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PHONOLOGY

ARTICLE

Tone and morphological level ordering in Dagaare

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Abstract

Dagaare is a language of northern Ghana and adjoining areas of Burkina Faso. There are two tones, H and L, and contrastive downstep H!H that involves a non-automatic pitch drop between two H tones. The challenge is to explain the extensive morphological conditioning of tonal processes, including dissimilation, downstep and spreading. Our solution involves level ordering: tones are introduced at different morphological levels (stems, words and phrases) and later processes can make earlier processes opaque. Tonal differences between nouns (spreading) versus verbs (no spreading) and stems (dissimilation) versus words (downstep) arise from constraint ranking differences within and across levels. There are two kinds of downsteps: stem-level downsteps are underlying L tones affiliated with some morpheme; word-level downsteps are L tones inserted by a general process of word-final lowering. Only one downstep per word is allowed. If more would arise, the morphologically inner downstep blocks the morphologically outer downstep.

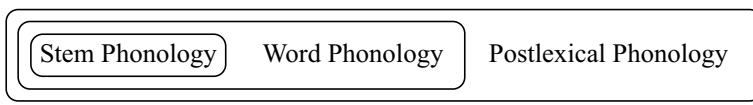
Contents

1. Introduction

Dagaare is a Mabia (formerly known as Gur) language of northern Ghana and adjoining areas of Burkina Faso. Earlier descriptions include Kennedy (1966), Hall (1977), Kropp Dakubu (1982), Delplanque (1983), Bodomo (1997) and Ali *et al*. (2021). For general overviews of this language group, see Bendor-Samuel (1971), Manessy (1975), Naden (1989), Miehe (2012) and Eberhard *et al*. (2020). The tone system of Dagaare can be briefly described as follows. There are two tones: H and L. Simple words are typically monosyllabic or disyllabic. Monosyllables surface as either H or L. Disyllables show the expected four surface patterns HH, HL, LH and LL. In addition, there is a fifth pattern H!H with a pitch drop between the two H tones that is conventionally marked by a raised exclamation point. This is contrastive downstep common in tone languages south of the Sahara (Connell 2011). Each downstep sets a new ceiling for subsequent H tones making Dagaare a 'terraced-level' language (Welmers 1959; Winston 1960; Clements 1979; Connell 2011). Trisyllabic and longer words are often compounds or recent borrowings.

Several common processes target H tones, including dissimilation (Meeussen's Rule), spreading and absorption. What makes Dagaare tone analytically challenging is that tone alternations are often triggered or blocked by morphological and lexical conditions. Our goal in this article is to show that once morphology is properly understood, phonology turns out simple. Dagaare tone operates elegantly just as one would expect tone to operate. The apparent complexity arises because tones are introduced at different morphological levels (stems and words) and undergo processes specific to that level. The levels interact serially: stem-level phonology feeds word-level phonology and word-level phonology feeds postlexical phonology in the way familiar from Lexical Phonology and Morphology and Stratal Optimality Theory (Kiparsky 1982, 2000, 2015; Pulleyblank 1986).

(1) *The organisation of morphology and phonology*



Phonology applies inside out in tandem with morphology, and later processes can make earlier processes opaque. Downstep turns out to provide key evidence that helps unlock the apparently complex tone system and its interaction with morphology.

The article is structured as follows. §2 gives a brief sketch of Dagaare morphology that serves as a backdrop for the subsequent phonological analysis. §3 introduces downstep. §§4–6 divide the tone alternations into stem, word and postlexical processes. The phonological generalisations are stated in terms of informal rules intended to serve as a descriptive lingua franca readily understood by phonologists. §7 proposes an analysis in terms of Stratal Optimality Theory that instantiates the organisation

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shown in (1) and correctly derives many of the descriptive generalisations. §§8 and 9 discuss alternative hypotheses and residual problems. §10 concludes.

2. A morphological sketch

2.1. Inflection

Dagaare is a suffixing language where nouns inflect for number/class and verbs inflect for aspect.[1] The number/class suffix immediately follows the noun root which determines the choice of the suffix allomorph and its phonological shape. Consider the paradigms in (2):[2]

(2) *Noun inflection: Number/class*

	ROOT	SINGULAR	PLURAL	
a.	/bi/	bíé	bíí-rí	'child'
	/dè/	dìé	dè-rí	'room'
	/pʊ/	pʊ́ɔ́	pʊ́ʊ́-rí	'stomach'
	/wè/	wìɛ́	wè-rí	'farm'
b.	/bí/	bí-rì	bí-è	'seed'
	/pì/	pìì-rí	pì-é	'rock'
	/nɔ́/	nʊ́ɔ́-rì	nɔ́-è	'mouth'
	/gbɛ́/	gbɛ́-rì	gbɛ́-è	'leg'

In class (2a), the singular adds a vowel to the root (Anttila & Bodomo 2009). The plural is marked by /-ri/ or /-rɪ/, depending on ATR harmony, and the root vowel is lengthened if high. In class (2b), this pattern is inverted. The singular is marked by /-ri/ or /-rɪ/ and the root vowel is lengthened or diphthongised, this time in a lexically conditioned manner. The plural is marked by /-e/ or /-ɛ/ depending on ATR harmony. The tonal behaviour of the suffix depends on the root tone in a way to be explained below. Grimm (2021) proposes that the choice between (2a) and (2b) correlates with the lexical semantics of the root. The upshot is that the root conditions the suffix in two ways: lexically/semantically (choice of allomorph) and phonologically (ATR harmony and tone).

The imperfective aspect suffix /-rV́/ also immediately follows the verb root and undergoes both ATR and rounding harmony. Consider the verb paradigms in (3):

(3) *Verb inflection: Imperfective*

	ROOT	CITATION FORM	IMPERFECTIVE	
a.	/da-/	dà	dàà-rá	'buy'
	/bú-/	bú	búú-rò	'measure, calculate'
	/kɔ́-/	kɔ́	kʊ́ɔ́-rɔ̀	'farm'
	/kyɛ-/	kyɛ̀	kyìɛ̀-rɛ́	'cut'

[1] The data represent the Jirapa district dialect, of which the second author is a native speaker. Some of the data are previously unpublished; some can be found in Kennedy (1966), Bodomo (1997), Anttila & Bodomo (2009), Anttila & Bodomo (2019) and Ali *et al*. (2021), which are referred to in the text.

[2] We follow the transcription conventions of Bodomo (1997). /i, e, o, u/ are [+ATR]; /ɪ, ɛ, ɔ, ʊ/ are [−ATR]. The [ATR] value of /a/ is controversial (Bodomo 1997: 23; Ozburn *et al*. 2018).

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b.	/tá-/	tá	tá-rà	‘reach’
	/kʊ-/	kʊ̀	kʊ̀-rɔ́	‘give, offer’
	/kó-/	kó	kó-rò	‘get ready for rain’
	/tɛ́-/	tɛ́	tɛ́-rɛ̀	‘display’
c.	/gaa-/	gàà	gɛ̀-rɛ́	‘go’

The suffix /-rV́/ copies the root vowel except that a high vowel becomes mid: *dàà-rá* ‘buy-IPFV’ *vs. búú-rò* ‘measure-IPFV’, *tá-rà* ‘reach-IPFV’ *vs. kʊ̀-rɔ́* ‘give-IPFV’. Root vowel length is lexically conditioned. In (3a), the vowel lengthens if low or high and diphthongises if mid. In (3b), there are no alternations. In (3c), the vowel undergoes shortening and ablaut: /gàà-rV́/ → *gɛ̀-rɛ́* ‘go-IPFV’. There is no obvious phonological or semantic rationale behind the three-way choice which seems to be simply a lexical property of the root. Any analysis of Dagaare phonology must find a way of dealing with such lexically specific alternations.

In sum, both the number/class and imperfective suffixes appear immediately after the root and interact with the root in multiple ways: lexically, semantically and phonologically. This is typical stem-level behaviour.

2.2. Enclitics

Enclitics are phonologically part of their host but syntactically separable and show no morpholexical conditioning. An example from Dagaare is the postverbal focus particle *lá,* which has an underlying H tone. Its regular location is after the inflected verb, immediately after the aspect suffix, but it can be separated from it by light object pronouns. Such pronouns are underlyingly toneless. They are probably themselves enclitics, an assumption we will make but will not attempt to defend here. Subject and object are only distinguished in the first person singular *N vs. ma*.

(4)	/ma/	1SG.OBJ	/te/	1PL	/lá/	FOC
	/fʊ/	2SG	/yɛ/	2PL		
	/ʊ/	3SG	/ba, a/	3PL.HUM, 3PL.NONHUM		

In double object constructions where the arguments are full DPs, the focus marker *lá* appears immediately after the inflected verb.

(5) ʊ̀ kɔ́=ˡlá à sáán-à à gán-ì
3SG give.PFV=FOC DEF stranger-SG DEF book-SG
‘S/he gave the stranger the book’

A light pronoun recipient intervenes between the inflected verb and *lá* as shown in (6). If both the recipient and the theme are light pronouns, both can be sandwiched between the inflected verb and *lá* as shown in (7) where the resulting clitic cluster /ma=ʊ/ 1SG=3SG coalesces into [mʊʊ], with some tonal variability. Alternatively, and perhaps preferably, the serial verb construction in (8) is used. The focus particle *lá* is thus always the rightmost element of the verb and occurs outside both suffixes and (other) clitics.

