“Tone in Degema nouns and noun phrases”

Abstract (~200 words):

This paper presents the first systematic study of tone in nouns and noun phrases in Degema. From a database of approximately 1000 nouns, we find that nouns fall into three main tone patterns: /L-L/ (48% of nouns), /H-H/ (18%), and /L-HH/ (13%). This last case is theoretically important in that it includes cases where two separate H tones associate to the same tone-bearing unit, in violation of the Obligatory Contour Principle. In isolation, nouns are subject to two basic tone rules which alter their underlying forms: downstep is inserted between two final H’s (e.g. /H-H/ → [H$^{!}$H]), and H is inserted at the end of an all-low sequence (e.g. /L-L/ → [LH]). The combined effect of these rules is that virtually all nouns and noun phrases have a pitch change. Further, we catalogue tonal effects found on nouns in 33 distinct modificational contexts within the noun phrase. We attribute these tonal effects to whether modifiers plus the noun form phonological phrases (φ) or phonological words (ω), and whether they form recursive prosodic structures, e.g. of the type ((**A**)φ **B**)φ. By positing recursive structure, we can localize tonal effects to an outermost prosodic layer (e.g. $\varphi_{[+max]}$), innermost layer (e.g. $\varphi_{[+min]}$), non-inner or outermost layers (e.g. $\varphi_{[-max]}$), or to the prosodic category as a whole (i.e. all layers of a φ).

Keywords (3-5): Tone, Lexical contrast, Prosodic domains, Recursion, Niger Delta

1 Introduction[1]

This paper presents a systematic study of tone in nouns and noun phrases in Degema [ISO 639-3: deg], an Edoid language of the Benue-Congo family (Niger-Congo phylum), spoken in the Niger Delta region of southern Nigeria. While a significant amount of description and analysis of Degema already exists – a grammar (Kari 2004), a dictionary (Kari 2008), studies on its vowel harmony (Fulop *et al.* 1998; Kari 2007), and extensive studies on its morphosyntax (Kari 2003a, Kari 2003b, Kari 2012, Kari 2015, Kari 2016a, Kari 2018; Rolle and Kari 2016; Rolle 2020) – there has been no dedicated study to date of its tone system.

Previous work has established two tones in Degema, high (H) and low (L), as well as surface downstepped high (ꜜH). Tone is lexically contrastive on nouns, adverbs, ideophones, and grammatical items (but not for verbs). A tonal (near) minimal pair is in (1), with the proposed underlying representations in / / slashes and the surface forms in [ ] brackets.

(1) Tonal (near) minimal pair

a. / **úgó** / [**úꜜgó**] ‘type of stew’

b. / **úgò** / [**úgò**] ‘butterfly’

c. / **ùgó** / [**ùgó**] ‘West African river eagle’

d. / **ùgù** / [**ùgú**] ‘word for counting thatches’

These data show that the underlying form of the noun and its surface form are not always identical. Further changes take place when nouns appear in noun phrases (NPs),

[1] We wish to thank Larry M. Hyman, Ohoso Kari, Ozo-mekuri Ndimele, two anonymous reviewers, and the editorial team at JALL.

depending on the NP modifier they appear with. This is illustrated in Table 1 below, comparing nouns in isolation to three modificational contexts (each modifier bears the same HL pattern). The tone changes from the underlying form are in red, and include raising, lowering, and downstep insertion.

Noun	Isolation	/ **kɪ́rè** / 'all'	/ **ḍíyèr** / 'bad'	/ **nénì** / 'our'
/ **ạ̀gàdà** / 'chair' (PL: **ì-**)	[**ạ̀gà<u>dá</u>**]	[**ìgàdà kɪ́rè**]	[**ạ̀gà<u>dá</u> ḍíyèr**]	[**ạ̀gàdà nénì**]
/ **óḅíḅí** / 'banana' (PL: **í-**)	[**ó<u>↓</u>ḅíḅí**]	[**íḅíḅí kɪ́rè**]	[**óḅíḅí ḍíyèr**]	[**ó<u>ḅìḅì</u> nénì**]

