



Why spread? Kalabari clitics spread their tone due to word-minimality, prosodic constituency, and *LHH tonotactics

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Why do certain morphemes spread their tones, while other morphemes do not? We address this fundamental question in Kalabari (**Kalabari-Ijò**), where certain clitics trigger a process of ‘low tone spread’ targeting following high tones (e.g. à ‘I’ in /à pábùrù tẹ́*é/ → [à pábùrù tẹ́*é] ‘I have stammered’). We provide a comprehensive description of this process, establishing that its only triggers are a small class of prosodically-deficient pronominal clitics, all of which are low-toned, monosyllabic, and onsetless. We claim that these properties together prevent it from being parsed as a separate phonological word, and instead, the low tone of these clitics must tonally incorporate into a neighboring prosodic domain. We argue that the domain for low tone spread is the phonological phrase and show independent evidence for this exact constituent from grammatical tone. Finally, low tone spread is unbounded and targets a contiguous string of high tones within the relevant domain. We attribute its unboundedness to a consequence of tonal incorporation: this creates new LHH sequences which are independently marked in the language and consequently repaired by low tone spread. In total, our study demonstrates that tone spreading can profitably be decomposed into several sub-operations triggered by multiple interacting factors (here, word-minimality, prosodic constituency, and *LHH tonotactics).

Keywords: clitics; tone; spreading; word minimality; prosodic constituency

1 Introduction

How do we model and ultimately explain the cross-linguistic propensity for tones to spread? Such a question continues to shape tonological research, resulting in a range of theoretical innovations seeking to capture some guiding intuition. These include spreading due to a requirement that all vowels bear tone or due to a requirement to align tone with a specific prosodic edge (via SPECIFY-TONE and ALIGN-TONE, respectively, Yip 2002), or spreading as due to a requirement that local segments phonologically ‘agree’ in some fundamental way (e.g. SHARE-TONE, McCarthy 2011; Agreement By Correspondence, Shih & Inkelas 2018). In the languages which have spawned this research, generally tone spreading is central to the phonological grammar, whose effects are pervasive and cannot be overlooked. In this paper, however, we examine a case of tone spreading which is the exception rather than the norm in the language: it is triggered by three and only three morphemes.

Specifically, we examine a process we refer to as ‘low tone spread’ in Kalabari, a member of the Ijoid language family of southern Nigeria. While other aspects of this language’s tonology have been established (Jenewari 1977; Harry 2003, 2004; Harry & Hyman 2014), low tone spread has not hitherto been investigated.

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An example of low tone spread is provided in (1a), which shows that the low tone of the pronominal clitic à ‘I’ in subject position spreads to both the following object and verb, and in this way is unbounded (i.e. it is not per se bounded to a particular number of vowels). In contrast, the superficially similar pronominal clitic àrì ‘I’ (appearing before vowel-initial words) does not trigger tone spread, in (1b).

(1) Unbounded low tone spread in Kalabari

a. **à** féní sélé tẹ́ḗ [à fèní sèlẹ̀ tẹ́ḗ] (cf. *[à féní sélé tẹ́ḗ])
 I bird choose PERF ‘I have chosen a bird’

b. **àrì** ígbé sélé tẹ́ḗ [àrì ígbé sélé tẹ́ḗ] (cf. *[àrì ígbè sèlẹ̀ tẹ́ḗ])
 I box choose PERF ‘I have chosen a box’

In this paper, we ask (i) what precisely defines the triggers of low tone spread, (ii) what are its targets, (iii) what is the domain within which spread operates, and finally (iv) why does it happen in the first place?

Starting from these questions, we present three major empirical findings. First, we establish that the only triggers of low tone spread are three pronominal clitics: à ‘I’, ò ‘he’, and ò ‘they’. These form a phonologically natural class in that they are all low-toned, monosyllabic, and onsetless, and we refer to them as ‘ \check{V} -clitics’ in what follows. No other comparable morphemes fit this exact phonological profile. Second, the target of low tone spread is always a contiguous string of high tones to the right of the triggering \check{V} -clitic. Tone spread exhibits two surface patterns. In one, low tone spreads to all but the final high tone in the string (i.e. $\check{V} \acute{V} \dots \acute{V} \acute{V} \rightarrow \check{V} \acute{V} \dots \check{V} \acute{V}$). We refer to this informally as ‘H-compression’. In another, low tone spreads to all high tones (i.e. $\check{V} \acute{V} \dots \acute{V} \acute{V} \rightarrow \check{V} \check{V} \dots \check{V} \check{V}$), and is only found before a domain-external high tone. We refer to this informally as ‘H-absorption’. Importantly, any intervening low tone (or downstepped high) blocks spreading up to that point (i.e. $\check{V} \acute{V} \acute{V} \check{V} \acute{V} \rightarrow \check{V} \check{V} \acute{V} \check{V} \acute{V}$; cf. $*\check{V} \check{V} \check{V} \check{V} \acute{V}$). The third major empirical finding is that while low tone can spread across multiple words (as in 1a), it is constrained by underlying syntactic structure. Modifiers plus their nouns (NPs) and NPs plus their verbs (VPs) form single domains for spread, but other similar structures do not, e.g. nouns plus determiners/quantifiers, verbs in series, or verbs plus inflectional particles, auxiliaries, or clause-final markers.

Based on these empirical findings, we develop an analysis for low tone spread based on the interaction of three factors: word minimality, prosodic constituency, and tonotactics. Firstly, the three properties which define the triggers of low tone spread—low tone, monosyllabicity, and onsetlessness—all characterize prosodic weakness cross-linguistically. In Kalabari, when all three factors are present they prevent the morpheme from being an independent phonological word (ω); such words would be sub-minimal. Thus while pronouns like bisyllabic àrì ‘I’ form separate phonological words, e.g. (àrì) ω (ígbé) ω ... from (1b), \check{V} -clitics do not, e.g. à (féní) ω ... from (1a). Further, we posit that Kalabari has a constraint which requires that all tones be associated to a vowel within a phonological word. This results in the low tone of a \check{V} -clitic having to associate to the word to the right, what we refer to as ‘tonal incorporation’. Of note is that while the tone incorporates into the following ω -word, its counterpart segments remain unincorporated, showing a lack of complete isomorphy between prosodic constituents on separate phonological tiers.

These components of our analysis account for why low tone spread is initiated, but do not account for its unbounded nature within its domain, nor what precisely that domain is. To this end, we posit that the domain for low tone spread is the phonological phrase, ϕ , and that the unbounded spreading is a response to the general markedness in the language of a low-toned vowel followed by two high-toned vowels, what we call the ‘*LHH’ constraint. We present independent evidence for phonological phrases from replacive grammatical tone, which precisely match the domain for low tone spread (what we call ‘prosodic domain matching’). Low tone can target high tones within the same ϕ -phrase, but cannot extend past a ϕ -boundary.

Moreover, when \check{V} -clitics are tonally incorporated this may result in novel LHH sequences. The final component of our analysis centers this fact as the ultimate cause of the unbounded nature of low tone spread: LHH sequences are marked and avoided in Kalabari. They are categorically banned within the phonological

ω -word, and are rare within a phonological phrase due to a conspiracy of factors. When they do arise, they are (optionally) subject to repair via downstep insertion or other lowering operations, which are not available in non-LHH contexts. Spreading the tone of \check{V} -clitics circumvents any *LHH violations.

We diagram our analysis in Figure 1, using the data from (1). This shows that the \check{V} -clitic \grave{a} spreads its low tone to the following word (i.e. tonal incorporation, shown by the dotted association line), followed by unbounded spread of this low tone to the end of the ϕ -phrase in response to *LHH (the association lines with alternating dots and dashes). We contrast this with the clitic $\grave{a}r\grave{i}$ which does not trigger tone spread.

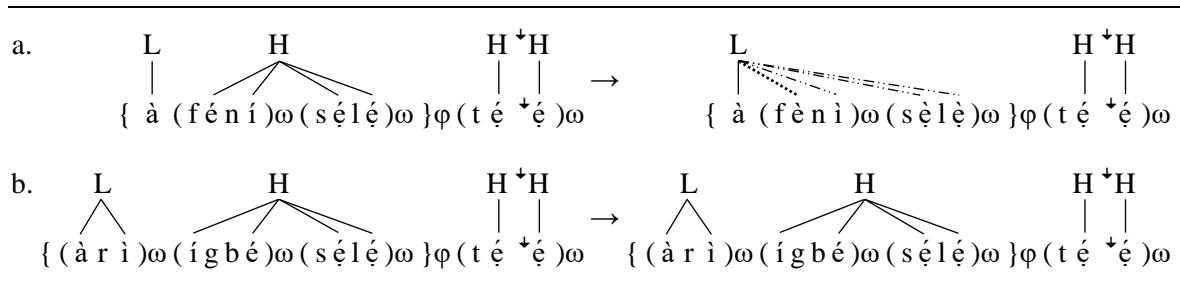


Figure 1: Trigger vs. non-trigger of low tone spread

We end our paper with an observation about examples like Figure 1b: although clitics like $\grave{a}r\grave{i}$ are independent words and therefore do not need to be ‘tonally incorporated’, by virtue of them forming a phrase with the following verb phrase they too create new violations of *LHH. Why does this not also trigger low tone spread? It appears that unbounded low tone spread is parasitic on the application of tonal incorporation, which only happens with prosodically deficient \check{V} -clitics. In this way, low tone spread resembles a phonologically derived environment effect, whereby the application of a rule exists “only by virtue of the application of another phonological alternation” (Inkelas 2014:242). In short, phonologically derived environments are subject to unbounded spread to avoid a phrase-level *LHH violation (Figure 1a), but non-phonologically derived environments are not and must instead tolerate this violation (Figure 1b).

This paper is organized as follows. §2 provides background information on the Kalabari language and tone system. §3 begins our comprehensive description of low tone spread, including its triggers, targets, domain of application, and how low tone spread differs from other tonal processes in the language. §4 lays out our analysis involving tonal incorporation and defends our thesis that low tone spread derives from a *LHH constraint. §5 provides a conclusion.

2 Kalabari language

Kalabari (also known as Kalabari-Ijo or simply Kalabari; IPA [kálá⁺ḃárí]; ISO code 639-3: [ijn]) is an Ijoid language of the far south of Nigeria within the Niger Delta area, with perhaps 500,000 speakers (Eberhard, Simons, & Fennig 2023).¹ Kalabari is a regionally important language, though the consistent influx of Nigerian Pidgin and English render the language endangered. It is bordered by other Ijoid languages to its west (numerous Izon dialects [ijc], including Nembe/Akassa [ijs]) and to its east (Kirike [okr]), as well as bordering many non-Ijoid languages to its north from three different branches of Benue-Congo (Igboid, Cross River, and Edoid). The data for this paper is based around the speech and intuitions of the second author, a speaker of the Buguma dialect (also called Asari). Where we supplement this with data from the Kalabari literature, we note this explicitly. For a review of Kalabari linguistic literature, see Harry (2004).

¹Similar figures are found on the Joshua Project webpage (https://joshuaproject.net/people_groups/12441/NI). In decades past, previous estimates put the speaker population at approximately 250,000 speakers (Jenewari 1989:108).

2.1 Typological profile

In our transcriptions, we follow Kalabari orthographic practices. All consonants are equivalent to their IPA value except the following: =/b/, <d>=/d/, <j>=/dz/, and <y>=/j/. The language exhibits tongue root vowel harmony, where non-advanced vowels ([-ATR], a.k.a. retracted tongue root) are written with a dot, i.e. <ì ẹ ọ ù>. The sole low vowel /a/ may appear with either set, and can be classified as neutral for our purposes (see Akinlabi 1997 for discussion). Nasal vowels are written as an orthographic <n> after the vowel, e.g. bín ‘full’ is IPA /bĩ/. Syllabic nasals in Kalabari are marked with tone in this work, which will distinguish them from their non-syllabic counterparts. Long vowels will be treated as a sequence of two adjacent vowels and transcribed as such; these vowels are often the result of tone-conditioned lengthening. Morphemes may begin with either a consonant or a vowel, but codas are prohibited.

Kalabari word order is strongly head-final, which makes it noticeably distinct from the non-Ijoid languages in the area (and indeed Niger-Congo generally, the phylum within which it is traditionally placed). Clause-level word order is [Subject Adverbial Object Verb INFL], where INFL stands for a set of inflectional particles encoding tense, aspect, mood, and polarity. Within the noun phrase, modifiers generally precede the noun (e.g. possessors, modifying nouns, adjectives, numerals, and demonstratives). However, quantifiers and determiners follow the noun. In adpositional phrases, the noun precedes the postposition. These orders are in line with canonical head-final syntax (Dryer 2007:52) and will become important when we examine the domain of low tone spread (§3-4).

2.2 Tone system

Kalabari has a basic contrast between low (L) and high (H) tone. Downstepped high tones (i.e. ⁺H) also occur in some underlying and derived contexts, discussed separately in §2.4. All lexical morphemes and most functional morphemes are fully specified for tone on all tone-bearing units. There is evidence for floating tones conditioned by certain morphemes and morphological constructions. We denote floating tones with a circle (following Yip 2002), e.g. a floating low tone as ⊙.

Table 1 shows a representative sample of tonal patterns with monosyllabic and bisyllabic lexical items (i.e. nouns and verbs). Contour tones are only allowed on long vowels or diphthongs (e.g. pùá ‘split, divorce’, Harry 2004:23), which we interpreted as adjacent level tones. We return to possible and impossible lexical tone patterns in §4.5.

Table 1: Sample of lexical tone contrasts on nouns and verbs

	Tone pattern	Example nouns	Example verbs
a.	L	sò ‘sky’	sò ‘cook’
	H	sẹ ‘nation’	só ‘go’
b.	LL	pùlò ‘oil’	lẹ̀gì ‘sit down’
	LH	gàrí ‘garri flour’	ḍùkó ‘tell, talk’
	HL	bélè ‘light’	bámà ‘punish’
	HH	námá ‘meat’	óló ‘cough’
	H ⁺ H	bá ⁺ rá ‘hand’	ò ⁺ lò ‘hold’

2.3 Tonal processes

Lexical tone patterns are manipulated by three main tonal processes, all of which are morphologically conditioned in some way. The first is the most basic, which we refer to as ‘concatenative grammatical tone’. As the name suggests, in this type a tone or sequence of tones is simply added (i.e. concatenated) to the edge of an independent word. For example, the imperative/subjunctive is expressed by a floating ⊙⊙ sequence which is concatenated to the right edge of the verb (Table 2).

Table 2: Concatenative grammatical tone—imperative as floating $\textcircled{\text{H}}\textcircled{\text{L}}$ sequence

	Lexical tone	Verb		Surface	Imperative form
a.	L	sò	→	LHL	sòòò
	H	só	→	HL	sòò
b.	LL	lègì	→	LHL	lègìì
	LH	dùkó	→	LHL	dùkòò
	HL	bámà	→	H ⁺ HL	bá ⁺ máà
	HH	óló	→	HHL	ólòò
	H ⁺ H	ó ⁺ ló	→	H ⁺ HL	ó ⁺ lòò

Concatenative grammatical tone never replaces the underlying lexical tones of the verb. For example, the low-toned verb sò ‘cook’ is realized as a complex contour [sòòò] ‘cook!’ on a super-long vowel, a tonal pattern never found in monomorphemic contexts. The fact that low-toned lègì ‘sit down’ becomes [lègìì] rather than *[lègììì] provides evidence that there is only one lexical L tone spread over two vowels. Relatedly, the fact that high-toned verbs, such as só ‘go’, are realized as [sòò] ‘go!’ suggests that the lexical and grammatical high tones fuse.