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(6) ò kʊ́=ˡmá=lá à gán-ì
3SG give.PFV=1SG.OBJ=FOC DEF book-SG
'S/he gave me the book'

(7) ò kʊ́=mʊ́=ˡʊ́=lá (/ma/=/ʊ/ → [mʊʊ])
3SG give.PFV=1SG.OBJ=3SG=FOC
'S/he gave it to me'

(8) ò dí=ˡʊ́=lá ˡkʊ́=má
3SG take.PFV=3SG=FOC give.PFV=1SG.OBJ
'S/he gave it to me' (lit. s/he took it FOC gave me)

The light pronoun is phonologically dependent on the verb. This is shown by ATR harmony:

(9) ŋ̀ ngmɛ̀=ʊ́=ˡlá
1SG beat.PFV=3SG=FOC
'I beat it'

(10) ŋ̀ dó=ˡó=lá
1SG climb.PFV=3SG=FOC
'I climbed it'

The phonological dependence of *lá* on the verb is not reflected in vowel harmony because /a/ does not participate in ATR harmony (*pace* Ozburn *et al*. 2018). Instead, we will see tonal evidence for the dependence of *lá* on the verb shortly.

To complete the picture, tense and negation are expressed as preverbal particles that appear to be independent words. Tense particles include /dà/ 'PAST', /záà/ 'ONE.DAY.PAST' and /dáá/ 'TWO.DAYS.PAST'. The negation particle is /bá/ 'NEG', the unmarked future is /nă/ 'FUT' and the negative future is /kʊ̌ŋ/ 'NEG.FUT'.[3] The two future particles are phonetically low but carry a trailing H tone that interacts with the following verb tone as we will see in a moment. Other preverbal particles seem to have no special tonal effects.

In sum, the focus marker *lá* comes after the inflected verb and any other enclitics. Unlike suffixes, *lá* appears to have no morpholexical conditioning. It is syntactically separable from the inflected verb by light object pronouns but phonologically dependent on it as we will see shortly. This is typical clitic behaviour. The two morphological levels, stem level *vs.* word level, correspond to affixes *vs.* enclitics, and suffixes come before enclitics. This is exactly the linear ordering expected in a stratal grammar.

2.3. Compounds

Compounding is productive in Dagaare (Bendor-Samuel 1971: 172; Bodomo 1997: 49). Nominal compounds typically consist of two roots, of which the second is inflected for number/class. Consider the following four compounds:

[3]The focus marker *lá* is a positive polarity item. It is in complementary distribution with the negative particles *bá* 'NEG' and *kʊ̌ŋ* 'NEG.FUT'. The two cannot co-occur in the same clause.

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(11)		ROOT		WORD		COMPOUND	
	a.	/wɛ̀/	'farm'	wìɛ́	'farm.SG'		
		/fa/	'bad'	fáá	'bad.SG'	wɛ̀-fáá	'bad farm'
	b.	/yí/	'house'	yí-è	'house-PL'		
		/zì/	'red'	zìì-rí	'red-PL'	yí-zìì-rí	'red houses'
	c.	/pò/	'back'	pùò-rí	'back-SG'		
		/tu/	'follow'	túú-ró	'follow-AG'	pò-túú-ró	'disciple'
	d.	/bi/	'child'	bíé	'child.SG'		
		/dɔɔ/	'man'	dɔ́ɔ́	'man.SG'	bì-dɔ́ɔ́	'son'

It is also possible to combine multiple roots, in which case only the last is inflected for number/class:

(12) bì-fà-túú-ró
child-bad-follow-AG
'bad child follower'

Are compounds formed at the stem level, at the word level, or postlexically? The fact that (12) means 'bad child follower', not 'follower of a bad child', suggests the right-branching structure [*bì-* [*fà-* [*túú-ró*]]], where *túú-ró* 'follower' is modified by *fà-* 'bad', which in turn takes *bì-* 'child' as its complement. This implies that inflectional morphology happens inside compounds.[4] The fact that ATR harmony often fails in compounds, as in *yí-zìì-rí* 'red houses' and *bì-dɔ́ɔ́* 'son', where the first part is [+ATR] and the second part [−ATR], suggests that compounding cannot happen at the stem level where ATR harmony is regular, yet there are individual compounds where ATR harmony is possible. We will later present tonal evidence suggesting that compounding happens at the word level. A more rigorous study of Dagaare compounds is much needed.

3. Downstep

Kennedy (1966: 42) was the first to observe that Dagaare has 'two levels of the register type and a downstepped high unit' and that the TBU is the syllable.[5] In addition to H

[4]The meaning 'follower of bad children' is expressed as a phrase, not as a compound: *bì-fáá-rí túú-ró* 'child-bad-PL follow-AG.

[5]The question of whether Dagaare allows contours, i.e. syllables with more than one tone, depends partly on the syllabification of (C)VV sequences. Here, we assume that *yí-è* 'house-PL' and *wìɛ́* 'farm.SG' are syllabified *yí.è* and *wì.ɛ́,* where LH and HL are sequences of two tones, and thus not contours. This allows us to maintain that there are no contours in the lexical phonology of Dagaare. Alternatively, one could reasonably assume that (C)VV is a single syllable and that contours are only possible on word-final syllables. Assuming that the TBU is not the syllable but the mora would incorrectly predict a systematic four-way contrast HH, LL, HL and LH on all (C)VV and (C)VC syllables, no matter where they occur in the word. Finally, we note that nasals may be syllabic, e.g. the first person singular subject pronoun is /ŋ/ (spelled *N*). Nasals often carry an independent tone word-finally, e.g. *dòsùòlúŋ̀* 'shadow', *fààlóŋ̀* 'badness', *ìróŋ̀* 'culture'.

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and L, a downstepped ꜜH is possible after a H tone, resulting in a three-way surface contrast after H as illustrated in (13).[6]

(13)

	UNDERLYING	SURFACE	EXAMPLE	
a.	/∅-H/	H-H	bíí-rí	'child-PL'
b.	/H-LH/	H-ꜜH	zú-ꜜrí	'head-PL'
c.	/H-H/	H-L	yí-rì	'house-SG'
d.	/L-H/	L-H	wìr-í	'horse-SG'

These examples illustrate some key tone alternations. In (13a), the suffixal H spreads to the toneless root resulting in a level H tone. In (13b), a H root combined with a LH suffix sets the L tone afloat, triggering downstep on the suffix. In (13c), the suffixal H undergoes dissimilation after a H root (Meeussen's Rule) resulting in a HL sequence. In (13d), the root and suffix tones simply combine with no alternation.

Before proceeding, it is necessary to establish why ꜜH is not a mid-tone. First, ꜜH is only possible after H. Positing a M tone would predict a word-initial contrast H *vs.* M *vs.* L which is not found in Dagaare (Kennedy 1966: 43). Second, Dagaare is a 'terraced-level' language (Welmers 1959; Winston 1960; Clements 1979; Connell 2011) where each downstep sets a new ceiling for subsequent H tones. The downstep analysis predicts that a ꜜHH sequence should surface with level pitch, which is correct. Analysing downstep as M would predict a pitch rise, which is incorrect.[7]

(14) a. kpą́ą́-ꜜǫ́ yí-rì [˥˦˦˩] *[˥˦˥˩]
guineafowl-SG house-SG
'guineafowl's house'

b. à bó-ꜜmá ámɛ̀ (lá k'=ʊ̀ bʊ́ɔ́-rɔ̀) [˥˦˦˩] *[˥˦˥˩]
DEF thing-PL these (FOC that=3SG want-IPFV)
'It is these things that he wants.'

While some downsteps are underlying, we will see that others arise by the final lowering of a word-final H tone (Gussenhoven 2004: 110–113; see Childs 1995: 48 for Kisi). Our proposal is that underlying downsteps are introduced at the stem level, whereas final lowering occurs at the word level. The number of downsteps is in principle unlimited in an utterance (cf. Rialland & Somé 2000, 2011 for the related Dagara). The following examples illustrate two downsteps inside the same DP and VP:

(15) à dɔ̀ɔ̀ wóg-kpóng-ꜜfáá ꜜná (= /nă/)
DEF man tall-big-bad.SG DEM
'that tall big bad man'

[6]In addition, LL is possible but rare in nouns, e.g. *tɔ̀bɔ̀* 'tobacco'. LL is common in the uninflected citation forms of toneless verbs, e.g. *bɔ̀ŋì* 'know', *sàgì* 'answer', *bùrì* 'soak', *yèlì* 'speak', *kànnì* 'learn', *pègìì* 'carry', *nàànì* 'get ready, develop', *pùòrì* 'thank, greet, pray' (Anttila & Bodomo 2019). Note that the final vowel is always /i, ɪ/, suggesting that it may be epenthetic.

