV-), as shown in (27). We further assumed a process of lexically conditioned vowel lengthening that lengthens the vowel before /-ri/ in the word ‘rock’, but not in the word ‘seed’, as shown in (28).

(27) Underlying short vowel in both nouns

- (a) bí-fáá ‘bad seed’
 bí-bódò ‘which seed?’
 (b) pì-fáá ‘bad rock’
 pì-bódò ‘which rock?’

(28) Lexically conditioned vowel lengthening before /-ri/

- (a) bírì ‘seed-SG’ no vowel lengthening before /-ri/ in ‘seed’
 bíè ‘seed-PL’
 (b) pìrì ‘rock-SG’ vowel lengthening before /-ri/ in ‘rock’
 pié ‘rock-PL’

The counteranalysis assumes that the length alternation before the /-ri/-suffix reflects underlying length. Thus, ‘seed’ would be underlyingly CV-, whereas ‘rock’ would be underlyingly CVV-, as shown in (29).

(29) Counteranalysis: Length alternation reanalyzed as an underlying length contrast

	STEM	SINGULAR	PLURAL	
(a)	bí- (CV-)	bírì	bíè	‘seed’
(b)	pì- (CVV-)	pìrì	pié	‘rock’

The challenge is to come up with plausible rules for shortening the hypothetical long vowel in the appropriate environments. The counteranalysis needs two such rules: VOWEL SHORTENING and INTERVOCALIC V-DELETION. First, consider Vowel Shortening:

- (30) Vowel Shortening: $V \rightarrow \emptyset / _]$, where “[]” is the boundary between a noun stem and a following adjective or *wh*-question word

The problem is that there are many CVV-stems that fail to shorten in this environment:

- (31) A long stem vowel at the adjective/WH boundary:

dǎ̀	‘beer’	dǎ̀-ǎ̀	‘bad beer’	dǎ̀-ǎ̀	‘which beer?’
dǎ̀	‘man’	dǎ̀-ǎ̀	‘bad man’	dǎ̀-ǎ̀	‘which man?’
kǎ̀	‘oil’	kǎ̀-ǎ̀	‘bad oil’	kǎ̀-ǎ̀	‘which oil?’
kǎ̀	‘death’	kǎ̀-ǎ̀	‘bad death’	kǎ̀-ǎ̀	‘which death?’
kpǎ̀	‘guineafowl’	kpǎ̀-ǎ̀	‘bad g.fowl’	kpǎ̀-ǎ̀	‘which guineafowl?’
lǎ̀	‘bowl’	lǎ̀-ǎ̀	‘bad bowl’	lǎ̀-ǎ̀	‘which bowl?’
lǎ̀	‘car/lorry’	lǎ̀-ǎ̀	‘bad car/lorry’	lǎ̀-ǎ̀	‘which car/lorry?’
lǎ̀	‘west’	lǎ̀-ǎ̀	‘bad west’	lǎ̀-ǎ̀	‘which west?’
nǎ̀	‘cow’	nǎ̀-ǎ̀	‘bad cow’	nǎ̀-ǎ̀	‘which cow?’
sǎ̀	‘father’	sǎ̀-ǎ̀	‘bad father’	sǎ̀-ǎ̀	‘which father?’
tǎ̀	‘medicine’	tǎ̀-ǎ̀	‘bad medicine’	tǎ̀-ǎ̀	‘which medicine?’
tǎ̀	‘ear’	tǎ̀-ǎ̀	‘bad ear’	tǎ̀-ǎ̀	‘which ear?’
tǎ̀	‘forest’	tǎ̀-ǎ̀	‘bad forest’	tǎ̀-ǎ̀	‘which forest?’
zǎ̀	‘blood’	zǎ̀-ǎ̀	‘bad blood’	zǎ̀-ǎ̀	‘which forest?’

Under our analysis, the long vowel is expected: these stems actually do have an underlying long vowel that emerges in the unsuffixed forms. The shortening rule incorrectly predicts that these stems should surface as short and thus fails to capture the contrast between two types of long vowels: those created by lexically conditioned vowel lengthening, e.g. /pi-/: *pié*, *piè-rí*, and those that reflect an underlying long vowel, e.g. /tuu-/: *túú*, *túú-rí*.

Next, consider Intervocalic V Deletion. This rule is needed to account for the short vowel before the vocalic suffix:

- (32) Intervocalic V Deletion: $V \rightarrow \emptyset / V _ V$

- (33) Long vowel before /-ri/, short vowel before -V:

	STEM	SINGULAR	PLURAL	
(a)	bǎ̀- (CVV-)	bǎ̀	bǎ̀	‘child’
	tǎ̀- (CVV-)	tǎ̀	tǎ̀	‘tree’
(b)	pǎ̀-(CVV-)	pǎ̀	pǎ̀	‘rock’
	kǎ̀- (CVV-)	kǎ̀	kǎ̀	‘hoe’

The problem with Intervocalic V-Deletion is simple: VVV-sequences abound in Dagaare. Not only do we find them in nouns like *nǎ̀* ‘cow’ and *kpǎ̀* ‘guineafowl’, but they are productively created in nominalizations, e.g. *bǎ̀* ‘growing’ (from /bǎ̀-), *bǎ̀* ‘measuring’ (from /bǎ̀-), *dǎ̀* ‘taking’ (from /dǎ̀-), *dǎ̀* ‘joking’ (from /dǎ̀-), *dǎ̀* ‘swimming’ (from /dǎ̀-), *kǎ̀* ‘farming’ (from /kǎ̀-), *kyǎ̀* ‘cutting soil’ (from /kyǎ̀-), *kpǎ̀* ‘entering’ (from /kpǎ̀-), *lǎ̀* ‘laughing’ (from /lǎ̀-), *lǎ̀* ‘returning’ (from /lǎ̀-), *tǎ̀* ‘digging’ (from /tǎ̀-), etc. There is thus no evidence for an intervocalic deletion rule, but there is plenty of evidence against it. We conclude that the two rules fundamental to the deletion analysis fail on straightforward empirical grounds.