Concatenative grammatical tone may also occur with post-verbal inflectional particles that have overt segmental structure, such as future tense and factative tense/aspect (for our purposes, ‘factative’ can be interpreted as akin to perfective/completive aspect). Two examples are shown in (2) with low-toned $\textcircled{\text{H}}\textcircled{\text{bà}}$ future (FUT) and downstepped $\textcircled{\text{H}}\textcircled{\text{m}}$ factative (FAC). The words which precede the particles otherwise have all low tones, but in this context surface with a final high.

(2) Concatenative grammatical tone with overt post-verbal inflectional particles

- a. námá sì $\textcircled{\text{H}}\textcircled{\text{bà}}$ → [námá síì bà]
 animal be.bad FUT ‘the animal will become bad’ (Harry & Hyman 2014:658)
- b. òrì ìbì $\textcircled{\text{H}}\textcircled{\text{m}}$ → [òrì ìbì⁺ m]
 he be.good FAC ‘he is a good-natured person’ (Jenewari 1977:470)

The second type of tonal process is ‘replacive grammatical tone’, which is triggered in the context of certain morphemes and/or morphological constructions. The main patterns of replacive grammatical tone are established in Harry (2004) and Harry & Hyman (2014) and are most commonly found in noun phrases. In general, pre-nominal modifiers assign a grammatical tone which neutralizes the lexical tone of the noun and replaces it with one of four tone patterns: HL, HLH, LH, or L. These four patterns are illustrated in Table 3, with a possession-compound construction involving a possessor túbò ‘a child’s __’, a possessive pronoun ìnà ‘their’, and two other pre-nominal modifiers tò ‘which’ and já ‘some’. The replacive grammatical tone is indicated with the \Rightarrow arrow to distinguish it from concatenative tone. Modifiers tend to pattern as a single class, e.g. all possessive pronouns assign a replacive \Rightarrow HLH sequence, which surfaces as [H⁺H] or [HLH] depending on target length.

Table 3: Replacive grammatical tone completely neutralizing lexical tone (Harry & Hyman 2014:232)

Lexical tone	túbò ‘the child’s __’ (\Rightarrow HL)	ìnà ‘their __’ (\Rightarrow HLH)	tò ‘which __’ (\Rightarrow LH)	jà ‘some __’ (\Rightarrow L)
LL pùlò ‘oil’	túbò pùlò	ìnà pú ⁺ lò	tò pùlò	jà pùlò
LH gàrì ‘garri flour’	túbò gàrì	ìnà gá ⁺ rì	tò gàrì	jà gàrì
HL bélé ‘light’	túbò bélé	ìnà bé ⁺ lé	tò bélé	jà bélé
HH námá ‘meat’	túbò námà	ìnà ná ⁺ má	tò námá	jà námà
H ⁺ H bá ⁺ rá ‘hand’	túbò bàrà	ìnà bà ⁺ rá	tò bàrà	jà bàrà

Replacive grammatical tone is also seen in simple [Object Verb] phrases. Unlike with noun phrases, in [Object Verb] phrases the lexical tone of the verb is deleted but no dedicated tonal pattern replaces it. Instead, the final tone of the object spreads onto the verb. Examples are in Table 4, showing the object’s tone spreading to the verb, thereby neutralizing the lexical tone distinction between low-toned *sèlè* ‘choose’ and high-toned *èrì* ‘see’.

Table 4: Replacive grammatical tone in [Object Verb] phrases

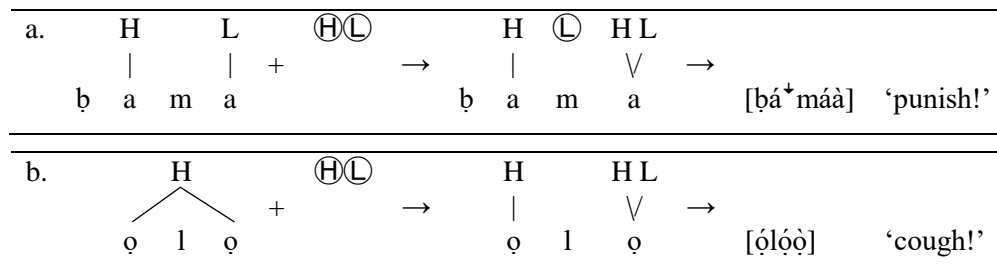
Verb\Object /L/ <i>sèlè</i>	‘choose’	/H/ <i>èrì</i>	‘see’
a. /LL/	à bìtè sèlè tèt ⁺ é ‘I have chosen cloth’	féní pùlò èrì tèt ⁺ é ‘the bird has seen the oil’	
b. /HL/	à sírì sèlè tèt ⁺ é ‘I have chosen a leopard’	ò bélè èrì tèt ⁺ é ‘he has seen the light’	
c. /HH/	àrì ígbé sèlè tèt ⁺ é ‘I have chosen a box’	á námá èrì tèt ⁺ é ‘she has seen the meat’	
d. /LH/	ò gàrì sèlè tèt ⁺ é ‘he has chosen <i>garri</i> flour’	ò gàrì èrì tèt ⁺ é ‘he has seen the <i>garri</i> flour’	
e. /H ⁺ H/	à wá rì sèlè tèt ⁺ é ‘I have chosen a house’	à wá rì èrì tèt ⁺ é ‘I have seen the house’	

Unlike concatenative and replacive grammatical tone, the third and final tonal process has not yet been studied in the Kalabari literature, namely the aforementioned ‘low tone spread’. This is described in §3.

2.4 Downstepped high tones

Before turning to low tone spread, the final piece of crucial background information involves downstepped high tones, hereafter simply called ‘downstep’. The appearance of downstep can be divided into three contexts: underlying downstep, word-level derived downstep, and derived downstep above the word.

The first type was shown in Table 1 above, where downstep is part of the underlying representation of a word (e.g. *bá⁺rá* ‘hand’), creating a three-way contrast between HL, HH, and H⁺H. Let us illustrate the next two, where downstep is derived in certain environments. One such environment happens within words, e.g. when a low tone becomes delinked between two high tones or is never linked in the first place. We have seen this already in Table 2, when the concatenative $\textcircled{\text{H}}\textcircled{\text{L}}$ tones dock to a /HL/ verb root (e.g. *bámà* ‘punish’). The result is a $[\text{H}^+\text{HL}]$ pattern, where the lexical L tone has now become a downstep. This is shown in Figure 2 below, where the derived floating $\textcircled{\text{L}}$ corresponds to downstep in the output (example a). We compare this to the behavior of /H/-toned roots where no downstep occurs (Figure 2b).

Figure 2: Derived downstep from a derived floating $\textcircled{\text{L}}$

A similar alternation between a low tone and a downstep can be seen in replacive grammatical tone patterns from Table 3 above, where the replacive floating tone sequence $\Rightarrow\text{HLH}$ associated with possessive pronouns surfaces as either $[\text{H}^+\text{H}]$ or $[\text{HLH}]$ depending on the length of the target. Tying together lexical downstep and word-level derived downstep, Harry (2004:22–23) explicitly analyzes H⁺H patterns as underlying /H $\textcircled{\text{L}}$ H/.

Finally, downstep derived above the word takes place when a word ends in a LH pattern and precedes another word which begins with H, i.e. ...LH#H... → [...LH#⁺H]. Examples are in (3), where a downstep is inserted between the LH and H words (other examples were seen as well already, in Table 4d above).

- (3) Derived downstep above the word level: LH#H → LH#⁺H
- | | | | | | | | |
|----|--------------|------------|-------------|-------------------|------|---|--------------------------------------|
| a. | òdòdó | fún | sélé | té ⁺ é | → | [òdòdó ⁺ fún sélé té ⁺ é] | |
| | snake | salt | choose | PERF | | ‘the snake has chosen salt’ | |
| b. | ḃìlà | má | ḃìsẹ | sáḃá | árí | → | [ḃìlà má ḃìsẹ ⁺ sáḃá árí] |
| | elephant | the.PL | sneeze | cross | CONT | ‘the elephants are sneezing over’ | |

We shall see instances of this type of derived downstep in the examples throughout this paper, and it consistently applies if the environment is met. Note, however, that such derived downsteps are rarely indicated in the Kalabari linguistic literature, and as such will not be reflected when we cite data taken from this literature. In §4.5 below we tie such derived downsteps to a general prohibition against LHH patterns in Kalabari (and the Ijoid family in general).²

3 Low tone spread (LTS)

3.1 What are the triggers?

Low tone spread (LTS) is triggered by only one class of morphemes: low-toned, vowel-initial, monosyllabic pronominal clitics. Let us first establish the paradigm of pronominal clitics. When pronominal clitics are used as the structural subject, they have two forms: one used before consonants and one used before vowels. This allomorphy is shown in (4) where the clitic expressing third singular masculine ‘he’ is ò before consonants but òrì before vowels (note an independent process of vowel harmony in these examples—see §4.3 below). This happens regardless of whether the following word is a verb, object, adverbial, *etc.*

- (4) Pronominal clitic allomorphy based on C/V-initiality (Jenewari 1977)
- | | | | |
|----|---|------------------------|----------|
| a. | ò ḃó bà | ‘he will come’ | (p. 312) |
| | ò mìnìní bà | ‘he will agree’ | (p. 132) |
| | ò wámìnà ẹrì bà | ‘he will see us’ | (p. 263) |
| | ò páà ẹkúẹn árí | ‘he is still talking’ | (p. 540) |
| | ò kpómà á ẹlẹmá ⁺ m | ‘he really loves her’ | (p. 156) |
| b. | òrì ìgàní bà | ‘he will get annoyed’ | (p. 132) |
| | òrì ì kún bà | ‘he will catch me’ | (p. 261) |
| | òrì ìfókò mù té ⁺ é | ‘he has gone to Ifoko’ | (p. 158) |
| | òrì árú kẹ bó ⁺ m | ‘he came by boat’ | (p. 158) |
| | òrì ìḃìòkú ànì yé ⁺ m | ‘he did it well’ | (p. 156) |

A complete paradigm of pronominal clitic allomorphs is in Table 5. While there are clearly similarities between the pre-C and pre-V allomorphs, there are no regular phonological rules which can derive one form from the other and we therefore treat them as suppletion. The only clitic not exhibiting allomorphy is ‘we’ which is uniformly wá in both contexts. This is also the only clitic which begins with an onset (n ‘they’ is a syllabic nasal, bearing tone).

²For the rule LH#H → LH#⁺H to apply, the LH sequence must specifically be contained within a single word, and the H#H sequence must be across words. No downstep is inserted if the tones are each associated to a separate word as in (i) below, nor is downstep ever inserted within a word in a L#HH sequence as in (ii).

- | | | | | | | | | |
|------|-----|----------|-------------------|-----|-------------------|---|---------------------------------|--|
| (i) | ò | tà | fún | fẹ | té ⁺ é | → | [ò tà fún fẹ té ⁺ é] | (cf. *[ò tà fún ⁺ fẹ té ⁺ é]) |
| | his | wife | salt | buy | PERF | | ‘his wife has bought salt’ | |
| (ii) | sò | kánákáná | té ⁺ é | | | → | [sò kánákáná té ⁺ é] | (cf. *[sò ká ⁺ nákáná té ⁺ é]) |
| | sky | dark | PERF | | | | ‘the sky is dark’ | |

- (7) Bisyllabic low-toned pronominal clitics never trigger LTS
- a. àrì ìyẹ́ ẹ́rì ʘ⁺m → [àrì ìyẹ́ ẹ́rì ⁺m] Cf. *[àrì ìyẹ́ ...]
I you see FAC 'I saw you (SG)' (Jenewari 1977:268)
- b. òrì íkírì mà ẹ́ ọ́ ọ́rì → [òrì íkírì mà ẹ́ ọ́ ọ́rì] Cf. *[òrì íkírì ...]
he creep MAN come CONT 'he comes creeping' (Jenewari 1977:406)
- c. ìnì ówú ʘbà → [ìnì ówú bà] Cf. *[ìnì òwú ...]
they cry FUT 'they will cry/weep' (Jenewari 1977:260)

Other comparable monosyllabic contexts also do not trigger LTS, or any process like it. For example, LTS is not triggered by low-toned monosyllabic lexical items such as sò 'sky, heaven, destiny' (8), nor is it triggered by functional particles such as mà 'not yet' (9).

- (8) No LTS from low monosyllabic lexical items
- a. sò kánákáná tẹ́⁺ẹ́ Cf. *[sò kà~~n~~àkà~~n~~à tẹ́⁺ẹ́]
sky dark PERF 'the sky is dark' (Blench 2008:195)
- b. sò ẹ́lápù tẹ́⁺ẹ́ Cf. *[sò ẹ́lápù tẹ́⁺ẹ́]
sky twinkle PERF 'heaven displays a sudden flash of fire' (Blench 2008:320)
- (9) No LTS from low monosyllabic functional particles
- a. mà wá mú á⁺á Cf. *[mà wá mù á⁺á]
not.yet we go NEG 'we are not going (there) yet' (Jenewari 1977:539)
- b. mà á ẹ́ ọ́ Cf. *[mà à ẹ́ ọ́]
not.yet she come NEG.Q 'hasn't she come yet?'
- c. tùbọ mà ẹ́kí á Cf. [... mà ẹ́kí á]
who not.yet fall NEG.Q 'who has not yet fallen?'

Equally, there is no equivalent 'high tone spread' triggered by high-toned monosyllabic pronominal clitics, e.g. á 'she' in (10).

- (10) No comparable process of 'high tone spread'
- a. á fìnì pòkú ⁺kpó tẹ́⁺ẹ́ Cf. *[á fìnì ...]
she fire heap tie PERF 'she has tied the bundle'
- b. á màngì wérì ọ́rì Cf. *[á màngì ...]
she run keep CONT 'she has run away (and is still not back)'

An exhaustive search of the Kalabari dictionary (Blench 2008) reveals that the only other words of the shape /V/ are pronominal clitics ì 'my' and ọ́ 'his' used in possessive contexts. However, because pronominal possessives as a class assign a HLH replacive grammatical tone to the noun (Table 3), the prerequisite tonal environment needed for LTS is not met (to be made precise momentarily).⁴

⁴There does exist one prefix of the shape /V-, namely the plural maker a- which attaches to plural nouns. Examples are in (iii)-(iv), where an effect akin to LTS may be observed on high-toned nouns fùkùrù 'hole' and túbóniápù 'traders'.