[7]A genuine M tone is found in the related Supyire (Carlson 1983), Bimoba (Snider 1998) and Buli (Akanlig-Pare & Kenstowicz 2002). Akanlig-Pare & Kenstowicz (2002: 65–67) observe a regular correspondence between Buli M roots and Dagaare toneless roots and propose a phonetic explanation for the connection.

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(16) à bíé nà díg-ré=ˡlá sʊ̀ʊ́ˡŋ-á̰á̰
DEF child FUT chase-IPFV=FOC rabbit-SG
'the child will be chasing the rabbit'

In both examples, the first downstep comes from word-final lowering, and the second downstep arises from an underlying L tone (/nă/ = LH 'DEM', /sʊ̀ʊ̰́ŋ/ = HL 'rabbit').[8] Only one downstep per word is allowed, however. In cases where multiple downsteps might be expected to arise within a word, the leftmost one wins, an effect we will attribute to level ordering.

4. Stem-level tone

Dagaare has the stem-level processes in (17); see Kenstowicz *et al*. (1988) for similar processes in Moore. Each process has morphological or lexical conditions.

(17)	NAME	PROCESS	ENVIRONMENTS
	Meeussen's Rule	HH → HL	number/class, aspect, nominaliser
	H Spreading	∅H → HH	nouns, adjectives

Dagaare roots can be toneless (= ∅), L, H, HL or LH, except that there seem to be no L verbs. Suffixes are usually H but can be LH. Examples of L, H and toneless roots are given in (18). H roots exhibit Meeussen's Rule; toneless roots exhibit H Spreading.

(18)						
a.	wɪr-i	→	wɪ̀r-í	'horse-SG'	—
	L H		L H		
b.	yi-ri	→	yí-rì	'house-SG'	Meeussen's Rule
	H H		H L		
c.	pɔg-ɔ	→	pɔ́g-ɔ́	'woman-SG'	H Spreading
	H		H		

Evidence for the tonelessness of roots like (18c) comes from noun–adjective compounds where the noun root surfaces without a number suffix. For the vowel alternations, see Anttila & Bodomo (2009).

(19)	UR	SINGULAR	PLURAL	'bad N'	
a.	L-H	bòŋó	bòn-ní	bòŋ-fáá	'donkey-bad.SG'
		wɪ̀é	wɛ̀-rí	wɛ̀-fáá	'farm-bad.SG'
b.	H-H	kyúù	kyúú-rì	kyúú-ˡfáá	'moon-bad.SG'
		wɛ́gɛ̀	wɛ́g-rì	wɛ́g-ˡfáá	'log-bad.SG'
c.	∅-H	bíé	bíí-rí	bì-fáá	'child-bad.SG'
		kúó	kúú-rí	kù-fáá	'wild.rat-bad.SG'

[8] The demonstrative is underlyingly /nă/, i.e. LH, but on the surface we often hear ˡH. In this article, we have systematically transcribed this morpheme as *ˡná* while recognising there is variability.

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The singular and plural have an underlying H suffix which surfaces as H in (19a), dissimilates to L by Meeussen's Rule in (19b) and spreads to the toneless root in (19c).[9] In the compound, the roots H and L surface intact, but toneless roots become low by default.

Dagaare systematically distinguishes between nominal and verbal tones at the stem level. Toneless nominals (nouns and adjectives) get a tone by H spreading from the suffix, but there is no H spreading in toneless verbs. Instead, we get the default low, just like in compounds. This is particularly clear in nominalisations (Anttila & Bodomo 2019). Consider the contrast between the imperfective /-rV́/, which is a verbal suffix, and the homophonous agentive /-rV́/, which is a nominal suffix (cf. Kennedy 1966: 45):

(20) *Default low insertion in verbs, H spreading in nouns*

a.	tuu-ro	→	tùù-ró	'follow-IPFV' (verb)	Default low insertion
	H		H		
b.	tuu-ro	→	túú-ró	'follow-AG' (noun)	H Spreading
	H		H		

In compounds, the suffix H only spreads to the immediately adjacent toneless root. Toneless roots further to the left remain toneless and receive the default low (cf. Kennedy 1966: 45). This suggests that H spreading is a stem-level process that does not extend to compounds, which are formed at the word level.

(21)

a.	bi-tuu-ro	→	bì-túú-ró	'child-follow-AG'
	H		H	
b.	bi-fa-tuu-ro	→	bì-fà-túú-ró	'child-bad-follow-AG'
	H		H	

Downstep can arise from a HL root or a LH suffix where the L tone is set afloat as shown in (22) and (23). We enclose floating tones in parentheses.

(22)

	kʊɔr-aa	→	kʊ́ɔ́r-ꜜáá	'farmer-SG'
	HL H		H(L) H	

(23)

	sa̱a̱-ma̱	→	sa̱á̱-ꜜmá̱	'stranger-PL'
	H LH		H (L)H	

The source of the downstep is the root /kʊ́ɔ̀r/ in (22) and the plural suffix /mă/ in (23). This can be seen by placing the roots before a H adjective such as /wóg/ 'long,

[9] This tone alternation is found in several related languages, including Moore (Kenstowicz *et al.* 1988), Dagbani (Hyman 1993) and Kɔnni (Cahill 2007: 333).

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tall'. The root /kɔ́ɔ̀r/ 'farmer' triggers downstep, whereas the root /sa̱á̱/ 'stranger' does not.

(24) a. à kɔ́ɔ̀r-ꜜwóg-kpóngì ꜜná not *kɔ́ɔ̀r-wóg-
DEF farmer-tall-big DEM
'that tall big farmer'

b. à sa̱á̱-wóg-kpóngì ꜜná not *sa̱á̱-ꜜwóg-
DEF stranger-tall-big DEM
'that tall big stranger'

Most verbs are toneless, H or HL, but there are a few LH roots that trigger downstep on themselves. One such verb is /tàá/ 'have'. The H tone on the subject *ó* is the exponent of the hortative construction.

(25) ó ꜜtáá=ò
3SG.HORT have=3SG
'He should have it.'

5. Word-level tone

Downstep can come from a variety of sources (Leben 2018). Dagaare stem-level downsteps illustrate one common source: an underlying floating L wedged between H tones (Clements & Ford 1979; see Pulleyblank 1986: 34 for Tiv). However, the downstep systematically present in compounds requires a different explanation:

(26)

	SINGULAR	PLURAL	'bad N'	
a.	yí-rì	yí-è	yí-ꜜfáá	'house-bad.SG'
b.	kyúù	kyúú-rì	kyúú-ꜜfáá	'moon-bad.SG'
c.	wɛ́g-è	wɛ́g-rì	wɛ́g-ꜜfáá	'log-bad.SG'

Where does the downstep on *fáá* 'bad.SG' come from? The noun cannot be its source: /yí/ 'house', /kyúú/ 'moon' and /wɛ́g/ 'log' must be underlyingly H because their number/class suffix undergoes Meeussen's Rule (H-H → H-L), yielding *yí-rì* 'house-SG', *kyúú-rì* 'moon-PL' and *wɛ́g-rì* 'log-PL'. If the nouns were underlyingly HL, we would incorrectly predict downstep on the number/class suffix: **yí-ꜜrí*, **kyúú-ꜜrí*, **wɛ́g-ꜜrí*.

The adjective itself can also be excluded as the source of downstep. This becomes evident when we embed 'bad' in a compound where it reveals its underlying tone:

(27) à bì-bìl-fà-wóg ꜜná
DEF child-small-bad-tall.SG DEM
'that bad tall toddler'

The three initial roots *bì-bìl-fà-* have the corresponding singular forms *bíé* 'child.SG', *bílé* 'small.SG' and *fáá* 'bad.SG', where the H tone comes from the number/class suffix. In the compound, where there is no suffix, they receive the default low, showing that all three roots are underlyingly toneless (/bi/ 'child', /bil/ 'small' and /fa/ 'bad').[10]

[10]Note that the singular adds a vowel to the root: /bi/ → *bíé*; /bil/ → *bílé*; /fa/ → *fáá*. The vowel is not a suffix but epenthetic, and required by word minimality (Anttila & Bodomo 2009).

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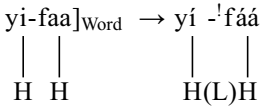
The downstep on *fáá* in (27) must thus have some independent source. Our proposal is that a word-final H undergoes automatic downstep. This is stated as the informal rule in (28), which introduces a floating L after a H tone before a word-final H tone.

(28) Word-final downstep: ∅ → (L) / H _ H]$_{\text{Word}}$

(29) yí-ꜜfáá 'house-bad.SG'



The rule portrays stem-level and word-level downsteps as materially the same: both involve a floating L tone. The difference is that stem-level downsteps arise from underlying L tones that belong to some morpheme, whereas word-level downsteps arise from epenthetic L tones that have a structural origin.[11]

Despite their different sources, the two types of downstep are impressionistically indistinguishable and occur at the same location in the surface string. This is illustrated in (30) by 'sheep', 'sheep skinner' and 'bad sheep'.