The evidence presented above is already sufficient to refute the counteranalysis. However, there still remain two auxiliary rules that are necessary for the deletion analysis. The failure of these rules is instructive and further strengthens the case for metrically driven epenthesis. Recall our central claim: the vocalic alternations in Dagaare number morphology sometimes involve phonological epenthesis, sometimes morphological suffixation. The counteranalysis proposes that both singulars and plurals involve suffixation and hence there is no epenthesis. Consider (34):

(34) Long vowel before /-ri/, short vowel before -V:

- | | | |
|-----|--------|------------|
| (a) | dè-fáá | 'bad room' |
| (b) | dìé | 'room-SG' |
| (c) | dèrí | 'room-PL' |

Under our analysis, the noun stem is /dè-/ 'room' as shown by the unsuffixed form. The singular involves metrically driven epenthesis that results in the insertion of a medial /i/ (*dìé*). The plural is formed by the suffixation of /-ri/ (*dèrí*). The counteranalysis proposes that both forms involve suffixation, hence the final /é/ in the singular is a suffix. The emergence of the medial /i/ must thus be explained by a rule of MID-VOWEL RAISING: /dè-é/ → *dìé*.

(35) Mid Vowel Raising: V[-hi, -lo] → V[+hi] / _ V[-hi, -lo]

This rule works in the singular, but—mysteriously—not in the plural where mid-vowel sequences are common:

(36) Sequences of mid vowels in the plural:

nó-	núórí	nóé	'mouth'
pò-	pùòrí	pòé	'back'
yó-	yúórí	yoè	'name'
yò-	yùòrí	yòé	'penis'
gbé-	gbérí	gbéé	'leg'
lè-	lèrí	lèé	'bead'
kpé-	--	kpéé	'malt' (mass noun)

The pattern in (36) is expected under our analysis. Only the plural has two underlying mid vowels: one from the stem, another from the suffix. The high-ranked IDENT(V) guarantees that underlying mid vowels surface faithfully. Things are different in the singular: mid-vowel sequences are not found because they cannot be created by epenthesis. The counteranalysis wrongly predicts vowel raising in both singulars and plurals. Under our analysis, the asymmetry in the distribution of long mid vowels shows that singular and plural vowels have different sources: the former are pieces of phonology, the latter are pieces of morphology.

Finally, consider rounding harmony. The reviewer's autosegmental rule is stated in (37) using the SPE notation:

(37) Rounding Harmony: V → [+rd] / V[-hi, -lo, +rd] _

This rule states that a mid vowel spreads its roundedness value to the vowel immediately on its right. This rule fails exactly like Mid Vowel Raising. In (38), the rule applies in the singular, but not in the plural.

(38) Rounding harmony in the singular, but not in the plural

	STEM	SINGULAR	PLURAL	
(a)	kù-	kúó	kúúrí	‘wild rat’
	pù-	púó	púúrí	‘stomach’
	wù-	wúó	wúúrí	‘wallet’
	bù-	búó	búúrí	‘goat’
(b)	nó-	nóórí	nóè	‘mouth’
	pò-	pùòrí	pòé	‘back’
	yó-	yúórí	yóè	‘name’
	yò-	yúòrí	yóè	‘penis’
(c)	pó-	púò	póé	‘farmland’

This pattern is explained under our analysis: the singular forms in (38a) have an epenthetic high vowel that succumbs to rounding harmony; the plural forms in (38b) have a suffix /-e, -ɛ/ which is underlyingly specified as [-round] and fails to harmonize due to the high-ranked IDENT(V); the word ‘farmland’ in (38c) illustrates both harmony and its absence within the same lexeme. In terms of Lexical Phonology (Kiparsky 1982), rounding harmony is structure-filling and cannot supersede the underlying feature [-round] which is part of the plural suffix /-e, -ɛ/. The counteranalysis has no explanation for this asymmetry because it assumes that both singular and plural involve suffixation.

In sum, evidence from multiple sources converges in favor of metrically driven epenthesis in Dagaare. The discovery that Dagaare has metrical structure is important because Gur languages are tonal and there is little direct evidence for stress (but see Anttila and Bodomo 2000). However, segmental alternations can nevertheless provide evidence for metrical structure, in this case for a bimoraic foot $(\mu\mu)_\phi$.

5. Summary

We have provided a description of the main features of the morphophonology of Dagaare number inflection. We have used the data to argue that Dagaare has metrical structure: an epenthetic vowel is inserted in monomoraic stems to satisfy the requirement that every phonological word must contain at least one foot which in the case of Dagaare is bimoraic $(\mu\mu)_\phi$. We have also shown that a deletion-based counteranalysis fails to predict the Dagaare quantity alternations and must thus be rejected in favor of the epenthesis-based analysis proposed in this paper.

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