(iii) ọ̀pù a-fùkùrù → [ọ̀pù à-fùkùrù]~[ọ̀pù à-fùkùrù] 'big holes'
(iv) ìbì a-túbóniápù → [ìbì à-túbòniápù]~[ìbì à-túbòniápù] 'good traders'

However, several factors conspire to undermine a clear analysis of these data. First, the plural marker a- always takes the tone of the previous word, e.g. low in (iii)-(iv) versus high in [sìn á-bàrá] 'branches of trees' with sìn 'tree' (Blench 2008:1). Therefore we must attribute the low tone in these examples to the pre-nominal modifier (i.e. ọ̀pù 'big, important' and ìbì 'good'), and not to

3.2 What is the target?

With regard to the target, LTS targets a contiguous string of high-toned vowels after the trigger. There are two surface patterns: one where all high tones become low in the relevant string (i.e. $\acute{V}\acute{V}\acute{V} \rightarrow \grave{V}\grave{V}\grave{V}$), and one where all high tones but the last become low (i.e. $\acute{V}\acute{V}\acute{V} \rightarrow \grave{V}\acute{V}\acute{V}$). We shall revise our formulation of LTS as we further scrutinize the data, but this is a sufficient characterization at this juncture. To illustrate, consider the data in (11) involving \grave{V} -clitics before verbs of one to four syllables. In each of these, low tone can spread unboundedly to the end of the verb (that is, it is not bound to spreading to only one vowel).

- (11) LTS targeting contiguous strings of high tones
- a. 1 σ : \grave{o} bó tẹ́⁺é → [ò bò tẹ́⁺é]
 he come PERF ‘he has come’ (Jenewari 1977:144)
- b. 2 σ : \grave{o} bíkí tẹ́⁺é → [ò bíkí tẹ́⁺é]
 he fall PERF ‘he has fallen’
- c. 3 σ : à pábùrù tẹ́⁺é → [à pábùrù tẹ́⁺é]~[à pábùrù ⁺tẹ́⁺é]
 I stammer PERF ‘I have stammered’
- d. 4 σ : à fékékéké tẹ́⁺é → [à fèkèfèkè tẹ́⁺é]~[à fèkèfèké ⁺tẹ́⁺é]
 I be.light PERF ‘I have become light (in weight)’

Notice the two alternative pronunciations in (11c–d). The all-low pronunciation is most natural, while the one where one high remains is possible but with a meaning difference related to emphasis. As stated in §3.1, each of these utterances may alternatively be pronounced with its lexical all-high pattern without low tone spread. This is the least natural pronunciation but still grammatical. Note as well the derived downstep in (11c) and (11d), due to the fact that a new LH#H environment was created across the word boundary (§2.4; see §4.5 below as well).

To characterize the variation in the two pronunciations with LTS, we deconstruct spread into two components: ‘H-compression’ and ‘H-absorption’. The first of these processes is H-compression, schematized in Figure 3. This is presented in an autosegmental representation (Goldsmith 1990), where the parentheses indicate the LTS domain (to be formalized in §4). H-compression captures the pattern where a low spreads to all but the last high-toned vowel of the domain, i.e. the string of high tones is compressed to the rightmost position. This results in patterns like /à pábùrù tẹ́⁺é/ → [à pábùrù ⁺tẹ́⁺é] (again, ignoring derived downstep for the moment).



Figure 3: Schema of H-compression

Figure 4 schematizes the other operation, H-absorption. Here, there is no trace of the target H, i.e. it is ‘absorbed’ by the following domain-external H. This results in the alternative (and most natural) pronunciation

an underlying value of a-. Further, pre-nominal modifiers like òpù themselves trigger a type of optional low tone operation, e.g. lexically high búrú má ‘indigo’ variably becoming all low in /òpù búrú má/ → [òpù búrú má]~[òpù búrú má] ‘big indigo’ (Harry & Hyman 2014:658). It is therefore difficult to specifically attribute the changes in (iii–iv) to a- itself or the pre-modifier. We return to the tone properties of the modifier òpù in §4.5.

Secondly, Jenewari (1977:211) states that the plural prefix a- never appears in phrase initial position and is always preceded by a modifier. This prevents us from testing whether it unambiguously triggers LTS itself.

[à pàbùrù tẹ́⁺é].



Figure 4: Schema of H-absorption

A set of all logically possible spreading patterns is in Table 6, using /à fèkèfèké tẹ́⁺é/ ‘I have become light’ from (11d). In Table 6a LTS does not apply, which as we have said is possible but is least natural and not preferred. More natural are pronunciations with both H-compression and H-absorption (Table 6e), or the less natural but still acceptable pronunciation with only H-compression (Table 6d). Other pronunciations are ungrammatical where LTS does not apply to the immediate high tones in the string (Table 6b–c).

Table 6: Possible patterns with LTS

	/à fèkèfèké tẹ́ ⁺ é/	LTS:	H-compression	H-absorption
a.	ok (least natural) [à fèkèfèké tẹ́ ⁺ é]	No	-	-
b.	* [à fèkèfèké tẹ́ ⁺ é]	Yes	No	No
c.	* [à fèkèfèké tẹ́ ⁺ é]	Yes	No	No
d.	ok (less natural) [à fèkèfèké tẹ́ ⁺ é]	Yes	Yes	No
e.	ok (most natural) [à fèkèfèké tẹ́ ⁺ é]	Yes	Yes	Yes

Moreover, multi-word units are also targeted by LTS, as long as they form a contiguous string of high-toned vowels. Representative examples are in (12). Such multi-word targets display the same patterns as single-word targets with respect to H-compression and H-absorption.

(12) Multi-word targets and LTS

a.	ò	jén	bó	á ⁺ á		→	[ò jèn bò á ⁺ á]	
	he	again	come	NEG			‘he didn’t come again’	
b.	ò	yé	tólúmá	sí ⁺ mé	Ⓜ ⁺ m	→	[ò yè tólùmá sí ⁺ mé m̄]	
	he	thing	teach	used.to	FAC		‘he used to teach’ (but no longer)	
c.	ò	tírà	sákí	kè	dèrì	Ⓜ ⁺ m	→	[ò tìrà sàkí kè dèrì m̄]
	he	three	time	P	laugh	FAC	‘he laughed three times’	
d.	ò	hùrúmá	sèlè	tẹ́ ⁺ é		→	[ò hùrùmá sèlè tẹ́ ⁺ é]	
	he	indigo	choose	PERF			‘he has chosen indigo’	
e.	ñ	jùmójùmò	đúkà	bó	ⓂⓁ	→	[ñ jùmòjùmò ðùkà bóò]	
	they	each.other	follow	come	SBJV		‘they should follow each other’	
f.	ñ	dùéjìn	dìbì	pírì	éřì	tẹ́ ⁺ é	→	[ñ dùéjìn dìbì pìrì éřì tẹ́ ⁺ é]
	they	corpse	bury	ground	see	PERF	‘they have seen a cemetery’	
g.	à	jén	fénì	fẹ	tẹ́ ⁺ é	→	[à jèn fèni fẹ tẹ́ ⁺ é]	
	I	another	bird	buy	PERF		‘I have bought another bird’	
h.	ò	númè	súsú	tẹ	sékí	áři	→	[ò nùmè sùsù tẹ sékí áři]
	he	song	sing.REDUP	and	dance	CONT	‘he is alternatively singing and dancing’	

The multi-word targets in (12) show a large range of syllable counts (1–4σ words) and phrase types, such as noun compounds and other complex noun and verb phrases. Notice, however, that not all contiguous

(17) High-toned words not undergoing LTS

ò nùmé súsú tẹ sẹkí ári → (ò nùmè sùsù tẹ) sẹkí ári
 he song sing.REDUP and dance CONT ‘he is alternatively singing and dancing’
 Cf. *(ò nùmè sùsù tẹ sẹkí) ári

In this section, we catalogue the various contexts which act as a single domain for LTS and those which do not, specifically tying it to phrase and clause structure.

One LTS domain involves nouns plus any pre-nominal modifiers, which we shall refer to simply as the noun phrase (NP) for our purposes. Example (18) shows low tone spreading across multiple words within an NP, such as in possession-compound constructions *dùjẹ́n dǐbí pírí* ‘cemetery’ (18a) or *féní mínjí kùkù* ‘bird’s water pot’ (18c), or in a quantified nominal construction (*tírà sákí* ‘three times’, 18d). In each of these examples, the NP constituent is indicated in the input (in square brackets) which corresponds to a LTS domain in the output (in parentheses).

(18) NP as a single domain for LTS

a.	ò	[dùjẹ́n dǐbí pírí]NP	᠄	éří	tẹ ⁺ é	→	(ò dùjẹ́n dǐbí pírí) ⁺ éří tẹ ⁺ é
	they	corpse bury ground	D	see	PERF		‘they have seen a cemetery’
b.	à	[námá kálíyè]NP	fẹ	tẹ ⁺ é		→	(à námá kálíyè) fẹ tẹ ⁺ é
	I	animal small.thing buy	PERF				‘I have bought a small-ish animal’
c.	à	[féní mínjí kùkù]NP	fẹ	tẹ ⁺ é		→	(à féní mínjí kùkù) fẹ tẹ ⁺ é
	I	bird water pot buy	PERF				‘I have bought a bird’s water pot’
d.	ò	[tírà sákí]NP	kẹ	dẹří	᠄ ⁺ m	→	(ò tírà sákí) kẹ dẹří ⁺ m
	he	three time P laugh	P	laugh	FAC		‘he laughed three times’
e.	à	[bébé óbóngòrò]NP	fẹ	tẹ ⁺ é		→	(à bèbè óbóngòrò) fẹ tẹ ⁺ é
	I	whole turtle buy	PERF				‘I have bought a whole turtle’

The mapping of an NP to a single LTS domain holds regardless of the size or contents of the modifiers. For example, (19) shows pre-nominal relative clauses (RCs) of various complexity e.g. *yé tẹlẹmá bó* ‘blacksmith’ (19a; lit. thing-fix-person, ‘the person who fixes things’). As long as these consist of a contiguous string of high-toned vowels, both the relative clause and the noun will be targeted for LTS.

(19) NP with relative clauses forming a single domain for LTS

a.	ò	[[yé tẹlẹmá]RC bó]NP	᠄	éří	tẹ ⁺ é	→	(ò yé tẹlẹmá bó) ⁺ éří tẹ ⁺ é
	they	thing fix person	D	see	PERF		‘I have seen a blacksmith’
b.	à	[[mẹnjí tẹ]RC túbàrà]NP	bẹ	dọkí	tẹ ⁺ é	→	(à mẹnjí tẹ túbàrà) bẹ ⁺ dọkí tẹ ⁺ é
	I	walk PERF antelope the look.for	PERF				‘I have looked for the antelope that has walked’
c.	à	[[námá fùrú]RC óbóngòrò]NP	mẹ	dọkí	tẹ ⁺ é	→	(à námá fùrú óbóngòrò) mẹ ⁺ dọkí tẹ ⁺ é
	I	meat steal turtle the look.for	PERF				‘I have looked for the turtle that stole the meat’

Another domain which forms a single LTS domain are [Object Verb] constructions, which we refer to simply as verb phrases (VPs). Examples with unmodified nouns in object position are in (20). As above, the VP constituent is indicated in the input with square brackets, which corresponds to an LTS domain in the output in parentheses.

(20) VPs as a single domain for LTS

a.	ò	[bùrú má sẹlẹ]VP	tẹ ⁺ é		→	(ò bùrú má sẹlẹ) tẹ ⁺ é
	he	indigo choose	PERF			‘he has chosen indigo’
b.	ò	[yé tólú má]VP	sí ⁺ mé	᠄ ⁺ m	→	(ò yé tólú má) sí ⁺ mé ⁺ m
	he	thing teach used.to	FAC			‘he used to teach’ (but no longer)
c.	ò	[júmọjúmọ dúká]VP	bó	᠄᠌	→	(ò júmọjúmọ dúká) bó
	they	each.other follow come	SBJV			‘they should follow each other’

As expected, the VP forms a single domain with a complex NP as well if it is in object position, in (21).

(21) VPs with a complex NP forming a single domain for LTS

à [[jén fénì]NP fẹ]VP tẹ́ᵀᵀ → (à jèn fènì fẹ) tẹ́ᵀᵀ
 I another bird buy PERF ‘I have bought another bird’

The NP and the VP are the only major constituents which correspond to a single LTS domain. In contrast, most other types of contexts do *not* form a single domain. Let us go through these systematically. First, any modifiers which follow the noun are not part of the LTS domain, such as the determiners and quantifiers mé ‘the’, ré ‘instead’, íngéří ‘only’, ímgbà ‘all’, and the general determiner ʘ simply glossed D in (22).⁵ This is notated ‘Noun) D/Q’, where the parenthesis marks the boundary of the LTS domain.

(22) Outside of the LTS domain: Determiners and quantifiers—Noun) D/Q

- a. ọ́ nà má mé sẹ́lẹ́ tẹ́ᵀᵀ → (ọ́ nà má) mé sẹ́lẹ́ tẹ́ᵀᵀ (cf. *ọ́ nà má mé ...)
 he animal the choose PERF ‘he has chosen the meat’
- b. ọ́ ɗín mé ímgbà kẹ́ ànì yẹ́ ʘᵀᵀᵀ → (ọ́ ɗín) mé ímgbà kẹ́ ànì yẹ́ ᵀᵀᵀ (cf. *ọ́ ɗín mé ...)
 he night the all P it do FAC ‘he spent the whole night doing it’
- c. à nà má ré fẹ́ tẹ́ᵀᵀ → (à nà má) ré fẹ́ tẹ́ᵀᵀ
 I animal instead buy PERF ‘I have bought an animal instead’
- d. à nà má íngéří fẹ́ tẹ́ᵀᵀ → (à nà má) íngéří fẹ́ tẹ́ᵀᵀ
 I animal only buy PERF ‘I have bought only an animal (alone)’
- e. ọ́ ɓùrú má ʘ sẹ́lẹ́ tẹ́ᵀᵀ → (ọ́ ɓùrú má) sẹ́lẹ́ tẹ́ᵀᵀ
 he indigo D choose PERF ‘he has chosen the indigo’

Moreover, while [Object Verb] VPs form a single domain, any material which follows the verb does not. For example, in serial verb constructions only the first verb is subject to LTS, in (23). Other contexts which do not form a single domain include auxiliary verb constructions (i.e. Verb) AUX, in 24), post-verbal inflectional particles encoding tense, aspect, mood, and polarity (i.e. Verb) INFL, in 25), and verbs plus various clause-final markers (i.e. Verb) CFM, in 26).

(23) Outside of the LTS domain: Verbs in series—Verb) Verb

- a. ọ́ mẹńjì sá bá tẹ́ᵀᵀ → (ọ́ mẹńjì) sá bá tẹ́ᵀᵀ Cf. *(ọ́ mẹńjì sá bá) ...
 he walk cross PERF ‘he has stepped over’
- b. ọ́ gẹ́lẹ́ á nẹ́ngí ʘᵀᵀᵀ → (ọ́ gẹ́lẹ́) á nẹ́ngí ᵀᵀᵀ Cf. *(ọ́ gẹ́lẹ́ à nẹ́ngí) ...
 he tall her be.more.than FAC ‘he is taller than she is’ (Jenewari 1980:30)
- c. à ɓó yé fí ʘᵀᵀ → (à ɓó) yé fí ʘᵀᵀ Cf. *(à ɓó yé) ...
 I come thing eat FUT ‘I will come eat’
- d. ọ́ ɓó ɓó tẹ́ só á rì → (ọ́ ɓó ɓó tẹ́) só á rì
 he come.REDUP and leave CONT ‘he comes and goes from time to time’
 Cf. *(ọ́ ɓó ɓó tẹ́ sò) á rì (Jenewari 1980:146)

(24) Outside of the LTS domain: Auxiliary verbs—Verb) AUX

ọ́ ɓìkì wẹ́rì á rì → (ọ́ ɓìkì) wẹ́rì á rì Cf. *(ọ́ ɓìkì wẹ́rì) ...
 he fall keep CONT ‘he has fallen’ (and still on the ground)

⁵Although we can often identify the presence of this floating ʘ determiner, at this point its exact semantic contribution is not clear. In the examples we have, it corresponds to translations with both definite and indefinite meaning. Harry & Hyman (2014:673) simply call it the ‘final determiner tone’, and we gloss it consequently as DETERMINER (D).