(30) a. pí - ꜜrʊ́ʊ́ — H(L)H — 'sheep-SG'

b. pí - ꜜsíí - rɛ́ — H(L) H — 'sheep-skin-AG'

c. pí - ꜜfáá — H(L)H — 'sheep-bad.SG'

The downstep in (30a) 'sheep' is underlying and comes from the suffix: H + LH = H(L)H. The downstep in (30b) 'sheep skinner' and (30c) 'bad sheep' is structural and results from word-final lowering: ∅ → (L) / H _ H]$_{\text{Word}}$. Note that even though the downstepped H tone in (30b) is not on the final syllable, it is still the final autosegmental H.

The structural downstep is restricted to the word edge. In (31a)–(31c), the word-final H undergoes downstep. In (31d)–(31f), the word-final tone is L, and the preceding H tones surface with no intervening downsteps.

(31) a. pí-ꜜsíí-rɛ́
sheep-skin-AG
'sheep skinner'

b. yí-ꜜbílé
house-small
'small house'

c. a dɔ̀ɔ̀-wóg-kpóng-ꜜfáá
DEF man-tall-big-bad.SG
'the tall big bad man'

d. pí-nɛ́nì
sheep-meat
'mutton'

e. yí-dúó-rò
house-climber
'house climber'

f. à bìbìl-wóg-kpóng-fíí-lɛ̀ ꜜná
DEF kid-tall-big-young-PL DEM
'those tall big young kids'

[11] Lowering at the ends of larger prosodic domains is not uncommon. In Dagaare, we have observed an (optional) downstep on the last word of sentences like *ò dí=ꜜó=lá (ꜜ)kó=má* 'S/he gave it to me', lit. 'S/he took it FOC gave me' and *ò táá ꜜlá (ꜜ)pɔ́ɔ́* 'she is pregnant' (lit. 'She has FOC stomach'). Gjersøe (2016) describes a pattern in Kikuyu where downstep appears preferably at the right edge of a p-phrase that corresponds to the maximal phrase (XP). For utterance-final lowering, see Downing & Rialland (2017b: 3–4).

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An anonymous reviewer suggests that instead of word-final lowering, the downstep in compounds might be a morphological linking element L parallel to the associative H in Etsako and Bini (Akinlabi 1996: 259–272). That seems unlikely: there is no evidence for a linking L in the compound-internal sequences H-H and H-H-H (31d)–(31f). Only the final H is downstepped, suggesting that the downstep is not a morpheme but has a structural origin.

Word-final lowering also applies to enclitics. The focus marker *lá,* which has an underlying H tone, encliticises to the verb and undergoes downstep.[12]

(32) a. ò dáá [bùrí=ꜜlá]$_{\text{Word}}$ à mírì
3SG PAST.2.DAYS soak.PFV=FOC DEF rope
'S/he soaked the rope two or more days ago.'

b. à dą̀ą̀ nă ò nàŋ dóg-rɔ̀ [é=ꜜlá]$_{\text{Word}}$ nʊ̀ɔ́
DEF pito REL 3SG REL brew-IPFV be=FOC sweet
'The pito he is brewing is sweet.'

However, word-level downstep fails to materialise if there is a downstep earlier in the word. This ban on two downsteps in the same word can be seen by contrasting /buri/ 'soak' (toneless) and /búrì/ 'fetch' (HL). The verb-final H is the perfective suffix.

(33) a. ò dà [bùrí=ꜜlá]$_{\text{Word}}$ à mírì (/buri/, toneless)
3SG PAST soak.PFV=FOC DEF rope
'He soaked the rope'

b. ò dà [búꜜrí=lá]$_{\text{Word}}$ à kʊ̀ɔ́ (/búrì/, HL)
3SG PAST fetch.PFV=FOC DEF water
'He fetched the water'

The tonal configurations are shown in (34). We get downstep on *ꜜlá* in (34a), but not in (34b), where it is preceded by the earlier downstep on *ꜜrí*.[13]

(34) a. bùrí =ꜜlá]$_{\text{Word}}$
H(L)H

b. bú ꜜr í = lá]$_{\text{Word}}$
H(L)H H

This leaves us with the question of why it is the downstep on the left, i.e. the underlying floating tone, that blocks the downstep on the right, i.e. word-final lowering. Just saying that the leftmost downstep must be realised would provide no rationale for the asymmetry. One natural hypothesis is level ordering: the stem-level downstep in *búꜜrí* is privileged because it is 'old' (derived earlier), whereas the word-level downstep is dispensable because it is 'new' (derived later).[14]

[12]To exclude the possibility that *lá* 'FOC' is underlyingly LH, consider *ò nà gáá=lá* 'S/he will go', *ónɔ́=lá là wà* 'It is he who has come again', *ò kúꜜl-éé=lá* 'She has gone home', etc., where there is no downstep on *lá*. These examples will be glossed and discussed below.

[13]We have observed that the downstep on *lá* can be absent when a H tone follows, e.g. *ò zò-ró=lá yágà* 'S/he is running a lot'. This is not explained by the present analysis. For more on variation in the linearisation of downstep, see §9.

[14]There are other languages that dislike successive downsteps. One is Aghem (Grassfields Bantu, Cameroon; Hyman 1987); another is Paicî (Oceanic, New Caledonia; Lionnet 2022), which allows no more than one pitch drop within a prosodic word. Lionnet ties the 'leftmost wins' pattern of Paicî to culminativity, suggesting a metrical explanation.

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Finally, Dagaare shows evidence for the common process of tone absorption that simplifies LH-H sequences (Hyman & Schuh 1974: 90–91) and is also found in the related Buli (Akanlig-Pare & Kenstowicz 2002). In Dagaare, tone absorption appears with the intransitive perfective suffix /-èé/ followed by /lá/. The verbs are /kúl/ 'go home' (H) and /di/ 'eat' (toneless). The intransitive perfective and the future (to be discussed below) are the only environments where we have observed tone absorption so far.

(35) a. ò kú[!]l-éé=lá
3SG go.home-INTR.PFV=FOC
'She has gone home'

b. ò dì-èè=lá
3SG eat-INTR.PFV=FOC
'She has eaten'

The tonal configurations are shown in (36):

(36) a. kul-ee = la → kú [!]l- éé = lá
H LH H H H(L)H H

b. di-ee = la → dì-èè = lá
LH H L H

In /kúl-èé/, the suffix triggers a stem-level downstep on itself which blocks the word-level downstep on *lá*. In /di-èé/, the suffix H simply vanishes: it is 'absorbed' into the clitic H. The process can be described by the informal rule in (37):

(37) Tone Absorption: LH-H → L-H

Note that in (36a), downstep at the stem level yields *kú*[!]*léé*, bleeding tone absorption. This implies that tone absorption is either word-level or postlexical.

The nature of tone absorption is not clear to us. Various possibilities are discussed by Hyman & Schuh (1974: 91). An anonymous reviewer notes that in related languages, contour tones are often only allowed word-finally or phrase-finally, providing a possible phonological motivation for tone absorption here. This is consistent with our proposal that contours are not allowed in the lexical phonology of Dagaare and an underlying LH is repaired by tone absorption. We must leave the analysis of tone absorption for future work.

6. Postlexical tone

The postlexical level introduces no new cases of dissimilation or downstep. A H##H sequence with a word boundary between the two H tones surfaces with level pitch.

(38) a. à dɔ́ɔ́ pɔ́gɔ́ 'the man's woman'
L H H

b. à bíí-rí fáá-rí fáá-rí 'the children are very bad'
L H H H

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The key tone alternation at the postlexical level involves the three preverbal particles /nàá/ 'EMPH.FUTURE', /nă/ 'FUTURE' and /kŏŋ/ 'NEG.FUTURE'. All three have an underlying LH tone. The vowel sequence in *nàá* accommodates the entire LH tone. In contrast, the short vowels of *nà* and *kòŋ* leave the H component floating and subject to deletion except in suitable contexts to be discussed below.

(39) a. nà á 'EMPH.FUT' b. nà 'FUT' c. kòŋ 'NEG.FUT'
LH L(H) L(H)

The majority of Dagaare verbs are HL, H or toneless. Before HL and H, the trailing H is simply absorbed, but before a toneless root, it docks onto the verb (Kennedy 1966: 47–48). The toneless verb /gaa/ 'go' illustrates H docking: the verb surfaces with the default L after *nàá*, but with the trailing H after *nă*.

(40) a. ò nàá gàà=lá
3SG EMPH.FUT GO=FOC
'He will willingly go.'

b. ò nà gáá=lá
3SG FUT GO=FOC
'He will go.'

Similarly, the toneless /buri/ 'soak' receives the default low after the negation particle *bá*, but the trailing H after the negative future *kŏŋ*. The perfective H is absent under negation.[15]

(41) ò dà nàŋ bá bùrì à mírì
3SG PAST ADV NEG soak DEF rope
'He had not (yet) soaked the rope'

(42) ò dà nàŋ kòŋ búrí à mírì
3SG PAST ADV NEG.FUT soak DEF rope
'He will not (yet) have soaked the rope'

H docking results in phonological opacity. When the trailing H ends up next to the enclitic *lá,* we get no downstep:

(43) ò nà gáá = lá]$_{Word}$ not *gáá=ˡlá]$_{Word}$
L L H H

This is explained by level ordering: the H H]$_{Word}$ sequence was created postlexically, counterfeeding final lowering, which applies at the word level.