- (25) Outside of the LTS domain: Inflectional particles—Verb) INFL
- a. $\text{\textcircled{0}} \text{ b\textsubscript{i}k\textsubscript{i}} \text{ t\textsubscript{e}}^{\text{+}\text{\textcircled{e}}}$ → $(\text{\textcircled{0}} \text{ b\textsubscript{i}k\textsubscript{i}}) \text{ t\textsubscript{e}}^{\text{+}\text{\textcircled{e}}}$ Cf. $*(\text{\textcircled{0}} \text{ b\textsubscript{i}k\textsubscript{i}} \text{ t\textsubscript{e}}^{\text{+}\text{\textcircled{e}}})$
 he fall PERF ‘he has fallen’
- b. $\text{\textcircled{0}} \text{ b\textsubscript{i}k\textsubscript{i}} \text{ \textcircled{H}}^{\text{+}\text{\textcircled{m}}}$ → $(\text{\textcircled{0}} \text{ b\textsubscript{i}k\textsubscript{i}}) \text{ \textcircled{H}}^{\text{+}\text{\textcircled{m}}}$ Cf. $*(\text{\textcircled{0}} \text{ b\textsubscript{i}k\textsubscript{i}} \text{ \textcircled{H}}^{\text{+}\text{\textcircled{m}}})$
 he fall FAC ‘he fell’
- c. $\text{\textcircled{a}} \text{ b\textsubscript{o}} \text{ \textcircled{a}}^{\text{+}\text{\textcircled{s}}}$ → $(\text{\textcircled{a}} \text{ b\textsubscript{o}}) \text{ \textcircled{a}}^{\text{+}\text{\textcircled{s}}}$ Cf. $*(\text{\textcircled{a}} \text{ b\textsubscript{o}} \text{ \textcircled{a}}^{\text{+}\text{\textcircled{s}}})$
 I come NEG even ‘even if I didn’t come...’
- (26) Outside of the LTS domain: Clause-final markers—Verb) CFM
- $\text{\textcircled{0}} \text{ b\textsubscript{o}} \text{ t\textsubscript{i}r\textsubscript{e}m\textsubscript{e}}, \text{ w\textsubscript{a}} \text{ s\textsubscript{o}} \text{ \textcircled{H}}^{\text{+}\text{\textcircled{m}}}$ → $(\text{\textcircled{0}} \text{ b\textsubscript{o}}) \text{ t\textsubscript{i}r\textsubscript{e}m\textsubscript{e}}, \dots$ Cf. $*(\text{\textcircled{0}} \text{ b\textsubscript{o}} \text{ t\textsubscript{i}r\textsubscript{e}m\textsubscript{e}}) \dots$
 he come before we leave FAC ‘he came before we left’

Finally, adverbials as a class form a separate LTS domain from the following verb phrase. As stated in (§2.1), adverbials appear between the subject and the verb phrase. Example (27) shows that low tone does not spread through the adverb to the following object or verb.

- (27) Adverbials forming a separate LTS domain
- a. $\text{\textcircled{0}} \text{ [kp\textsubscript{e}k\textsubscript{e}l\textsubscript{e}]ADV} \text{ b\textsubscript{o}} \text{ \textcircled{a}}^{\text{+}\text{\textcircled{a}}}$ → $(\text{\textcircled{0}} \text{ kp\textsubscript{e}k\textsubscript{e}l\textsubscript{e}}) \text{ b\textsubscript{o}} \text{ \textcircled{a}}^{\text{+}\text{\textcircled{a}}}$ Cf. $*(\text{\textcircled{0}} \text{ kp\textsubscript{e}k\textsubscript{e}l\textsubscript{e}} \text{ b\textsubscript{o}}) \dots$
 he in.time come NEG ‘he did not come in time’
- b. $\text{\textcircled{0}} \text{ [b\textsubscript{u}r\textsubscript{o}]ADV} \text{ K\textsubscript{a}l\textsubscript{a}b\textsubscript{a}r\textsubscript{i}} \text{ m\textsubscript{a}} \text{ b\textsubscript{e}l\textsubscript{e}m\textsubscript{a}} \text{ \textcircled{a}}^{\text{+}\text{\textcircled{a}}}$ → $(\text{\textcircled{0}} \text{ b\textsubscript{u}r\textsubscript{o}}) \text{ K\textsubscript{a}l\textsubscript{a}b\textsubscript{a}r\textsubscript{i}} \dots \sim (\text{\textcircled{0}} \text{ b\textsubscript{u}r\textsubscript{o}}) \text{ K\textsubscript{a}l\textsubscript{a}b\textsubscript{a}r\textsubscript{i}} \dots$
 he RHET Kalabari the love NEG
 ‘Does he not love the Kalabari people?! (surely he does!)’ [rhetorical question]
 Cf. $*(\text{\textcircled{0}} \text{ b\textsubscript{u}r\textsubscript{o}} \text{ K\textsubscript{a}l\textsubscript{a}b\textsubscript{a}r\textsubscript{i}}) \dots$

While this generalization holds for most adverbials, there are two adverbial contexts where results are mixed. The first is with multiplicative expressions involving a numeral followed by *sáki* ‘time’. These optionally form a single LTS domain with the following verb (28). We interpret this variation as reflecting two distinct underlying structures: one where the multiplicative is a true adverbial and thus in a separate LTS domain (28a), and another where it is the object and thus forming a joint domain with the verb (28b).

- (28) Domain variation with multiplicatives
- a. $\text{\textcircled{a}} \text{ [t\textsubscript{i}r\textsubscript{a}} \text{ s\textsubscript{a}k\textsubscript{i}]ADV} \text{ m\textsubscript{u}} \text{ t\textsubscript{e}}^{\text{+}\text{\textcircled{e}}}$ → $(\text{\textcircled{a}} \text{ t\textsubscript{i}r\textsubscript{a}} \text{ s\textsubscript{a}k\textsubscript{i}}) \text{ \textcircled{+}m\textsubscript{u}} \text{ t\textsubscript{e}}^{\text{+}\text{\textcircled{e}}}$
 I three time go PERF ‘I have gone three times’
- b. $\text{\textcircled{a}} \text{ [[t\textsubscript{i}r\textsubscript{a}} \text{ s\textsubscript{a}k\textsubscript{i}]OBJ} \text{ m\textsubscript{u}}]VP \text{ t\textsubscript{e}}^{\text{+}\text{\textcircled{e}}}$ → $(\text{\textcircled{a}} \text{ t\textsubscript{i}r\textsubscript{a}} \text{ s\textsubscript{a}k\textsubscript{i}} \text{ m\textsubscript{u}}) \text{ t\textsubscript{e}}^{\text{+}\text{\textcircled{e}}}$

The second exceptional adverbial context is with *jén*, which has two functions: in noun phrases it means ‘another, next’ (e.g. in 21 above), while in an adverbial function it means ‘again’, as in 29 below. Unlike other adverbials, the adverbial use of *jén* *does* form a single LTS domain with the following verb.

- (29) Adverbial *jén* ‘again’ forming a single LTS domain with following verb
- $\text{\textcircled{0}} \text{ j\textsubscript{e}n} \text{ b\textsubscript{o}} \text{ \textcircled{a}}^{\text{+}\text{\textcircled{a}}}$ → $(\text{\textcircled{0}} \text{ j\textsubscript{e}n} \text{ b\textsubscript{o}}) \text{ \textcircled{a}}^{\text{+}\text{\textcircled{a}}}$
 he again come NEG ‘he didn’t come again’

We tentatively assume that unlike other adverbials, *jén* is prosodically weak and as such it does not form a separate prosodic domain. Therefore the clitic *\text{\textcircled{0}}* can spread through *jén* to the verb. We shall turn to matters of prosodic constituency shortly.⁶

To summarize this subsection, noun phrases (a pre-nominal modifier plus the head noun) and verb phrases (an object plus the head verb) form a single domain with respect to LTS, while other contexts do not. These include a noun plus a post-nominal determiner/quantifier (D/Q), verb/verb phrases in series, a verb plus an

⁶Three notes are in order regarding *jén*. First, *jén* has another tonal irregularity when it acts as a modifier: it is one of the only pre-nominal modifiers which does not assign replacive grammatical tone (Harry & Hyman 2014:686fn13; cf. tone changes with other pre-nominal modifiers in Table 3). Second, to our knowledge *jén* is the only high-toned monosyllabic adverbial that may appear in this position between the subject and verb phrase (cf. *mà* ‘not yet’ from example 9; also, *sin* ‘again’, *páá* ‘still’, and *báá* ‘tomorrow’). Therefore directly comparing *jén* to other potentially prosodically deficient adverbials is not possible. Lastly, we acknowledge an alternative entertained by Jenewari (1977:192) that *jén* is always a pre-nominal modifier, but when it appears in an adverbial context it must occur with a null noun, i.e. [*jén* Ø]_{NP}.

auxiliary (AUX), post-verbal inflectional particle (INFL), or clause-final marker (CFM), or a clause with an adverbial. This is schematized in Table 7.

Table 7: Summary of structures forming a single LTS domain

Structures forming a single domain	Structures <i>not</i> forming a single domain
à [V́ V́]NP → (à V́ V́)	à [V́ V́]NP V _{D/Q} → (à V́ V́) V́ Cf. *(à V́ V́ V́)
à [V́ V́]VP → (à V́ V́)	à [V́ V́]VP [V́]VP → (à V́ V́) V́ Cf. *(à V́ V́ V́)
à [[V́ V́]NP V́]VP → (à V́ V́ V́)	à [V́ V́]VP V _{AUX} → (à V́ V́) V́ Cf. *(à V́ V́ V́)
	à [V́ V́]VP V _{INFL} → (à V́ V́) V́ Cf. *(à V́ V́ V́)
	à [V́ V́]VP V _{CFM} → (à V́ V́) V́ Cf. *(à V́ V́ V́)
	à [V́ V́]ADV [V́]VP → (à V́ V́) V́ Cf. *(à V́ V́ V́)

Abstracting over these contexts, the domain for LTS is a syntactic constituent to the right of the V́-clitic, necessarily terminating at the lexical head of that constituent.

3.4 Low tone spread as a distinct tonal process

Let us briefly return to the other tonal processes introduced in §2.3—namely, replacive grammatical tone and concatenative grammatical tone—and show how LTS is distinct. Firstly, while LTS appears to systematically replace high tones with low tones (akin to replacive grammatical tone), it acts differently from replacive tone in an important way: the target of LTS must be of a specific (underlying) tonal shape. We schematize this difference in Table 8, comparing replacive grammatical tone from jà ‘some’ with LTS from à ‘I’ (for actual examples with jà, see Table 3). Table 8 shows that while replacive tone applies with nouns of all lexical tone shapes and always completely neutralizes tone, LTS *only* applies on nouns beginning with H tone (strings). LTS never affects lexical tone of other shapes.

Table 8: Replacive grammatical tone with jà ‘some’ vs. LTS with à ‘I’

a. /jà HH/ → [jà LL] Cf. /à HH/ → [à HH]~[à LH]~[à LL]
b. /jà LH/ → [jà LL] /à LH/ → [à LH] * [à LL]
c. /jà HL/ → [jà LL] /à HL/ → [à HL] * [à LL]
d. /jà H ⁺ H/ → [jà LL] /à H ⁺ H/ → [à H ⁺ H]~[à LH] * [à LL]

Example (30) shows the lack of LTS with LH words lòkòlòkò ‘prosperous’ and wẹ̀n RP, a type of resumptive pronoun.

(30) Underlying LH sequences are not subject to LTS

- a. Bèné fí sá⁺kí, ò lòkòlòkò wẹ̀rí árí (cf. * [...ò lòkòlòkò ~ lòkòlòkò ...])
 Bene die time he prosperous keep CONT
 ‘When Bene died, he was well off’ (Jenewari 1980:152)
- b. Gògò fí tẹ̀⁺é, à wẹ̀n ná ⁺m (cf. * [...à wẹ̀n ná ...])
 Gogo die PERF I RP hear FAC
 ‘I heard that Gogo is dead’ (Jenewari 1977:394)

Moreover, LTS is also unlike concatenative grammatical tone. To illustrate, let us consider the tonal near minimal pair sò ‘cook’ versus só ‘go’. (31a) shows that when low-toned sò occurs with the floating tone sequence (H)(L) expressing subjunctive mood (sbjv), the tones concatenate and result in a LHL contour which is otherwise not found on monosyllables in Kalabari. In (31b), in contrast, when this floating (H)(L) concatenates with high-toned só with, the result is simply a HL contour [sòò] rather than a LHL contour. In this example LTS is not possible, i.e. it does not result in the same LHL contour *[sòòò].

- (31) Concatenative grammatical tone creates rare LHL contours, but LTS cannot
- a. ò sò (H)Ⓛ → [ò sòòò]
 he cook SBJV ‘he should cook’
- b. ò só (H)Ⓛ → [ò sóò] (cf. *[ò sòòò] with LTS)
 he go SBJV ‘he should go’

If these clitics were like concatenative grammatical tone, this would entail a hypothetical underlying structure /òⓁ/ with a floating tone. The fact that no tonal effect from the clitic can be detected here indicates that LTS is indeed a spreading operation and does not involve an additional floating tone. Taken together, LHL contours are possible only to preserve underlying tone (which includes underlying floating tone) and cannot be created otherwise (e.g. by a spreading operation).

4 Analysis

4.1 Prosodic deficiency and word-minimality

The first part of our analysis is examining why \check{V} -clitics (à, ò, and ò) and only \check{V} -clitics act as triggers of LTS. As we have stated, they are the only morphemes in the language which are monosyllabic, onsetless, and low-toned. These three qualities make them non-prominent compared to multisyllabic, onsetful, and/or high-toned counterparts. We formalize this non-prominence as a prosodic deficiency: these clitics do not form an independent phonological word (i.e. the ω -word). We adopt the word-minimality constraint in (32), referred to as $*((\check{V})\sigma)\omega$ as a shorthand. This constraint recapitulates the generalization that phonological words cannot solely consist of a single syllable which lacks both an onset and high tone. We formulate this constraint with respect to ‘vowels’ (‘Vs’) for convenience, but it should be understood as applying to any tone-bearing unit to cover the case of syllabic ò.

- (32) $*((\check{V})\sigma)\omega$: Phonological words cannot consist only of an onsetless low-toned vowel

\check{V} -clitics do not satisfy this constraint (i.e. they are sub-minimal), and therefore they cannot form phonological words on their own. This is illustrated below where the \check{V} -clitic à ‘I’ does not form a phonological word (33a). Compare this to its bisyllabic counterpart clitic àrì (33b), the high-toned onsetless clitic á ‘she’ (33c), or the low-toned but onsetful lexical noun sò ‘sky, heaven’ (33d), all of which do.

- (33) \check{V} -clitics are sub-minimal and do not form a separate phonological word (ω)
- a. à (pélé̀mà) ω (tè⁺é) ω (→ [à pélé̀mà tè⁺é])
 I pour.one.to.another PERF
 ‘I have poured from one (container) to another’
- b. (àrì) ω (íyè) ω (érí) ω (̀m) ω
 I you see FAC
 ‘I saw you’
- c. (á) ω (màngì) ω (wé̀rí) ω (á) ω
 she run keep CONT
 ‘she has run away (and is still not back)’
- d. (sò) ω (bálápù) ω (tè⁺é) ω
 sky twinkle PERF
 ‘heaven displays a sudden flash of fire’ (Blench 2008:320)

The prosodic deficiency of these three dimensions of \check{V} -clitics—i.e. its low tone, onsetlessness, and monosyllabicity—has much precedence in the literature. First, it is well-known that monosyllables may not satisfy the minimal requirement for prosodic wordhood (e.g. Hayes’ 1995:87f ‘minimal word syndrome’). Second, high tone tends to be treated as prominent across languages while low tone as non-prominent. For

example, stress (or other prominent positions) and high tone have a known affinity to one another (e.g. Köhnléin 2013), and equally there is an avoidance of stress and low-toned syllables (e.g. in Huajuapán Mixtec, Pike & Cowan 1967). De Lacy (2002) provides a typology of stress-tone interactions with extensive empirical studies and references, resulting in a prominence hierarchy ‘H>M>L’ where H is most prominent and L least prominent (see also corroborating studies in Yip 2001).

Lastly, while onsets are traditionally understood as independent of prosodic prominence (e.g. with respect to stress and weight considerations), a growing body of literature demonstrates that the presence of an onset and/or the type of onset repeatedly play a role in prosodic patterns. Onsetless syllables often suffer from prosodic deficiency (Downing 1998; Schwartz 2013; Rolle 2021), e.g. as manifested by being invisible for stress assignment (e.g. Gordon 2005; Topintzi 2010) or high tone alignment (Bamba 1991; Odden 1995, 2006; Jenks & Rose 2011). One clear example of this comes from Yoruba, also spoken in southern Nigeria. Orié (2000) details numerous places in (standard) Yoruba morphophonology where onsetless syllables pattern differently from onsetful ones, e.g. a ban on high tone on word-initial onsetless syllables (i.e. there are words *òwó* ‘money’ and *òwò* ‘business’, but not **ówó*). Combing the results of these studies together, the core conclusion is that vowels without onsets are non-optimal for starting prosodic constituents, non-optimal as tone-bearing units, and particularly non-optimal for prominent H tones. In Kalabari, these precursors have coalesced into the prosodic deficiency of V-clitics as seen.⁷

4.2 Tonal incorporation

Kalabari is perhaps unique in requiring all three deficiency conditions to be present (monosyllabicity, low tone, and onsetlessness) in order for a morpheme to be considered phonologically deficient, reflected by our constraint $*((\dot{V})\sigma)\omega$. This constraint however cannot account for the patterns alone. The second component of our analysis posits that all tones must be associated with some vowel (i.e. tone-bearing unit) within a phonological word. We refer to this as ‘tonal incorporation’, and capture this via a constraint ‘T-to- ω ’, defined in (34):

(34) T-to- ω : Tones must associate to a vowel within a phonological word

The combination of these two constraints initiates low tone spread. A \dot{V} -clitic is not parsed into a phonological word (due to $*((\dot{V})\sigma)\omega$), but there remains a requirement that its low tone be parsed into one (due to T-to- ω). To accommodate this contradiction, the tone must ‘tonally incorporate’ into a neighboring phonological word by spreading rightward. This is shown in Figure 5. Note that the segmental component of the \dot{V} -clitic does *not* incorporate with the following word, and it remains unparsed at the prosodic word level. The tonal and segmental tiers thus diverge here with respect to prosodic constituency. We return to matters of prosodic constituency shortly (§4.3–4.4).

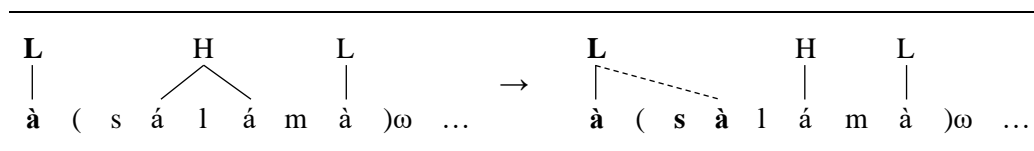


Figure 5: Low tone spread as a consequence of $*((\dot{V})\sigma)\omega$ plus T-to- ω

As we have detailed, low tone can only spread such that a H tone remains on the final high-toned vowel

⁷Unlike in Yoruba, in Kalabari VCV monomorphemic words show no restrictions on the tone on the initial vowel. All five main lexical tone patterns from Table 1b are attested: *èkpè* ‘chest’, *èkpé* ‘he-goat’, *éré* ‘female’, *élè* ‘space’, and *é*^hné* ‘rain’ (Harry 2004). This indicates that initial onsetless vowels within larger words are syllabified and not prosodically deficient *per se* (cf. Orié 2000). It is only when such onsetless vowels appear by themselves in a (low-toned) monosyllabic morpheme that they are deficient.

(H-compression) and can spread further only if followed by another H (H-absorption). Otherwise it does not apply, where we assume that T-to- ω is simply unsatisfied and cannot otherwise be repaired.

A crucial independent piece of evidence for the T-to- ω constraint and tonal incorporation comes from tone alignment with replacive grammatical tone (Table 3, §2.3). Of interest are possessive pronoun constructions, which assign a \Rightarrow HLH replacive grammatical tone as a class, e.g. $\grave{\text{i}}\text{n}\grave{\text{a}}\text{n}\acute{\text{a}}\text{m}\acute{\text{a}} \rightarrow [\grave{\text{i}}\text{n}\acute{\text{a}}\text{n}\acute{\text{a}}\text{m}\acute{\text{a}}]$ ‘their meat’ (the low is typically realized as a downstep). Relevant for our analysis, Harry & Hyman (2014) additionally state that the alignment of this \Rightarrow HLH sequence depends on the phonological shape of the possessor itself: if the possessor is of the shape \check{V} (i.e. low-toned, onsetless, and monosyllabic—the same as the relevant \check{V} -clitics), then the following noun surfaces with an initial L. This is shown in Table 9, where the exceptional forms are in bold. This pattern is not reported with other low-toned possessors, e.g. bisyllabic $\grave{\text{i}}\text{n}\grave{\text{a}}$ ‘their’.⁸

Table 9: Alignment of replacive grammatical tone with \check{V} possessive pronouns (Harry & Hyman 2014:654)

	Possessor		Replacive tones	Noun	Surface	Meaning
1SG	$\grave{\text{i}}$	+	\Rightarrow HLH	$\text{n}\acute{\text{a}}\text{m}\acute{\text{a}}$	\rightarrow [$\grave{\text{i}}$ $\text{n}\acute{\text{a}}\text{m}\acute{\text{a}}$ $\acute{\text{a}}$]	‘my meat’
2SG	$\acute{\text{i}}$	+	\Rightarrow HLH	$\text{n}\acute{\text{a}}\text{m}\acute{\text{a}}$	\rightarrow [$\acute{\text{i}}$ $\text{n}\acute{\text{a}}$ $\text{m}\acute{\text{a}}$]	‘your meat’
3SG.M	$\grave{\text{o}}$	+	\Rightarrow HLH	$\text{n}\acute{\text{a}}\text{m}\acute{\text{a}}$	\rightarrow [$\grave{\text{o}}$ $\text{n}\acute{\text{a}}\text{m}\acute{\text{a}}$ $\acute{\text{a}}$]	‘his meat’
3SG.F	$\acute{\text{a}}$	+	\Rightarrow HLH	$\text{n}\acute{\text{a}}\text{m}\acute{\text{a}}$	\rightarrow [$\acute{\text{a}}$ $\text{n}\acute{\text{a}}$ $\text{m}\acute{\text{a}}$]	‘her meat’
1PL	$\text{w}\acute{\text{a}}\text{n}\grave{\text{a}}$	+	\Rightarrow HLH	$\text{n}\acute{\text{a}}\text{m}\acute{\text{a}}$	\rightarrow [$\text{w}\acute{\text{a}}\text{n}\grave{\text{a}}$ $\text{n}\acute{\text{a}}$ $\text{m}\acute{\text{a}}$]	‘our meat’
2PL	$\acute{\text{o}}\text{m}\grave{\text{i}}\text{n}\grave{\text{a}}$	+	\Rightarrow HLH	$\text{n}\acute{\text{a}}\text{m}\acute{\text{a}}$	\rightarrow [$\acute{\text{o}}\text{m}\grave{\text{i}}\text{n}\grave{\text{a}}$ $\text{n}\acute{\text{a}}$ $\text{m}\acute{\text{a}}$]	‘your meat’
3PL	$\grave{\text{i}}\text{n}\grave{\text{a}}$	+	\Rightarrow HLH	$\text{n}\acute{\text{a}}\text{m}\acute{\text{a}}$	\rightarrow [$\grave{\text{i}}\text{n}\grave{\text{a}}$ $\text{n}\acute{\text{a}}$ $\text{m}\acute{\text{a}}$]	‘their meat’

We can straightforwardly account for this special association if \check{V} -shaped possessors do not form their own phonological word either, i.e. they are subject to the constraint $*((\check{V})\sigma)\omega$. The low tone must therefore spread into the neighboring word (due to T-to- ω). This consequently shifts the grammatical tones one vowel to the right (Figure 6a). In contrast, a possessor $\grave{\text{i}}\text{n}\grave{\text{a}}$ forms its own word and therefore its low tone does not need to spread (Figure 6b).

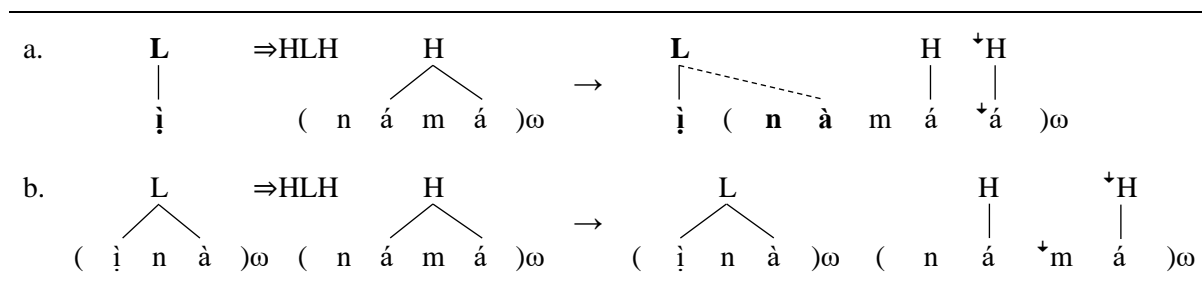


Figure 6: Consequence of $*((\check{V})\sigma)\omega$ plus T-to- ω to \Rightarrow HLH grammatical tone alignment

Our proposal thus unites two separate tonal patterns under the same account: low tone spread from pronominal clitics and exceptional grammatical tone alignment are both due to the prosodic deficiency of the trigger, coupled with the requirement to be (tonologically) parsed into a phonological word.

4.3 The domain of low tone spread as the phonological phrase

The next component of our analysis addresses the unbounded nature of low tone spread: it does not merely target a single vowel in a neighboring word, but rather spreads to *all* contiguous high-toned vowels (within

⁸On the relation of these possessive pronouns to \check{V} -clitics in subject position, see footnote 3.

the relevant domain). A constraint such as T-to- ω would be satisfied by merely spreading once, and therefore we require some other explanation. In short, how exactly does tone incorporation ultimately lead to H-compression and H-absorption?

In addressing this part of the analysis, we start by positing the precise domain for LTS: the phonological phrase (i.e. φ -phrase). This φ -phrase constituent by default is assumed to be the next level of the prosodic hierarchy after the phonological word (Nespor & Vogel 1986; Selkirk 2011). For maximum clarity, phonological phrases will be notated in curly brackets, i.e. $\{\}$ φ . To explicate this proposal, let us first establish phonological phrasing generally in Kalabari.

A basic prosodic division can be made between a (lexical) subject and its accompanying predicate. These form separate φ -phrases, a common cross-linguistic finding in the prosodic literature (Selkirk & Shen 1990; Dobashi 2003, 2014; Samuels 2009; Kalivoda 2018). We show this in (35), where the lexical noun *féní* ‘bird’ in subject position is prosodically separate from the verb phrase *pùlò èrì* ‘see oil’. An equivalent rendition of the prosodic structure is in Figure 7.

- (35) Lexical noun in subject position and predicate forming separate φ -phrases
féní *pùlò èrì* *té⁺é* → $\{(féní)\omega\}$ $\{(pùlò)\omega$ $(èrì)\omega\}$ φ $(té⁺é)\omega$
 bird oil see PERF ‘the bird has seen the oil’

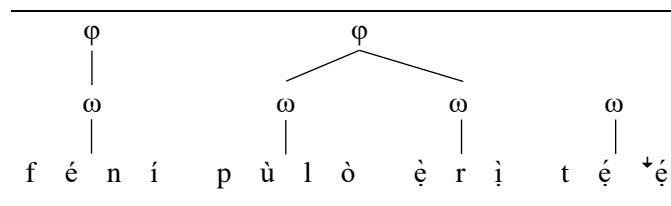


Figure 7: Subject and predicate forming separate phonological phrases

The inflectional particle *té⁺é* PERF is not included within the last phonological phrase, but it does form a phonological word on its own. We justify its independence from the previous φ -phrase shortly.

In contrast to lexical subjects, pronominal clitics—both the pre-consonantal and pre-vocalic series (Table 5)—do *not* form their own phonological phrase, and instead they must be grouped with the following φ -phrase. However, although both pronominal series lack their own φ -phrase, they show a crucial difference still: based on our analysis in §4.1, pre-vocalic allomorphs such as *òrì* ‘he’ form their own phonological word but pre-consonantal \dot{V} -clitics like *ò* ‘he’ do not. Updated prosodic structures are shown in Figures 8-9, repeating examples *òrì ìgàní bà* ‘he will get annoyed’ and *ò mìnìní bà* ‘he will agree’ from (4). In both these figures, the subject clitic adjoins to the verb’s φ -phrase (cf. Figure 7 above with a lexical subject).⁹

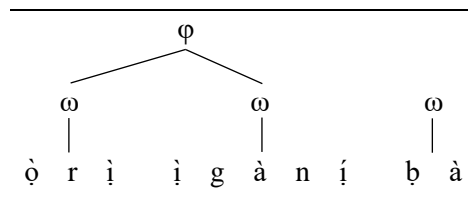
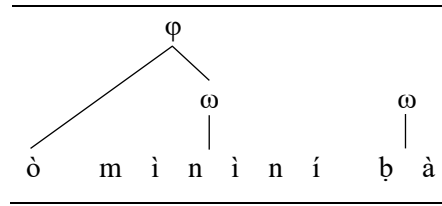


Figure 8: Pronominal clitic and verb forming φ -phrase

⁹Note that the structure as given in Figure 9 violates the *exhaustivity* principle of the prosodic hierarchy, since the clitic is directly parsed into a prosodic phrase without being parsed in an intervening prosodic word. We expand on this at Figure 15 below.