Another case of opacity emerges in the imperfective paradigm. Recall that the imperfective is realised as the stem-level suffix /-rV́/ with an underlying H tone. The stem-level status of the /-rV́/ suffix is evident from the fact that it undergoes

[15] A parallel example from Kɔnni (Cahill 2017: 61) is the preverbal past tense particle *tíŋ*. The future H suffix in Dagbani is similar except that it overwrites the verb tone (Hyman & Olawsky 2004).

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Meeussen's Rule (HH → HL) after H roots, e.g. /dóg-rV́/ → *dóg-rɔ̀* 'brew-IPFV'. Now, consider a toneless verb with the H imperfective suffix:

(44) dig-re 'chase-IPFV'
H

Adding the preverbal future particle /nă/ results in a H-H sequence across a stem-suffix boundary, but Meeussen's Rule does not apply. Again, this is explained by level ordering: the H-H sequence was created postlexically, counterfeeding Meeussen's Rule, which applies at the stem level.

(45) à bíé nà díg-ré = ꜜlá sʊ́ʊ́ꜜŋ-ą́ą́ not *díg-rè=lá
L H L H H(L)H H(L) H

The downstep on *ꜜlá* is also predicted: the stem-level *-ré* triggers word-level downstep because stem-level phonology feeds word-level phonology.

In addition to its postverbal uses, the focus particle *lá* 'FOC' also encliticises to fronted subjects in cleft sentences, but for some reason this time without downstep.[16]

(46) ʊ́nɔ́=lá là wà not *ʊ́nɔ́=ꜜlá
3SG.EMPH=FOC REP come
'It is he who has come again'

The absence of downstep in this context remains an outstanding puzzle. It would be expected if the sequence *ónɔ́ lá* were created, not at the word level, but postlexically, since postlexical phonology counterfeeds word-level phonology, but at this point we do not have independent evidence for such an assumption.

Finally, downstep may surface between words if it is underlying. Consider the underlyingly LH demonstrative pronoun *nă* 'that', which triggers downstep on itself:

(47) à pɔ̀g-bààl-vìɛ̀l-bílé ꜜná
DEF woman-slender-beautiful-small.SG DEM
'that slender beautiful small woman'

Also, note that the ban on multiple downsteps only applies within words, not across words. Adjacent downsteps are fine if they occur across words:

(48) a. à dɔ̀ɔ̀-wóg-kpóng-ꜜfáá ꜜná
DEF man-tall-big-bad.SG DEM
'that tall big bad man'

b. à só-bìl-gɔ̀ng-fʊ́ɔ-ꜜláá ꜜná
DEF road-small-crooked-narrow-SG DEM
'that small crooked narrow road'

[16]For the expression of focus in the related Ditammari, see Féry (2013).

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7. Stratal Optimality Theory

7.1. Preliminaries

The preceding sections have laid out the empirical generalisations in terms of informal rules. We now take the first steps towards deriving them from general principles in Stratal Optimality Theory (Kiparsky 2000, 2015). The key observation is that morphology plays an important role in Dagaare tone. Recall the main generalisations:

(49) *The role of morphology in Dagaare tone*

a. Downstep is underlying at the stem level and structural at the word level.
b. At the stem level, H-H undergoes dissimilation (Meeussen's Rule).
c. At the stem level, nouns and verbs differ in tone spreading.
d. At the word level, H=H undergoes structural downstep (Final Lowering).
e. At the postlexical level, H##H survives intact (no alternation).
f. Only one downstep per word is allowed.
g. Stem-level downstep blocks word-level downstep.

Notation: - suffix boundary, = clitic boundary, ## word boundary.

To simplify presentation, we start by identifying four high-ranked constraints. This allows us to simplify subsequent tableaux by omitting the candidates that violate them.

(50)

a.	IDENT(T)-ROOT	'The tone values (H, L) cannot be changed in roots.'
b.	MAX(T)	'No tone deletion'
c.	ALIGN-RIGHT(T)	'The domain-final syllable is associated with a tone.'
d.	*CONTOUR	'No contours' (i.e. TBUs with multiple tones)

The first constraint guarantees that root tone values cannot be changed. We will generalise this constraint to impose faithfulness to material inherited from the previous level: IDENT(T)-ROOT applies at the stem level; IDENT(T)-STEM applies at the word level; and IDENT(T)-WORD applies at the postlexical level. Giving privileged status to 'old' material through faithfulness in this way is reminiscent of the familiar principle of the cycle. Making *CONTOUR undominated guarantees that a syllable (TBU) can be associated with at most one tone. This seems like a reasonable null hypothesis that is not obviously contradicted by anything in the phonological system as a whole; see fn. 5 for alternative analyses.

7.2. Stem-level tone

Here are the six constraints that play a key role in Dagaare tone alternations:

(51)

a.	OCP(H)	'No adjacent H tones'
b.	DEP(T)	'No tone insertion'
c.	*TONELESS	'No toneless syllables' (i.e. TBUs without tone)
d.	*SPREAD	'No spreading' (i.e. tones with multiple TBUs)
e.	*FLOAT	'No floating tones' (i.e. tones without TBU)
f.	IDENT(T)	'Tone values (H, L) cannot be changed'

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OCP(H) (e.g. Hyman 2011: 1096) triggers dissimilation at the stem level.[17] The tableau in (52) derives Meeussen's Rule. We use comparative tableaux (Prince 2002a, 2002b; McCarthy 2008: ch. 2), where losing candidates have their constraints labelled **W** for 'favours the winner' or **L** for 'favours the loser'.

(52) *Meeussen's Rule:* yí-rì *'house-SG'*

/ yi-ri / H H	OCP(H)	DEP(T)	*TLESS	*SPREAD	*FLOAT	IDENT(T)
a. yi-ri H H	1 **W**					**L**
b. yi -r i H(L)H		1 **W**			1 **W**	**L**
☞ c. yi-ri H L						1
d. yi-ri H(L)				1 **W**	1 **W**	1

A ranking is guaranteed to work (i.e. to make the desired winner optimal) if all **L**s are dominated by some **W**. A comparative tableau is useful for making ranking arguments because it transparently shows the necessary rankings. In this case, Meeussen's Rule requires that OCP(H) ranks above IDENT(T), as shown by loser (52a), and that either DEP(T) or *FLOAT rank above IDENT(T), as shown by loser (52b). The constraints are neither totally ranked nor totally unranked: the ranking is genuinely partial. The dashed vertical lines between constraints are used simply for convenience. We highlight harmonically bounded candidates (i.e. candidates that only have **W**s) by greying out the entire row. The fact that dissimilation applies to suffixes, not to roots, is guaranteed by ranking IDENT(T)-ROOT above OCP(H).

Meeussen's Rule applies even when the suffix is simply H. Consider /kúlí-H/ 'go home-PFV'. The candidate **kúlì* is ruled out because of the high-ranked IDENT(T)-ROOT.[18] This leaves us with three candidates, none of which violate IDENT(T)-ROOT, since they remain H.

[17] Here, we differ from Cahill (2007: 314–315), who argues that similar dissimilation effects in Kɔnni should not be captured by the OCP but by a designated polarity constraint.

[18] Alternatively, we could analyse the root as /kúl/ 'go home' and the final /i/ as a postlexical epenthetic vowel. The point under consideration would still hold.

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(53) *Meeussen's Rule: /kúlí/ + H → kúlí(`) 'go.home.*PFV', *where perfective = H*

/ kuli / H-H	OCP(H)	DEP(T)	*TLESS	*SPREAD	*FLOAT	IDENT(T)
a. kuli HH	1 **W**			**L**	**L**	**L**
b. ku l i H(L)H		1 **W**		**L**	1	**L**
☞ c. kuli H(L)				1	1	1

Since the root must remain H and inserting a medial downstep (L) is not an option at the stem level due to the ranking DEP(T) ≫ {*SPREAD, IDENT(T)}, the result is dissimilation. The suffix H becomes L but remains floating, correctly predicting downstep on a following /lá/ 'FOC' at the word level. Examples where the downstep on /lá/ 'FOC' does not arise from a suffix but word-final lowering will be presented in the next section.

(54) ò kúlí=ꜜlá]$_{\text{Word}}$ yí-rì
3SG go.home.PFV FOC house-SG
'He has gone home.'

With HL roots and LH suffixes, a violation of *FLOAT is unavoidable because of the high-ranking *CONTOUR. This is shown in (55). We assume that only L can float.[19]

(55) *A floating L triggers downstep:* kʊ́ɔr-ꜜáá *'farmer-SG'*

/ kʊɔr-aa / HL H	OCP(H)	DEP(T)	*TLESS	*SPREAD	*FLOAT	IDENT(T)
☞ a. kʊ́ɔ́ r-ꜜáá H(L) H					1	
b. kʊ́ɔ́r-àà H L(L)					1	1 **W**

Finally, recall that at the stem level, we observed a difference between nouns and verbs in toneless roots: the suffix H spreads in nouns but not in verbs where the root remains toneless and receives a low tone at a later level, to be discussed shortly. We

[19]The faithful candidate is ruled out by *CONTOUR, implying that IDENT(T)-ROOT is not undominated but outranked by *CONTOUR.