Figure 9: V-clitic and verb forming joint φ -phrase

Independent evidence for this prosodic constituency comes from advanced tongue root (ATR) harmony, introduced in §2.1. Akinlabi (1997) shows that pronominal clitics harmonize with the word to their right in ATR value, shown in (36). ATR harmony applies to both the pre-consonant allomorph series (36a) as well as the pre-vocalic one (36b-c). Recall that [-ATR] vowels are written with a dot under the vowel, while [+ATR] vowels are typographically unmarked.

- (36) All pronominal clitics are subject to ATR harmony (Akinlabi 1997:106)
- a. [+ATR] **ó** b́òò ‘you (pl) are to come’
[-ATR] **ò** lègìì ‘you (pl) are to sit down’
 - b. [+ATR] **òrì** ókí [†]m ‘he swam’
[-ATR] **òrì** lègí [†]m ‘he sat down’
 - c. [+ATR] **ìni** ólókú [†]m ‘they shouted’
[-ATR] **ìni** èrì [†]m ‘they saw (it)’

In contrast, lexical subjects do not undergo harmony, nor do counterpart independent pronouns which are not clitics. Independent pronouns were introduced in Table 5 and are used in numerous positions where pronominal clitics are not permitted. Such contexts include when modified by a post-nominal modifier (e.g. *só* ‘also’ in 37a), being in the initial or final position of a copular clause (37b–d), or acting as a single-word response (37e).

- (37) Distribution of independent pronouns
- a. **ìyèrì** [†]só òrì èrì [†]m
I also him see FAC
‘I saw him too’ (Jenewari 1977:407)
 - b. **ìyèrì** àní[†]é ò dá
I COP his father
‘I am his father’
 - c. **ìyèrì** tù b́ò ?
I who
‘Who/what am I?’
 - d. ìndé[†]é **ìyèrì** ?
where **I**
‘Where am I?’
 - e. A: tù b́ò b́ò ? B: **ìyèrì[†]í** !
WHO come I
A: ‘Who came?’ B: ‘Me!’

This distribution is explained if such positions require content which must be able to form its own phonological phrase (a requirement not present in normal subject or object positions). Only independent pronouns fit this criterion—pronominal clitics do not, as in (38).

- (38) Pronominal clitics disallowed in positions requiring independent pronoun
 òrì pápá tòmbò Cf. *ò pápá tòmbò
 he useless person
 ‘he is a useless person’

As stated, unlike pronominal clitics independent pronouns *never* harmonize with the following word. Both [+ATR] independent pronouns (39a) and [-ATR] ones (39b) retain their underlying harmony value in the same context.

- (39) Lack of ATR harmony with independent pronouns
 a. òrì tù bọ ? ‘Who/what is **he**?’
 ìní tọ àpú ? ‘Who/what are **they**?’
 b. ìyẹ̀rì tù bọ ? ‘Who/what am **I**?’
 ómìní tọ àpú ? ‘Who/what are **you** (pl)?’

Example (40) is particularly telling. This example set involves a pre-subject independent pronoun in topic position with a co-referential pronominal clitic in subject or object position. The pronominal clitics undergo harmony while the independent pronouns do not, even in cases where they are otherwise phonologically identical and adjacent (40c).

- (40) Lack of ATR harmony with independent pronouns
 a. òrì, ò bọ †ín
 he he come FAC
 ‘As for him, he came’ (Jenewari 1977:274)
 b. òrì, ò kìnì sìn †ín
 he he someone call FAC
 ‘As for him, he called someone’
 c. Gògò òrì èrémè bèlẹ̀má árí kùrà ìní, ìní ò bèlẹ̀má á†á
 Gogo his women love CONT but **they** they him love NEG
 ‘Gogo loves his wives but they do not love him’ (Jenewari 1977:251)

These data can be accounted for if independent pronouns form a separate ϕ -phrase, and that ATR harmony is restricted to targets within a single ϕ -phrase (i.e. ATR cannot spread across a ϕ -phrase boundary). A partial diagram of (40c) is in Figure 10.

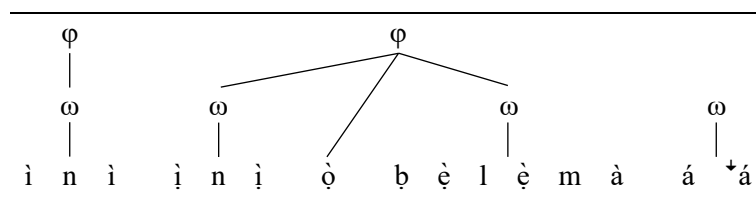


Figure 10: Independent pronouns form separate phonological phrases

Post-verbal inflectional particles are also not part of this phonological phrase, e.g. á†á NEG in Figure 10 above. This correctly predicts that they do not undergo ATR harmony with the word to their left. As Akinlabi shows, inflectional particles keep their inherent [-ATR] value such as tẹ†ẹ PERF in (41).

- (41) Inflectional particles do not undergo ATR harmony (Akinlabi 1997:106)
 Bòmá Gògò fómú tẹ†ẹ (cf. *[…fómú tẹ†ẹ])
 Boma Gogo beat PERF ‘Boma has beaten Gogo’

Moreover, notice that in our analysis (Figure 10), post-verbal inflectional particles form their own phonological word. One piece of evidence for their phonological wordhood is that all of such particles contain a high

tone. This complies with the constraint $*((\check{V})\sigma)\omega$ stating that phonological words cannot consist only of a single low-toned vowel. Inflectional particles include $\textcircled{H}^+\text{m}$ factative, $\text{t}\acute{\text{e}}^+\acute{\text{e}}$ perfect, $\text{a}\acute{\text{r}}\grave{\text{i}}$ continuous, $\textcircled{H}\text{b}\grave{\text{a}}$ future (plus its various allomorphs, Jenewari 1977:474f), the floating tone sequence $\textcircled{H}\textcircled{L}$ imperative/subjunctive, and a^+a negative. An inflectional particle of the shape m or a (or even $\text{b}\grave{\text{a}}$) is not attested.¹⁰

Having established the foundation for phonological phrasehood, let us return to the tonal facts. A remaining *explanandum* concerns the domain of LTS: some multi-word units form a single domain, most do not form, and a few contexts allow both (§3.3). To account for this contrast, we claim that low tone spreads rightward within a ϕ -phrase but cannot spread past it. Two examples of single LTS domains are in Figures 11–12. These figures model both H-compression (42a), as well as H-absorption before a phrase-external high tone (42b). Spreading is indicated via a checked line, and delinked tone association is indicated by a light gray line.

- (42) a. $\grave{\text{a}}$ [féní mǐnjí kùkù fè]VP $\text{t}\acute{\text{e}}^+\acute{\text{e}}$ → { $\grave{\text{a}}$ fèní mǐnjí kùkù fè} ϕ $\text{t}\acute{\text{e}}^+\acute{\text{e}}$
 I bird water pot buy PERF ‘I have bought a bird’s water pot’
 b. $\grave{\text{o}}$ [bùrúmá sélé]VP $\text{t}\acute{\text{e}}^+\acute{\text{e}}$ → { $\grave{\text{o}}$ bùrùmá sélé} ϕ $\text{t}\acute{\text{e}}^+\acute{\text{e}}$
 he indigo choose PERF ‘he has chosen indigo’

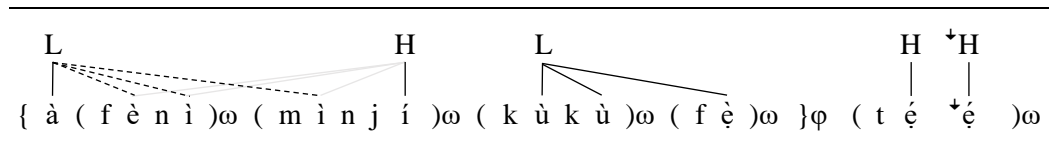


Figure 11: LTS within the phonological phrase (H-compression)

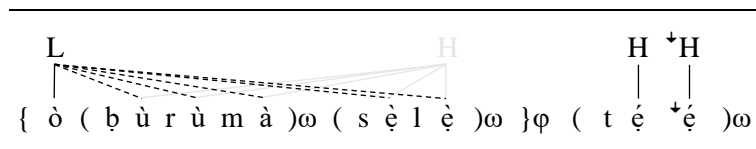


Figure 12: LTS within the phonological phrase (H-compression with H-absorption)

Recall that LTS in the context of a lexical downstep preferably leaves one high-toned vowel before the downstep (§3.2); H-absorption in these contexts was questionable (compare spreading past the downstep, which is fully ungrammatical). An example is repeated in (43), whose variable surface pronunciations are diagrammed in Figures 13–14.

- (43) $\grave{\text{a}}$ [béké⁺ké érí]VP $\text{t}\acute{\text{e}}^+\acute{\text{e}}$ → { $\grave{\text{a}}$ béké⁺ké érí} ϕ $\text{t}\acute{\text{e}}^+\acute{\text{e}}$ ~ ? { $\grave{\text{a}}$ békèkèké ... } ϕ
 I chin see PERF ‘I have seen a chin’

¹⁰A reviewer asks whether these particles also form their own phonological phrase. In future figures, we shall assume that they do not and attach directly to the intonational phrase (iP, e.g. Figure 15 below). We cannot definitively diagnose their status, however, as the environments which give evidence for independent ϕ -phrasehood do not directly appear before these inflectional clitics (e.g. the \check{V} -clitics triggering low tone spread). Whether these form a separate ϕ -phrase or not is not crucial for the rest of our analysis.

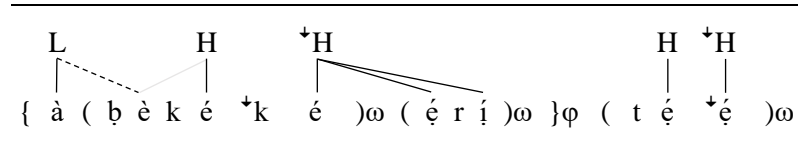


Figure 13: LTS in lexical downstep context (H-compression)

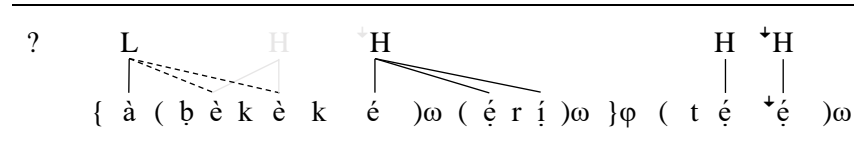


Figure 14: LTS in lexical downstep context (H-compression with questionable H-absorption)

These structures point to H only questionably being able to be absorbed by a downstepped ^+H when LTS applies.

Any material outside of the phonological phrase—such as the inflectional particle $té^+é$ PERF in these figures—is not targeted by LTS. Other examples of such extra-phrasal material are in (44), such as post-nominal quantifiers (*íngérí* ‘only’, 44a), the second verb in serial verb constructions (44b), a clause-final marker (*tírémè* ‘before’, 44c), or material after an adverbial (44d).

(44) Absence of low tone spread across a phonological phrase boundary

- | | | | | | | | |
|----|----------|----------------|---------------------|-----------|---------|---|--|
| a. | à | <i>námá</i> | <i>íngérí</i> | <i>fé</i> | $té^+é$ | → | { à námá }φ { <i>íngérí</i> $^+fé$ }φ $té^+é$ |
| | I | animal | only | buy | PERF | | ‘I have bought only an animal (alone)’ |
| b. | ò | <i>mènjí</i> | <i>sábá</i> | $té^+é$ | | → | { ò mènjí }φ { <i>sábá</i> }φ $té^+é$ |
| | he | walk | cross | PERF | | | ‘he has stepped over’ |
| c. | ò | <i>bó</i> | <i>tírémè</i> , ... | | | → | { ò bó }φ <i>tírémè</i> |
| | he | come | before | | | | ‘he came before, ...’ |
| d. | ò | <i>kpékélé</i> | <i>bó</i> | $á^+á$ | | → | { ò kpèkèlè }φ { <i>bó</i> }φ $á^+á$ |
| | he | in.time | come | NEG | | | ‘he did not come in time’ |

We schematize the relevant syntax–phonology mappings in the table below. Subjects and adverbials (Table 10a–e) by default are mapped to their own φ-phrase (with the exception of pronominal clitics as a class, Figures 7–9). A pre-nominal modifier, the head noun object, and the head verb (the complex VP) are mapped to a single φ-phrase (Table 10a). Modification structure after the head noun object or head verb do not belong to this φ-phrase, e.g. determiners/quantifiers (Table 10b), other verbs (Table 10c), auxiliaries (Table 10d), or inflectional particles (INFL) and clause-final markers (CFM).

Table 10: Syntax–phonology mapping

a.	[	{Subject}φ	{MOD	Noun	Verb}φ	INFL	CFM	]u
b.	[	{Subject}φ	{Noun}φ	{D/Q	Verb}φ	INFL	CFM	]u
c.	[	{Subject}φ	{Noun	Verb}φ	{Verb}φ	INFL	CFM	]u
d.	[	{Subject}φ	{Noun	Verb}φ	{AUX}φ	INFL	CFM	]u
e.	[	{Subject}φ	{ADV}φ	{Noun	Verb}φ	INFL	CFM	]u

Notice in this table that the entire clause maps to an intonational phrase (ι-phrase), denoted with an ι in square brackets. This is meant for the sake of completeness rather than for any worked-out clause-level

prosody (e.g. involving intonational boundary tones). Representing the ι -level also makes it clear that while post-verbal inflectional particles and clause-final markers are not placed within a phonological phrase, they *are* parsed within a supra-word prosodic constituent. This is shown in Figure 15 (an expansion of Figure 9), where the final phonological word is directly dominated by the ι -phrase, with no φ -phrase mediating between the two. Although this structure violates the *exhaustivity* principle of the prosodic hierarchy prohibiting ‘level-skipping’, recent incarnations of the prosodic hierarchy accept that this constraint is violable (e.g. Selkirk 1996, 2011).

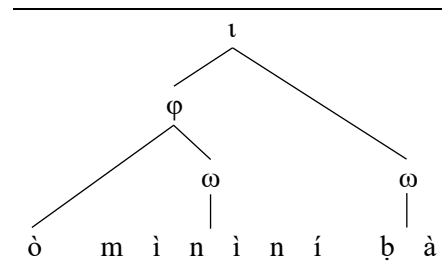


Figure 15: A ω -word directly dominated by an ι -phrase

4.4 Prosodic domain matching

A tacit assumption of prosodic constituency is that constituents are transparent and stable, meaning that they should be visible (i.e. accessible) to other phonological processes in the language, and they should persist at different stages of a phonological derivation. This does not entail that there will always be converging data, but when it is found it provides excellent corroborating evidence for prosodic constituency. When distinct phonological processes refer to the same prosodic constituent, we shall refer to this as ‘prosodic domain matching’.¹¹

Kalabari exhibits domain matching when comparing low tone spread with the scope of replacive grammatical tone. As established (Table 3, §2.3), in noun phrases pre-nominal modifiers assign one of four replacive grammatical tone patterns (HL, L, LH, and H⁺H~HLH), while in verb phrases (Table 4) the final tone of the object replaces all tones of the verb. Replacive grammatical tone does not simply target just the lexical head or just the following word: *all* words between the trigger and lexical head are targeted, including intervening modifiers. Consider the pronoun in possessor position ì ‘my’. This assigns a \Rightarrow HLH replacive tone melody to the lexical noun if it is adjacent (45a), but if there are intervening modifiers then this replacive melody ‘spreads out’ over all intervening words (45b–d). As with all cases of replacive grammatical tone, the lexical tone of all target words is completely neutralized.

(45) Possessor replacive grammatical tone \Rightarrow HLH targeting multiple words (Harry & Hyman 2014)

- | | | | | | | | | | | | | | |
|----|----|------|--------|-------------------|-----------------|----|-----------------------|--------------|------|----------|------|------|----------|
| a. | ì | námá | | | → | ì | námá ⁺ | á | | | | | |
| | my | meat | | | | | ‘my meat’ | | | (p. 654) | | | |
| b. | ì | fění | námá | | → | ì | fění | námá | | (p. 654) | | | |
| | my | bird | meat | | | | ‘my bird’s meat’ | | | | | | |
| c. | ì | fění | mìnjì | kúkú | → | ì | fění | mìnjì | kúkú | (p. 655) | | | |
| | my | bird | water | pot | | | ‘my bird’s water pot’ | | | | | | |
| d. | ì | sóná | námá | kálá ⁺ | wá ⁺ | rì | → | ì | sóná | námá | kàlà | wàrì | (p. 660) |
| | my | five | animal | small | house | | ‘my five animals’ | small house’ | | | | | |

The data in (45) above show that the replacive pattern can target more than one word. However, it never

¹¹This should not be conflated with ‘Match Theory’ (Selkirk 2011; Kalivoda 2018), which concerns the mapping of syntactic phrases to prosodic phrases (not prosodic phrases with one another *per se*, as we mean).

targets any material past the lexical head. Compare the minimal pair below where a pre-nominal modifier is targeted by replacive tone (féní ‘bird’, 46a), but a post-nominal quantifier is not (mángbà ‘all’, 46b).

(46) Replacive tone cannot target the quantifier beyond the head noun (Harry & Hyman 2014)

- a. ì féní námá → ì **féní námá**
 my bird meat ‘my bird’s meat’ (p. 654)
- b. ì námá mángbà → ì **námá** ⁺á mángbà (cf. *ì **námá mángbà**)
 my animal all ‘all my animals’ (p. 665)

This restriction holds for all the triggers of replacive tone—e.g. demonstratives assigning LH (47) or possession-compound constructions assigning HL (48)—and holds for all post-nominal modifiers as well—e.g. amèè PLURAL (47b) or mè ‘the’ (48b). The underlying tone is always retained in these contexts.

(47) Replacive LH from demonstrative cannot target post-nominal modifiers (Harry & Hyman 2014)

- a. mí féní námá → mí **fèni námá**
 this bird meat ‘this bird’s meat’ (p. 656)
- b. má námá amèè → má **námá** amèè ~ má **námà** amèè (cf. *mí **námà amèè**)
 these animal PL ‘these animals’ (p. 665)
- c. mí námá mángbà → mí **námá** ⁺mángbà ~ mí **námà** mángbà
 this animal the ‘all these animals’ (p. 665)
 (cf. *mí **námà mángbà**)

(48) Replacive HL in possession-compound construction cannot target the post-nominal (Harry & Hyman 2014)

- a. é⁺né mìnjì fù⁺rú → é⁺né **mínjì fùrù** ~ é⁺né **mínjì fùrù**
 rain water smell ‘rainwater smell’ (p. 661)
- b. féní púló mè → féní **púló mè** (cf. *féní **púló mè** ~ *féní **púlò mè**)
 bird oil the ‘the bird’s oil’ (p. 667)

Parallel restrictions exist for replacive grammatical tone affecting verb phrases (49). Replacive tone from the object targets the tones of the verb (the lexical head of the VP). In all cases, this replacive tone cannot target past the verb, such as to inflectional particles (49a), other verbs (49b), or auxiliary verbs (49c).

(49) Replacive tone from object to verb in VP cannot target beyond verb

- a. féní púlò èrì tèt⁺é → féní púlò **èrì tèt⁺é** (cf. *... púlò **èrì tèt**)
 bird oil see PERF ‘the bird has seen the oil’ (Harry & Hyman 2014:670)
- b. ìnà nàngà sá bá → ìnà **nàngà sá bá** (cf. *ìnà **nàngà sà bá**)
 them trample cross ‘cross them by trampling’ (Harry 2004:88)
- c. ọ̀rì ànì yé dìn tèt⁺é → ọ̀rì ànì **yè dìn tèt⁺é** (cf. *... ànì **yè dìn** ...)
 he it do know.how PERF ‘he knows how to do it’ (Jenewari 1977:519)

Comparing these data to low tone spread, we see that replacive grammatical tone exhibits the same boundary: it cannot target beyond the noun in a noun phrase or a verb in a verb phrase. This prosodic domain matching between low tone spread and replacive tone is summarized in Table 11.

Table 11: Prosodic domain matching

Structure	Low tone spread	Replacive tone
MOD Noun (NP)	Y	Y
Noun Verb (VP)	Y	Y
MOD Noun Verb	Y	Y
N D/Q	N	N
Verb Verb	N	N
Verb AUX	N	N
Verb INFL	N	N

These co-extensive domains are united under our proposal: both are bound to the phonological phrase, and this phrase terminates with the lexical head.

4.5 *LHH constraints in Kalabari

We have thus far established the triggers, targets, and domain of low tone spread. The final component of our analysis is answering exactly why low tone spread is unbounded (again, why is spreading to just one vowel of the next ω -word not sufficient?). Our proposal is that LTS is a consequence of a general *LHH constraint, which prohibits a low-toned vowel followed by two high-toned vowels. Before expanding on this, let us first establish how *LHH plays a key role in the tonology of Kalabari, independent of LTS.

First, *LHH should be properly understood as a family of constraints which reference different layers of the prosodic hierarchy, schematized in (50).

(50) *LHH constraint family

- Word-level: $*(\dot{V}\dot{V}\dot{V})\omega$
- Phrase-level: $*\{\dot{V}\dot{V}\dot{V}\}\phi$
- Inter-phrase-level: $*\dot{V}\dot{V}\}\phi\dot{V}$

The first constraint $*(\dot{V}\dot{V}\dot{V})\omega$ (50a) is a word-level constraint against *LHH. This is the clearest example of *LHH, as such sequences are categorically banned within lexical tone patterns. Harry (2004) establishes the licit and illicit lexical tone patterns which appear on 3σ and 4σ lexical items, recapped in Table 12. In this table, licit patterns are not marked, marginal patterns appear with a ‘

Table 12: Licit, marginal (%), and illicit (*) lexical tone patterns (3σ – 4σ)¹²

3 σ			4 σ					
LHL	HHL	*H ⁺ HL	LLHL	*LHHL	*LH ⁺ HL	HLHL	HHHL	*HH ⁺ HL
%LHH	HHH	H ⁺ HH	*LLHH	*LHHH	*LH ⁺ HH	*HLHH	HHHH	*HH ⁺ HH
LH ⁺ H	HH ⁺ H	*H ⁺ H ⁺ H	LLH ⁺ H	*LHH ⁺ H	*LH ⁺ H ⁺ H	HLH ⁺ H	*HHH ⁺ H	*HH ⁺ H ⁺ H
LLH	HLH		LLLH	LHLH	*HLLH	HHLH		
LLL	%HLL		LLL	%LHLL	*HLLL	%HHLL		

All cells with a LHH sequence are in bold all of which are either illicit or marginal. The marginal pattern %LHH appears in only two loanwords, àkótó ‘small container’ and ègúsí ‘melon’ (Harry 2004:108). These appear to be recent loanwords, the latter term being found across Nigeria as the general name for this melon

¹²LLHH 4 σ words are marked as illicit because the only instances are reduplicants, e.g. lòkòlòkò ‘prosperous’ (30a). Additionally, all 4 σ patterns which begin with H⁺H are unattested, not shown in this table.

dish (e.g. Yoruba *ègúsi*). For our purposes we adopt a categorical prohibition against *LHH at the word-level.¹³

The second *LHH constraint is *{ $\check{V}\check{V}\check{V}$ } ϕ (50b) which applies to the phonological phrase level. This manifests in several ways. First, we established that pre-nominal modifiers plus their noun (roughly the NP) and objects plus their verb (roughly the VP) form a single ϕ -phrase (Table 10 above). Such ϕ -phrases conspire to avoid LHH sequences. As established, pre-nominal modifiers assign one of four replacive grammatical tone patterns (§2.3), regardless of their own tone. This is recapped in Table 13. While HL, H⁺H, L, and LH replacive patterns are all attested, conspicuously missing are cases of a low-toned modifier assigning a H replacive tone. This would result in the illicit { $\check{V}\check{V}\check{V}$ } ϕ sequence.

Table 13: Lack of H replacive grammatical tone pattern

tùbò + ⇒HL	ìnà + ⇒HLH	tò + ⇒LH	jà + ⇒L	Cf. *... + ⇒H
‘the child’s __’	‘their __’	‘which __’	‘some __’	

*LHH sequences at the phrase level are thus rare and arise only occasionally, in three primary contexts. For each of these contexts, however, the derived LHH sequence is optionally or obligatorily altered. One context is with pre-nominal low-toned modifiers *mà* ‘two’ and *òpù* ‘big’, which do not consistently assign a replacive grammatical tone. When they appear before high-toned nouns, it may result in a LHH sequence. However, such contexts show two surface pronunciations, as in (51): one which allows the all-high-toned noun to surface as such (in violation of *{ $\check{V}\check{V}\check{V}$ } ϕ), and another which has an all low pattern. For the modifier *mà* ‘two’ (51a), we might attribute this to a variable L replacive grammatical tone. Many other numerals have this replacive pattern (Harry & Hyman 2014:656f), and nouns of all lexical tone patterns can undergo lowering (e.g. *wá⁺rí* → [wàrì]), as indicated). However, this is not a possible explanation for the other modifier *òpù* ‘big’ (51b), where only all-H nouns are affected. Unlike with *mà*, other lexical tone patterns show no alternation here.

(51) Derived $\check{V}\check{V}\check{V}\phi$ sequences with two pre-nominal modifiers (Harry & Hyman 2014:657–658)

- a. *mà féní* → {*mà féní*} ϕ → [mà féní] ~ [mà **fèni**]
 two bird ‘two birds’ (cf. [mà wá⁺rí] ~ [mà **wàrì]** ‘two houses’)
- b. *òpù féní* → {*òpù féní*} ϕ → [òpù féní] ~ [òpù **fèni**]
 big bird ‘big bird’ (cf. [òpù wá⁺rí], but *[òpù **wàrì]** ‘big house’)

Secondly, in possession-compound constructions when the possessor NP has underlying LH tones and assigns a HL replacive pattern (again, see Table 5), this can result in a derived LHH. Here, too, there are two surface pronunciations: the LH trigger (the possessor) may either surface faithfully as [LH], or as [LL] (i.e. *èkpé* → [èkpè] in 52). Superficially, this resembles the H-absorption pattern seen in LTS.

(52) Derived $\check{V}\check{V}\check{V}\phi$ sequences in a possession-compound construction

- èkpé* ⇒HL *námá* → {*èkpé námá*} ϕ → [èkpé námá] ~ [**èkpè** námá]
 he-goat meat ‘he-goat’s meat’ (Harry & Hyman 2014:686)

Thirdly, in [Object Verb] VP constructions the final tone of the object spreads and replaces the verb tone. Thus, if the object bears lexical LH tones, its H tone spreads rightward and should result in a derived LHH. However, in VP constructions a downstep must be inserted between the LH object and the all-H verb as in (53), seemingly to repair the *LHH violation that has been created (i.e. LH#H → [LH#⁺H]).

¹³Harry (2004) unites this *LHH restriction with an additional HLL gap apparent in Table 12, doing so via a right-to-left association algorithm that generates the acceptable tonal outputs for Kalabari words. This connection appears to hold only at the word-level. There is no comparable restriction on HLL at the phrase-level, as demonstrated by the lack of a counterpart ‘high tone spread’ shown in (10).

(53) Derived $\check{V}\check{V}\check{V}\varnothing$ sequences in verb phrases

ò kúkàlì sèlè tẹ́⁺é → {ò kúkàlì **sélè**} \varnothing tẹ́⁺é → [ò kúkàlì ⁺**sélè** tẹ́⁺é]
 he fruit choose PERF 'he has chosen the fruit' (Harry & Hyman 2014:668)

Returning to the *LHH family of constraints, let us examine the last constraint $*\check{V}\check{V}\check{V}\varnothing\check{V}$ (50c) which applies *across* a phrase boundary rather than *within* a phrase. Such sequences are very common and are derived whenever a phrase ends in a LH and is followed by a high tone outside of the phrase. In such inter-phrasal contexts, these structures are repaired by the insertion of a downstep; no repairs involving tone lowering of either the target or the trigger are permitted. Representative inter-phrase examples are below, involving nouns plus determiners/quantifiers (54a), verbs in series (54b), verbs followed by auxiliaries (54c) or inflectional particles (54d), and subjects followed by a verb phrase (54e). The relevant \varnothing -boundary is in bold, as is the LH sequence before it and the H tone after it.

(54) Downstep insertion to repair $*\check{V}\check{V}\check{V}\varnothing\check{V}$ violations in inter-phrase contexts

a. ...Noun} \varnothing D/Q... (Harry & Hyman 2014)

gàrí} \varnothing mé → [gàrí ⁺mé] 'the garri flour' (p. 663)
gàrí} \varnothing mámgbà → [gàrí ⁺mámgbà] 'all garri flour' (p. 663)
 mí **nà má**} \varnothing mámgbà → [mí **nà má** ⁺mámgbà] 'all the animals' house' (p. 665)

b. ...Verb} \varnothing Verb...

bìlà má **ḍìsẹ**} \varnothing **sáhá** árí → [bìlà má **ḍìsẹ** ⁺**sáhá** árí]
 elephant the.PL sneeze cross CONT 'the elephants are sneezing over'

c. ...Verb} \varnothing AUX...

ń **ḍìsẹ**} \varnothing **ḍín** ⁺m → [ń **ḍìsẹ** ⁺**ḍín** ⁺m]
 they sneeze know.how FAC 'they know how to sneeze'

d. ...Verb} \varnothing INFL...

námá **sélè**} \varnothing tẹ́⁺é → [námá **sélè** ⁺tẹ́⁺é]
 meat be.chosen PERF 'the meat has been chosen' (Harry & Hyman 2014:668)

e. ...Subject} \varnothing VP...

òdòdò} \varnothing **fún** sélè tẹ́⁺é → [**òdòdò** ⁺**fún** sélè tẹ́⁺é]
 snake salt choose PERF 'the snake has chosen salt'

The fact that downstep is used as a repair makes it clear that LH⁺H sequences do not violate any of the *LHH constraints (see Footnote 14 below for additional commentary on downstep as it pertains to our analysis).