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derive this by positing two minimally different COPHONOLOGIES within the stem-level grammar, in this case different rankings of *TONELESS and *SPREAD, following e.g. Anttila (2002) and Inkelas & Zoll (2007); see Jenks & Rose (2011, 2015) and Sande *et al*. (2020) for an extension of cophonologies to the phrasal domain.

(56) a. Nouns: *TONELESS ≫ *SPREAD
b. Verbs: *SPREAD ≫ *TONELESS

(57) *Nominal tone:* túú-ró *'follow-AG'*

/ tuu-ro / H	OCP(H)	DEP(T)	*TLESS	*SPREAD	*FLOAT	IDENT(T)
☞ a. tuu-ro (H)				1		
b. tuu-ro H			1 **W**	**L**		

(58) *Verbal tone:* tùù-ró *'follow*-IPFV'

/ tuu-ro / H	OCP(H)	DEP(T)	*SPREAD	*TLESS	*FLOAT	IDENT(T)
a. tuu-ro (H)			1 **W**	**L**		
☞ b. tuu-ro H				1		

7.3. Word-level tone

Word-level tone differs from stem-level tone in two ways. First, HH sequences do not dissimilate (Meeussen's Rule) but instead trigger floating L insertion (downstep). Second, there is no H spreading. The required rankings are visible in the tableau in (59), which derives the word-final downstep in *bùrí=ˈlá* 'soak.PFV=FOC'.[20]

[20] An anonymous reviewer brings up the possibility that the difference between stems and words might be prosodic. Perhaps root–affix combinations correspond to non-recursive prosodic words and word-clitic combinations to recursive prosodic words. It is not clear to us how such an analysis would differ empirically from ours. We would still need a two-way distinction grounded in morphology.

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(59) *Word-final lowering*

/ [buri] = la / H H	IDENT(T)	OCP(H)	*SPREAD	DEP(T)	*TLESS	*FLOAT
a. [buri] = la H H		1 **W**		**L**	1	**L**
☞ b. [buri] = ¡la H(L) H				1	1	1
c. [buri] = ¡la H(L) H			1 **W**	1	**L**	1
d. [buri] = la H L	1 **W**			**L**	1	**L**

At the word level, OCP(H) and IDENT(T) must rank above both DEP(T) and *FLOAT, and *SPREAD must rank above *TONELESS. Changing the perfective H to L would violate the high-ranked IDENT(T)-STEM, which requires faithfulness to 'old' material – here the output of the stem-level phonology – as would any other change in the stem-level tones.[21] Inserting a H tone on the root would violate OCP(H). Note that IDENT(T)-STEM is not violated by the spreading in (59c) because the root syllable is toneless and without tone value. Instead, (59c) is ruled out by *SPREAD.

The tableau in (60) shows that nothing happens to the stem-level *kúlí*(`) 'go.home.PFV' with a trailing (L) when combined with /lá/ 'FOC' at the word level. IDENT(T)-STEM maintains the stem tone H(L), and any change would make things worse.

[21] An anonymous reviewer suggests that only IDENT(T)-ROOT is required and that IDENT(T)-STEM and IDENT(T)-WORD are superfluous and can be eliminated. This would result in a simpler analysis. Pursuing the consequences of such a move must be left for future work.

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(60) kúlí=ˡlá *'go.home*.PFV', *where perfective = H*

/ [kuli] = la / H (L)H	IDENT(T)	OCP(H)	*SPREAD	DEP(T)	*TLESS	*FLOAT
☞ a. [kuli] = ˡla H (L) H			1			1
b. [kuli] = ˡla H (L) L	1 **W**		1			1
c. [kuli] = ˡla H(L)(L) L	1 **W**		1	1 **W**		1

The ban on multiple downsteps follows from the high-ranked constraint in (61):

(61) *ˡHˡH 'No multiple downsteps within a word.'

This constraint licenses at most one downstep in a word, but does not stipulate its location. The left–right asymmetry by which a stem-level downstep blocks a word-level downstep falls out from level ordering. The tableau in (62) shows this for *búˡrí=lá* 'soak.PFV=FOC'.

(62) *No multiple downsteps within a word*

/ [búˡ r í] = lá / H(L)H H	*ˡHˡH	IDENT(T)	OCP(H)	*SPREAD	DEP(T)	*TLESS	*FLOAT
☞ a. [buˡ r i] = la H(L)H H			1				1
b. [buˡ r i] = ˡlá H(L)H(L) H	1 **W**		**L**		1 **W**		2 **W**
c. [buˡ r i] = la H(L)H L		1 **W**	**L**				1

The 'old' stem-level downstep survives by satisfying the high-ranked IDENT(T)-STEM. Inserting a 'new' word-level downstep is blocked by *ˡHˡH, implying that this constraint must be ranked above OCP(H). Dissimilating the clitic to L is ruled out by IDENT(T) ≫ OCP(H).

In compounds, H spreading is limited to one root and never crosses compound boundaries. Roots further to the left remain toneless.

(63) a. tuu-ro → túú-ró 'follow-AG' (simple word)

H H

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b. bi-tuu-ro → bì-túú-ró ‘child-follow-AG’ (compound)

H H

c. bi-fa-tuu-ro → bì-fà-túú-ró ‘child-bad-follow-AG’ (compound)

H H

This follows if compounding occurs at the word level. At the stem level, the root /tu/ ‘follow’ combines with the suffix /rV́/ ‘AGENTIVE’ yielding the simple word *túúró* ‘follower’. Compounding adds roots to the left edge of this word. If they are toneless, they remain so, because H spreading is no longer an option. The tone of *túúró* ‘follower’ was derived at the stem level and remains intact given the high-ranked IDENT(T)-STEM.

(64) *No H spreading in compounds at the word level*

/ bi-[túú-ró] / H	IDENT(T)	OCP(H)	*SPREAD	DEP(T)	*TLESS	*FLOAT
☞ a. bi-[túú-ró] H (noun)			1		1	
b. bì-[túú-ró] L H (noun)			1	1 **W**	**L**	
c. bí-[túú-ró] H (noun)			2 **W**		**L**	

The analysis predicts that the initial syllable of *bì-túú-ró* ‘child follower’ is lexically toneless. Its low pitch must thus have a postlexical or phonetic origin. The evidence will be presented in the next section.

Finally, in our preliminary rule-based description, we stipulated that downstep is inserted before a word-final H tone preceded by a H tone: ∅ → (L) / H _ H]$_{\text{Word}}$. This results in a downstep in *pí-ꜜsíí-ré́* ‘sheep skinner’ but not in *pí-nɛ́nì* ‘mutton’. It is not clear to us why such a restriction should hold. In the Optimality-Theoretic analysis, we must similarly assume that OCP(H) only applies to a sequence of two H tones at the right edge of a constituent, suggesting that we should rename the constraint OCP(H)].[22]

[22] An anonymous reviewer suggests several interesting alternative formulations. One is ‘to posit an explicit constraint requiring that the last tone in a domain is lower than the preceding tone (final lowering, vacuously satisfied by HL). [M]any languages have something like this (see, e.g., Liberman & Pierrehumbert 1984 on English and Laniran 1992 on Yoruba).’

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7.4. Postlexical tone

The postlexical tone of Dagaare is relatively inert compared to related languages such as Moore (Kenstowicz *et al.* 1988) and Dagbani (Hyman 1993; Hyman & Olawsky 2004) where we see extensive rightward tone spreading across words.

The fact that H##H sequences survive intact across word boundaries implies that either *Float or Dep(T) dominates OCP(H) in the postlexical phonology. The violations are shown in (65). The high-ranked Ident(T)-Word keeps the word-level 'old' tones intact.

(65) *dɔ́ɔ́ ## pɔ́gɔ́* → dɔ́ɔ́ pɔ́gɔ́ *'man's woman'*

/ dɔ́ɔ́ pɔ́g-ɔ́ /	Ident(T)	*Spread	*Tless	Dep(T)	*Float	OCP(H)
H H						
☞ a. dɔ́ɔ́ pɔ́g-ɔ́		1				1
H H						
b. dɔ́ɔ́ pɔ́g-ɔ́		1		1 **W**	1 **W**	**L**
H(L) H						

The only postlexical alternation for which we have robust evidence is the pairing up of toneless syllables and trailing H tones. This involves the LH morphemes /nă/ 'FUT' and /kŏŋ/ 'NEG.FUT', whose H tone docks onto a toneless verb root across a word boundary.