To summarize, several pieces of evidence converge on the general markedness of LHH sequences in Kalabari, which we have formalized as a family of *LHH constraints prohibiting a low-toned vowel followed by two high-toned vowels. How individual *LHH constraints are repaired depends on the prosodic constituent and grammatical context, summarized in Table 14. Each of these contexts has a specific repair, and other logically possible repair strategies are not possible.

Table 14: Summary of *LHH restrictions (location of change is in bold and underlined)

Locus of *LHH violation	Repair	Schematized
a. Within word	Systematic gap	* $(\check{V}\check{V}\check{V})\omega$
b. Within phrase (mà 'two', òpù 'big')	Target lowering	$\{(\check{V})(\check{V}\check{V})\}\varnothing \rightarrow \{(\check{V})(\check{V}\check{V})\}\varnothing$
c. Within phrase (possession-compound construction)	Trigger lowering	$\{(\check{V}\check{V})(\check{V}\dots)\}\varnothing \rightarrow \{(\check{V}\check{V})(\check{V}\dots)\}\varnothing$
d. Within phrase (verb phrase)	Downstep insertion	$\{(\check{V}\check{V})(\check{V}\dots)\}\varnothing \rightarrow \{(\check{V}\check{V})(\check{V}\dots)\}\varnothing$
e. Across phrase boundary	Downstep insertion	$\check{V}\check{V}\check{V}\varnothing\check{V}\dots \rightarrow \check{V}\check{V}\check{V}\varnothing\check{V}\dots$

As a final note, *LHH effects are typologically common (Hyman & Schuh 1974:98), and they are often repaired by spreading, but much less commonly by downstep insertion. Similar *LHH restrictions are found in other Ijoid languages as well, such as Izon varieties Kolokuma (Williamson & Timitimi 1983) and Gbarain

(Rolle 2021). To a lesser extent, they are also present in a nearby non-Ijoid language Degema (Kari 2004; Rolle & Kari 2022), which has been significantly influenced by Kalabari.

4.6 Low tone spread as a response to *LHH

Now that we have established the *LHH family of constraints and the ways they manifest within Kalabari tonology, let us connect it to our central focus: pronominal clitics and low tone spread. Recall from §4.3 that unlike lexical nouns, pronominal clitics in subject position do not form their own φ -phrase and instead belong to the following ω -phrase. This prosodic parsing is repeated in (55).

(55) ò búrumá sélé tɛ́ɛ́ → {ò (bùrùmà)ω (sɛ̀lɛ̀)ω}φ (tɛ́ɛ́)ω
 he indigo choose PERF ‘he has chosen indigo’

The \check{V} -clitic ò here bears low tone and the following word or words bear high tone. Since these belong to the same phrase, this prosodic parsing incurs new violations of the *LHH constraint *{ $\check{V}\check{V}\check{V}$ }φ which prohibits phrase-level LHH sequences (see 50b above). Our main contention is that low tone spread applies as a repair to these new LHH sequences.

Let us walk through this final part of our analysis. Since \check{V} -clitics do not form separate ω -words, they violate the constraint T-to- ω which requires all tones to associate to a vowel within a word (§4.2). Consequently, its low tone must tonally incorporate into the following ω . This component of the derivation is illustrated in Figure 16, where tone spreading is indicated with the checked line.

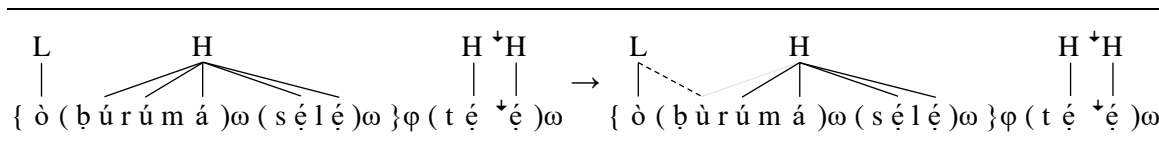


Figure 16: Tone of \check{V} -clitic tonally incorporates into following ω (due to T-to- ω)

This incorporation results in new *LHH violations at both the ω -level and the φ -level. In response, LTS applies. Recall that there are two surface LTS patterns. In LTS patterns which exhibit only H-compression, low spreads to all high-toned vowels but one (Figure 17). This complies with the within-phrase constraint *{ $\check{V}\check{V}\check{V}$ }φ but ends up creating new across-phrase * $\check{V}\check{V}$ }φ \check{V} violations, the latter of which must be repaired by downstep insertion (indicated by the checked box in this figure). As summarized in Table 14, downstep insertion is the only possible repair for *LHH violations across a φ -phrase boundary.

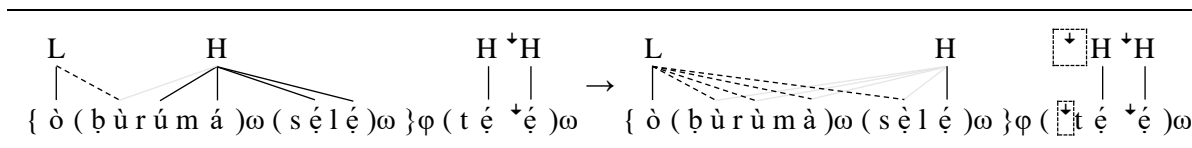
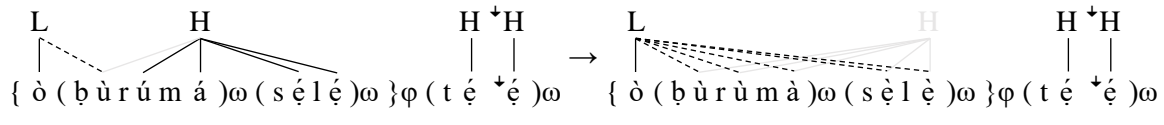


Figure 17: LTS (H-compression)—complies with *{ $\check{V}\check{V}\check{V}$ }φ, but creates new * $\check{V}\check{V}$ }φ \check{V} violation

In the other LTS pattern, H-absorption is exhibited as well whereby low spreads to all highs in the φ -domain (Figure 18). As established, this is only possible before another domain-external H. This complies with * $\check{V}\check{V}$ }φ \check{V} but leaves no trace of the underlying H.

Figure 18: LTS (H-absorption)—complies with $\ast\{VV\}\phi V$

Data such as these involving multi-word targets provides crucial evidence that phrase-level $\ast\{\check{V}\check{V}\check{V}\}\phi$ is involved in LTS, not merely word-level $\ast(\check{V}\check{V}\check{V})\omega$. If the only relevant constraint were $\ast(\check{V}\check{V}\check{V})\omega$, then we would have expected spreading to terminate at the word boundary contrary to fact. LTS can thus be added to the list of repairs in Table 14, being most similar to the ‘trigger lowering’ repair in possession-compound constructions (i.e. where $(\check{V}\check{V})(\check{V}\check{V}) \rightarrow [(\check{V}\check{V})(\check{V}\check{V})]$).¹⁴

4.7 Why does LTS not apply in other contexts?

Finally, recall that *all* pronominal clitics do not form their own ϕ -phrase, both pre-consonantal \check{V} -clitics such as \grave{o} ‘he’ in (55) above, but also their pre-vocalic counterparts such as $\grave{o}ri$ ‘he’ in (56) below. As indicated by the prosodic parsing in this example, clitics like $\grave{o}ri$ *do* form their own ω -word but belong to the following ϕ -phrase. However, unlike with \check{V} -clitics, LTS is not possible here.

(56) $\grave{o}ri$ íkírí mà bó árí → $\{(\grave{o}ri)\omega (íkírí)\omega (mà)\omega\}\phi \{(\acute{b}ó)\omega\}\phi (\acute{á}r\grave{i})\omega$
 he creep MAN come CONT ‘he comes creeping’

Based on our analysis, this fact requires explanation. If $\ast\{\check{V}\check{V}\check{V}\}\phi$ militates against phrase-level LHH sequences, and if the structure in (56) constitutes a single ϕ -phrase, then why is LTS not possible, i.e. a surface form $\ast\{(\grave{o}ri)\omega (íkírí)\omega \dots\}\phi$?

Intuitively, we may understand LTS as due to a kind of ‘chain reaction’: if the tone of prosodically deficient \check{V} -clitics spreads to the following word (due to T-to- ω), it may thereafter spread unboundedly to all highs in the phrase (due to $\ast\{\check{V}\check{V}\check{V}\}\phi$). Pronominal clitics like $\grave{o}ri$ are not subject to T-to- ω , as they form their own ω -word. The absence of this initial step results in no spreading at all, even in comparable environments which incur phrase-level violations.

This constitutes a kind of phonologically derived environment effect (Inkelas 2014, *inter alia*). Phonologically derived environment effects arise when a new phonological environment is created due to some phonological operation, after which other phonological operations may take place. Crucially, these latter operations do *not* take place without the new phonological environment being created first. A common example

¹⁴There is one context where LTS applies which still requires an explanation: in contexts of lexical downstep. Consider an example repeated in (v), where the \check{V} -clitic \grave{a} ‘I’ spreads but leaves one high tone before the downstepped high (the preferred form) but has an additional pronunciation where it spreads to all highs before the downstep (a questionable form, but not ungrammatical).

(v) \grave{a} [béké⁺ké érí]_{VP} t é⁺é → $\{\grave{a}$ héké⁺ké érí⁺_φ t é⁺é[~]? $\{\grave{a}$ hékéké⁺ ... _φ
 I chin see PERF ‘I have seen a chin’

We have already established that the correct interpretation of $\ast\text{LHH}$ is a low-toned vowel followed by two high-toned vowels. This specifically does *not* include downstep, as evidenced by the fact that $/LH^+H/$ lexical word patterns are common (Table 12; cf. $\ast/LHH/$), and that downstep insertion can be in fact a repair for $\ast\text{LHH}$ violations. In short, why does LTS seem to be able to ‘overapply’ here?

Tentatively, we may assume that the same H-absorption rule applies here. In order to accommodate these downstepping data, we may assume that what H-absorption is sensitive to is another H tone on the tonal tier. All contiguous strings of high-toned vowels within a phrase are associated to only one H toneme (invoking some prior merger operation). In contrast, contiguous strings of high-toned vowels *across* a phrase boundary constitute separate H tonemes on the tonal tier (the merger operation alluded to cannot apply). Downstep would necessarily also involve multiple H tonemes, within or across phrases. Viewing this together, H-absorption would apply both before phrase-external (non-downstepped) H’s as well as phrase-internal (downstepped) ^+H s. Both of these would constitute separate H tonemes. We leave an evaluation of this proposal to future work. We thank Daniel Gleim (U. Leipzig) for observations regarding Kalabari downstep and bringing them to our attention.

comes from Finnish (57, as presented in Inkelas 2014:251–252), where in certain derived environments a palatalization process applies whereby /t+i/ → [si]. One context where we see this derived palatalization process is following another phonological process whereby /e/ becomes [i] word finally.

(57) Phonologically derived environment effect in Finnish

Underlying ‘e→i’ ‘t→s’
/vete/ ‘water’ → veti → [vesi] (cf. [vete-] when suffixed)

Here, the application of the ‘t→s’ rule is parasitic on the application of the ‘e→i’ rule first (hence our ‘chain reaction’ analogy). We can compare this to non-derived phonological environments where palatalization does not occur, e.g. in æiti ‘mother’ (Inkelas 2014:243).¹⁵

In Kalabari, a similar parasitic relationship is evident. It is only if the low tone tonally incorporates into the following word (due to T-to-ω) that LTS can apply to the right edge of the phrase (due to *{V̇V̇V̇}φ). This is shown in (58), with the data from (55–56).

(58) Kalabari LTS as a phonologically derived environment effect

Underlying T-to-ω *{V̇V̇V̇}φ
a. ò búrú má sèlè tẹ́ é → ò búrú má sèlè tẹ́ é → ò búrùmà sèlè tẹ́ é
b. òrì íkírì mà ... → *does not apply* → *does not apply* (cf. *òrì íkírì mà...)

Words such as the clitic òrì ‘he’ do not violate T-to-ω and are therefore not subject to *{V̇V̇V̇}φ. In short, *{V̇V̇V̇}φ violations result in low tone spread only in derived environments and cannot otherwise apply.¹⁶

5 Conclusion

This paper has shown that certain pronominal clitics in Kalabari trigger a process of unbounded low tone spread whereby a string of contiguous high tones become low, exemplified by (59) used throughout this paper.

(59) à fénì sèlè tẹ́ é → [à fènì sèlè tẹ́ é] (cf. dispreferred [à fénì sèlè tẹ́ é])
I bird choose PERF ‘I have chosen a bird’

We have shown that the only triggering clitics are low-toned, monosyllabic, and onsetless clitics, and that the target must be a string of high tones. Our analysis of these patterns involved prosodic constituency coupled with word- and phrase-level tonotactics. The V̇-clitics which trigger low tone spread were analyzed as prosodically deficient (they would be ‘sub-minimal’ words), which need to be tonally incorporated into the following prosodic domain. If all high tones follow the trigger, then its incorporation violates a tonotactic restriction against LHH sequences. To repair the new *LHH violation, unbounded low tone spread takes place within the phonological phrase. To support our proposal, we have provided several pieces of independent evidence for *LHH tonotactics applying at different levels of the prosodic hierarchy in Kalabari, as well as independent evidence for the precise prosodic constituents of our analysis from grammatical tone (what we called ‘prosodic domain matching’). We ended our analysis by discussing the few contexts where phrase-level LHH sequences are tolerated, which we would expect to be subject to low tone spread as well. We take such data as showing that low tone spread constitutes a phonologically derived environment effect: unbounded spread only takes place if some other phonological operation (e.g. tonal incorporation) takes place

¹⁵These Finnish data are more complicated than presented here, and alternative analyses exist (e.g. Nie 2018, who treats such data as lexical exceptions to prosodically conditioned assibilation). The logic of phonologically derived environment effects remains, regardless of the validity of this Finnish exemplar.

¹⁶An interpretation as a phonologically derived environment may also account for the lack of downstep insertion in cases where the L and H belong to separate words (see footnote 2). Further, it is unclear at this point if target lowering and trigger lowering identified for certain phrases in §4.5 should be interpreted as LTS, and if so, whether this contradicts the notion that LTS only applies to phonologically derived environments. Future study is required.

first. In total, our study has shown that tone spread can profitably be decomposed into several sub-operations, which are triggered by multiple interacting factors involving word-minimality, prosodic constituency, and tonotactics.

Abbreviations

Supplemental to the abbreviations from the Leipzig Glossing Rules, glosses used for language examples are CONT continuous aspect; D general determiner; FAC factative aspect (\approx perfective/completive); M masculine; MAN manner adverbial maker; NEG negative polarity; P postposition; PERF perfect aspect; REDUP reduplication; RHET rhetorical; and RP resumptive pronoun.

Symbols used are H high tone; L low tone; \textcircled{H} floating high tone; \textcircled{L} floating low tone; \downarrow downstep; σ syllable; ω phonological word; φ phonological phrase; and ι intonational phrase.

Abbreviations in the body text include ADV adverb; ATR advanced tongue root; AUX auxiliary; C consonant; CFM clause-final marker; D determiner; INFL inflectional tense/aspect/mood/polarity particles; LTS low tone spread; MOD nominal modifier; NP noun phrase; Q quantifier; V vowel; and VP verb phrase.

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