(66) *nă dig-ré* → nà díg-ré *'FUT chase*-IPFV'

/ na dig-re /	Ident(T)	*Spread	*Tless	Dep(T)	*Float	OCP(H)
LH H						
a. nà dìg-ré			1 **W**		1 **W**	1
L[H] H						
☞ b. nà díg-ré						1
L H H						
c. nà dìg-ré	1 **W**					**L**
L L H						

The H docking simultaneously satisfies *Float and *Toneless. The winner violates OCP(H), but that cannot be helped. Dissimilation (Meeussen's Rule) is not an option in the postlexical phonology because the high-ranking Ident(T)-Word rules out **nà díg-rè*. Changing the floating H to L would eliminate the OCP(H) violation but is ruled out by the ranking Ident(T) ≫ OCP(H). The analysis correctly associates

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the trailing H tone from the future particle with the toneless syllable in the following verb root. Note that there is no general compulsion to fill toneless syllables by tone spreading from neighbouring syllables. This restriction is not yet accounted for under the present analysis. The editor suggests adding the ranking *Spread ≫ *Toneless into the postlexical phonology, which would correctly block spreading into toneless syllables. Exploring the consequences of this additional ranking elsewhere in the data must be left for future work.

After H docking, the verb surfaces with a level H-H tone with no intervening downstep. This provides evidence that the verb must have emerged as ∅-H from the word level. If *dìg-ré* had been L-H, we would have expected the root L tone to block H docking, or else the L would have been dislodged, triggering a downstep on the suffix: **nà díg-ꜜré*. Neither happens. We conclude that at the word level, the verb root remains toneless and receives a L tone in the postlexical phonology in virtue of an additional ranking *Toneless ≫ Dep(T) or alternatively receives a default low pitch in the phonetics. Both analyses correctly predict that the low tone is phonologically inert and does not feed any phonological alternations.

8. Are cophonologies necessary?

We have seen that H spreads from suffixes to toneless roots in nouns but not in verbs:

(67) a. tuu-ro → túú-ró ‘follow-ag’ (noun)

H H

b. tuu-ro → tùù-ró ‘follow-ipfv’ (verb)

H H

We derived this by positing two minimally different cophonologies within the stem level: *Toneless ≫ *Spread for nouns and *Spread ≫ *Toneless for verbs. An anonymous reviewer suggests an alternative: perhaps nominal affixes belong to the stem level and verbal affixes to the word level. This would immediately yield the right result, since H spreading is possible at the stem level but not at the word level. It would also simplify the analysis by eliminating level-internal cophonologies. For an analogous approach to Korean noun–verb asymmetries, see Yun (2009).

The problem is that there is no independent evidence for separating nouns and verbs to different levels in Dagaare. Affix ordering provides no such evidence: verbal suffixes do not occur outside nominal suffixes. Nouns and verbs also share many phonological alternations, including lexically conditioned vowel lengthening, vowel harmony and tone dissimilation (Meeussen’s Rule), all located at the stem level. Indeed, they only differ in H spreading. Postponing verb inflection to the word level would require us to replicate these processes at two separate levels. The opposite ordering, i.e. locating verbs at the stem level and nouns at the word level, as in Yun’s (2009) analysis of Korean, fails for straightforward empirical reasons. It would incorrectly allow H spreading in toneless verbs once they reach the word level, but as

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evidence from the future tense H docking shows, toneless verbs remain toneless until the postlexical phonology.

The reviewer further suggests that within-level cophonologies should be ruled out on theoretical grounds; for proposals similar in spirit, see e.g. Bermúdez-Otero (2012) and Jaker & Kiparsky (2020). This implies that differences in ranking should always correspond to different levels. However, such a position is far too strong to be empirically tenable (Kiparsky 2020). Phonological differences among nouns, adjectives and verbs are found in many languages (see e.g. Smith 2011) and seem to require a variety of explanations, including cophonologies. In contrast, level ordering reflects morphosyntactic structure that holds systematically across the language and is independent of individual lexical items.[23]

9. Future work

What we have presented above reflects our current best understanding of Dagaare tone. The analysis is obviously incomplete. We conclude by pointing out some residual problems that seem important, with the hope of stimulating future work.

There appears to be some variability in word-final lowering that may be related to speech rate and prosodic parsing. The following examples illustrate variability in tone linearisation and downstep placement in clitic sequences.

(68) ò kʊ́=ꜜmá=lá à gán-ì
3SG give.PFV=1SG.OBJ=FOC DEF book-SG
'S/he gave me the book'

Here, the verb is the toneless /kʊ/ 'give'; the perfective aspect is a H tone; the pronominal clitic is the toneless /ma/ '1SG.OBJ'; and the focus clitic is /lá/ 'FOC', which is always H. Schematically:

(69) kʊ =ma =la underlying tones
H H

At the stem level, the perfective H is aligned with the (right edge of the) toneless verb:

(70) kʊ́ =ma =lá output of stem level
H H

At the word level, the toneless /ma/ receives a H tone from the following /lá/ for reasons that are not clear to us. The final H of the word then undergoes downstep in the usual way.

[23] For example, in Finnish, nouns, adjectives and verbs differ systematically in the stem-level phonology with respect to vowel deletion/mutation, assibilation and stylistic vowel coalescence (Anttila 2018). These differences suggest that lexical categories can differ in foot structure within the stem-level phonology.

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(71) kó =ˡmá =lá — output of word level

H (L) H

The toneless verb /buri/ ‘soak’ works in the same way:

(72) ò bùrí=ˡmá=lá
3SG soak.PFV=1SG.OBJ=FOC
‘S/he soaked me’

Puzzlingly, the toneless verb /ngmɛ/ ‘beat’ and the toneless pronominal clitic /ʊ/ ‘3SG’ show a different linearisation pattern:

(73) ŋ̀ ngmɛ̀=ó=ˡlá
1SG beat.PFV=3SG=FOC
‘I beat it’

It is as if the perfective H tone were realised one syllable too late, not on the verb but on the enclitic. Instead of **ngmɛ́=ˡó=lá*, we get *ngmɛ̀=ó=ˡlá*. The word-final downstep is as expected, as illustrated below.

(74) ngmɛ =ʊ =la — underlying tones

H H

(75) ngmɛ =ó =ˡlá — output of word level

H(L) H

With three clitics, multiple tone linearisations are possible, perhaps depending on the speech rate. One tone linearisation for ‘S/he gave it to me’ is given below, with a hypothetical derivation:

(76) ò kó=mó=ˡó=lá
3SG give.PFV=1SG.OBJ=3SG=FOC
‘S/he gave it to me’

(77) kʊ =ma =ʊ =la — underlying tones

H H

(78) kó =ma =ʊ =la — output of stem level

H H

(79) kó =mó =ˡó =la — output of word level

H (L) H

In addition, we get at least two more patterns:

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(80) ò kó=mó=ó =ˡlá

(81) ò kò=mó=ó =ˡlá

Despite this variation, the focus clitic *lá* is always H, and there is always one downstep somewhere within the clitic sequence. A more systematic exploration of these patterns of variation is clearly needed.

Finally, we have not mentioned trisyllabic and longer words. Such words are often compounds but some seem simplex, e.g. *tákór-ó* 'window-SG', *kùnkún-í* 'tortoise-SG' and *fíntíl-è* 'lamp-SG'. In general, the same tonal processes apply and our analysis generalises to these longer words under the assumption that the initial syllable is simply ignored. A detailed analysis must be left for future work.

10. Conclusion

Dagaare is a two-tone 'terraced-level' language with non-automatic downstep. There are two main analytical challenges: tone alternations are often triggered or blocked by morphological and lexical conditions and downstep has at least two sources: lexical and structural. We have shown that the apparent complexity arises because tones are introduced at different morphological levels (stems and words) and undergo processes specific to that level. The levels interact serially: stem-level phonology feeds word-level phonology and word-level phonology feeds postlexical phonology as in Lexical Phonology and Morphology and Stratal Optimality Theory. Phonology applies inside out in tandem with morphology and later processes can make earlier processes opaque. Downstep provides key evidence that helps unlock the apparently complex tone system and its interaction with morphology.

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References

Akanlig-Pare, George & Michael Kenstowicz (2002). Tone in Buli. *Studies in African Linguistics* **31**. 55–95.
Akinlabi, Akinbiyi (1996). Featural affixation. *JL* **32**. 239–289.
Ali, Mark, Scott Grimm & Adams Bodomo (2021). *A dictionary and grammatical sketch of Dagaare*. Berlin: Language Science Press.
Anttila, Arto (2002). Morphologically conditioned phonological alternations. *NLLT* **20**. 1–42.
Anttila, Arto (2018). Variation in phonology. In Mark Aronoff (ed.) *Oxford research encyclopedia of linguistics*. Oxford: Oxford University Press.

Anttila, Arto & Adams Bodomo (2009). Prosodic morphology in Dagaare. In Masangu Matondo, Fiona McLaughlin & Eric Potsdam (eds.) *Selected proceedings of the 38th Annual Conference on African Linguistics*. Somerville, MA: Cascadilla Proceedings Project. 56–68.

Anttila, Arto & Adams Bodomo (2019). Metrically conditioned vowel length in Dagaare. In Emily Clem, Peter Jenks & Hannah Sande (eds.) *Theory and description in African linguistics: selected papers from the 47th annual conference on African linguistics*. Berlin: Language Science Press. 21–39.

Bendor-Samuel, John T. (1971). Niger-Congo, Gur. In Jack Berry & Thomas Albert Sebeok (eds.) *Linguistics in Sub-Saharan Africa*, number 7 in Current Trends in Linguistics. The Hague: Mouton. 141–178.

Bermúdez-Otero, Ricardo (2012). The architecture of grammar and the division of labor in exponence. In Jochen Trommer (ed.) *The morphology and phonology of exponence*. Oxford: Oxford University Press. 8–83.

Bodomo, Adams (1997). *The structure of Dagaare*. Stanford, CA: CSLI Publications.

Cahill, Michael (2017). Kɔnni intonation. In Downing & Rialland (2017a). 53–88.

Cahill, Michael C. (2007). *Aspects of the phonology and morphology of Konni*. Dallas, TX: SIL International and the University of Texas at Arlington.

Carlson, Robert (1983). Downstep in Supyire. *Studies in African Linguistics* **14**. 35–45.

Childs, G. Tucker (1995). *A grammar of Kisi: A Southern Atlantic language*. Berlin: De Gruyter Mouton.

Clements, G. N. (1979). The description of terraced-level tone languages. *Lg* **55**. 536–558.

Clements, G. N. & Kevin C. Ford (1979). Kikuyu tone shift and its synchronic consequences. *LI* **10**. 179–210.

Connell, Bruce (2011). Downstep. In van Oostendorp *et al*. (2011). 824–847.

Delplanque, Alain (1983). *Phonologie transformationnelle du dagara (langue voltaïque du Burkina-Faso)*. Paris: Société d'études linguistiques et anthropologiques.

Downing, Laura J. & Annie Rialland (eds.) (2017a). *Intonation in African tone languages*. Berlin: De Gruyter Mouton.

Downing, Laura J. & Annie Rialland (2017b). Introduction. In Downing & Rialland (2017a). 1–16.

Eberhard, David M., Gary F. Simons & Charles D. Fennig (eds.) (2020). *Ethnologue: languages of the world*, 23rd edition. Dallas, TX: SIL International.

Féry, Caroline (2013). Focus as prosodic alignment. *Natural Language & Linguistic Theory* **31**. 683–734.

Gjersøe, Siri (2016). Cyclic optimization of floating L tones in Kikuyu. *NELS* **46**. 301–310.

Grimm, Scott (2021). Inverse number in Dagaare. In Patricia Cabredo Hofherr & Jenny Doetjes (eds.) *The Oxford handbook of grammatical number*. Oxford: Oxford University Press. 444–562.

Gussenhoven, Carlos (2004). *The phonology of tone and intonation*. Cambridge: Cambridge University Press.

Hall, Edward (1977). Dagaare. In Mary Esther Kropp Dakubu (ed.) *West African language data sheets*. Legon, Ghana: West African Linguistic Society, DAGA. 1–9.

Hyman, Larry M. (1987). Downstep deletion in Aghem. In David Odden (ed.) *Current approaches to African linguistics*, volume 4. Dordrecht: Foris. 209–222.

Hyman, Larry M. (1993). Structure preservation and postlexical tonology in Dagbani. In Sharon Hargus & Ellen Kaisse (eds.) *Phonetics and phonology, studies in Lexical Phonology*, volume 4. San Diego, CA: Academic Press. 235–254.

Hyman, Larry M. (2011). The representation of tone. In van Oostendorp *et al*. (2011). 1078–1102.

Hyman, Larry M. & Knut J. Olawsky (2004). Dagbani verb tonology. In Chege Githiora, Heather Littlefield & Victor Manfredi (eds.) *Trends in African linguistics*, volume 6. Trenton: Africa World Press. 97–108.

Hyman, Larry M. & Russell G. Schuh (1974). Universals of tone rules: evidence from West Africa. *LI* **5**. 81–115.

Inkelas, Sharon & Cheryl Zoll (2007). Is grammar dependence real? A comparison between cophonological and indexed constraint approaches to morphologically conditioned phonology. *Linguistics* **45**. 133–171.

Jaker, Alessandro & Paul Kiparsky (2020). Conjugation tone mapping and level ordering in Tetsǫ̀t'ıné. *Phonology* **37**. 617–655.

Jenks, Peter & Sharon Rose (2011). High tone in Moro: effects of prosodic categories and morphological domains. *NLLT* **29**. 211–250.

Jenks, Peter & Sharon Rose (2015). Mobile object markers in Moro: the role of tone. *Lg* **91**. 269–307.

Kennedy, Jack (1966). Collected field reports on the phonology of Dagaari, number 6 in Collected Language Notes. Legon, Ghana: Institute of African Studies, University of Ghana.
Kenstowicz, Michael, Emmanuel Nikiema & Meterwa Ourso (1988). Tonal polarity in two Gur languages. *Studies in the Linguistic Sciences* **18**. 77–103.
Kiparsky, Paul (1982). Lexical morphology and phonology. In The Linguistic Society of Korea (ed.) *Linguistics in the morning calm: Selected papers from SICOL-1981*. Seoul: Hanshin. 3–91.
Kiparsky, Paul (2000). Opacity and cyclicity. *The Linguistic Review* **17**. 351–367.
Kiparsky, Paul (2015). Stratal OT: a synopsis and FAQs. In Yuchau E. Hsiao & Lian-Hee Wee (eds.) *Capturing phonological shades within and across languages*. Newcastle: Cambridge Scholars Publishing. 2–44.
Kiparsky, Paul (2020). Morphological units: stems. In Heidi Harley, Shigeru Miyagawa & Mark Aronoff (eds.) *Oxford research encyclopedia of linguistics*. Oxford: Oxford University Press. 23 pp.
Kropp Dakubu, Mary Esther (1982). The tones of Dagaare. Ms, Language Centre, University of Ghana, Legon.
Laniran, Yetunde (1992). *Intonation in tone languages: the phonetic implementation of tones in Yoruba*. PhD dissertation, Cornell University.
Leben, William R. (2018). The nature(s) of Downstep. Ms, Stanford University.
Liberman, Mark & Janet Pierrehumbert (1984). Intonational invariance under changes in pitch range and length. In Mark Aronoff, Richard T. Oehrle, Frances Kelley & Bonnie Wilker Stephens (eds.) *Language sound structure: studies in phonology*. Cambridge, MA: MIT Press. 157–223.
Lionnet, Florian (2022). Tone and downstep in Paicî (Oceanic, New Caledonia). *Phonological Data and Analysis* **4**. 1–47.
Manessy, Gabriel (1975). *Les langues Oti-Volta*. Paris: Société d'études linguistiques et anthropologiques de France.
McCarthy, John J. (2008). *Doing Optimality Theory*. Oxford: Blackwell.
Miehe, Gudrun (2012). Dagara cluster. In Gudrun Miehe, Brigitte Reineke & Kerstin Winkelmann (eds.) *Noun class systems in Gur languages, volume II: North Central Gur languages*. Köln: Rüdiger Köppe. 250–268.
Naden, Anthony J. (1989). Gur. In John Bendor-Samuel & Rhonda L. Hartell (eds.) *The Niger-Congo languages: a classification and description of Africa's largest language family*. Lanham, MD: University Press of America. 141–168.
Oostendorp, Marc van, Colin J. Ewen, Elizabeth V. Hume & Keren Rice (eds.) (2011). *The Blackwell companion to phonology*. Oxford: Wiley-Blackwell.
Ozburn, Avery, Samuel Akinbo, Alexander Angsongna, Murray Schellenberg & Douglas Pulleyblank (2018). Dagaare [a] is not neutral to ATR harmony. *JASA* **144**. 1938.
Prince, Alan (2002a). Arguing optimality. Ms, Rutgers University. ROA #562.
Prince, Alan (2002b). Entailed ranking arguments. Ms, Rutgers University. ROA #500.
Pulleyblank, Douglas (1986). *Tone in lexical phonology*. Dordrecht: D. Reidel.
Rialland, Annie & Penou-Achille Somé (2000). Dagara downstep: how speakers get started. In Vicki Carstens & Frederick Parkinson (eds.) *Trends in African linguistics: advances in African linguistics*, volume 4. Trenton: Africa World Press. 251–263.
Rialland, Annie & Penou-Achille Somé (2011). Downstep and linguistic scaling in Dagara-Wulé. In John A. Goldsmith, Elizabeth Hume & W. Leo Wetzels (eds.) *Tones and features: phonetic and phonological perspectives*, volume 107. Berlin: Mouton De Gruyter. 108–136.
Sande, Hannah, Peter Jenks & Sharon Inkelas (2020). Cophonologies by ph(r)ase. *NLLT* **38**. 1121–1261.
Smith, Jennifer L. (2011). Category-specific effects. In van Oostendorp *et al*. (2011). 2439–2463.
Snider, Keith L. (1998). Phonetic realisation of downstep in Bimoba. *Phonology* **15**. 77–101.
Welmers, W. E. (1959). Tonemics, morphotonemics, and tonal morphemes. *General Linguistics* **4**. 1–9.
Winston, F. Dennis (1960). The 'mid tone' in Efik. *African Language Studies* **1**. 185–192.
Yun, Jiwon (2009). A Stratal OT approach to a noun–verb asymmetry with respect to opacity in Korean. *University of Pennsylvania Working Papers in Linguistics* **15**. 233–241.