Table 1: Sample of tonal effects in four different contexts

With these observations as the foundation, the study has three goals: (i) what are the attested and unattested surface tone patterns on nouns in isolation, (ii) what underlying representations are justified (i.e. lexical tone contrasts), and (iii) how is the underlying tone on nouns systematically altered within noun phrases (NPs)? This last question is motivated by previous observations of tone changes in NPs (as in Table 1), as well as the ubiquity of grammatical tone in genetically related Edoid languages (Elimelech 1976; Thomas 1978; Elugbe 1989) and areally proximate languages of the Niger Delta (e.g. Williamson 1988). To address these questions, we created a database of approximately 1000 non-derived nouns (excluding compounds, nominalizations, *etc*.), based on entries in the Degema dictionary and supplemented by native speaker intuitions from the second author.[2]

This paper details our findings, split into two main sections. Section 2 provides a summary of tone contrasts on nouns across various sizes and morphological composition (those with noun class prefixes versus those without). Next, Section 3

[2] Degema has two dialects, Usokun and Ạtala (also called 'Degema Town'). Data presented here is on the Usokun dialect only.

provides a full description and analysis of the tonal effects on nouns when they appear in noun phrases. Here, we examine the results of all major tone contrasts in 33 NP contexts. Section 4 provides a conclusion. Finally, we provide an Appendix which briefly summarizes core tonal patterns with pre-nominal NP modifiers, otherwise outside of the scope of this paper.

2 Tone contrasts on nouns

This section details the findings of our database of 994 Degema nouns (the database is included in the supplemental materials). Nearly all nouns consist of a noun class prefix of the shape /V-/ (a single vowel), plus a noun root consisting of one or more syllables, for example **ò-fâl** 'red-necked lizard' [SG] vs. **ì-fâl** 'red-necked lizards' [PL]. We first examine the tone patterns on two-syllable nouns such as **ò-fâl** (§2.1), followed by three-syllable nouns (§2.2), then four-syllable nouns (§2.3). Following these, we present a small section on classless nouns which do not appear with a noun class prefix (§2.4). As stated already, any nouns whose stems were suspected of being synchronically multi-morphemic were not included (e.g. derived nominalizations, compounds, and transparent reduplication).

2.1 Two-syllable nouns

We begin our analysis by looking at 2σ nouns, which consist of a 1σ prefix plus a 1σ root (*n*=367). There are six tone pattern contrasts here, shown in Table 2 below. We provide both our proposed underlying representations (in slashes) as well as the surface pattern (in square brackets).[3]

[3] All Degema graphemes are their IPA equivalent, with the following exceptions. Retracted Tongue Root (i.e. [RTR], or non-advanced [-ATR]) is indicted by placing a dot under the vowel. Since all vowels within a word have the same harmony value, the Degema convention is to put a dot only under the first

	UR	Surface	Example		Meaning	*n*=
a.	/L-L/	[L.H]	**/ ù̩-bì̩ /**	**[ù̩bí̩]**	‘leaf, book’	229
b.	/L-H/	[L.H]	**/ ù-gó /**	**[ùgó]**	‘river eagle’	3
c.	/L-HL/	[L.HL]	**/ ò̩-gbôny /**	**[ò̩gbôny]**	‘clay soil’	8
d.	/L-HH/	[L.H^{+}H]	**/ ò-wé´y /**	**[òwé$^{+}$´y]**	‘person’	27
e.	/H-L/	[H.L]	**/ ú-gò /**	**[úgò]**	‘butterfly’	12
f.	/H-H/	[H.$^{+}$H]	**/ á̩-kí /**	**[á̩$^{+}$kí]**	‘cooking pot’	88

Table 2: Tone patterns on 2σ words (1σ prefix + 1σ root) (*n*=367)

Underlyingly, four of these patterns consist of a single tone on the prefix and separately a single tone on the root, i.e. /L-L/, /L-H/, /H-L/, and /H-H/. The other two patterns involve multiple tones on the root – i.e. /L-HL/ and /L-HH/ – the latter of which we analyze as having two independent high tones. Note that the noun class prefix itself does not show any consistent underlying tone. The same prefix may appear with several different tone patterns, which are entirely controlled by the root. As such, there are no instances where the singular and plural forms differ in tone pattern.

Certain regular tonal operations affect the underlying representations and result in the surface patterns as provided. We refer to these surface patterns as ‘unmodified forms’, and these are the reference forms in the Degema dictionary (Kari 2008). Degema shows a regular operation which affects underlyingly entirely low-toned nouns (/L-L/ in row a. from Table 2), whereby a H is placed on the final tone-bearing unit (TBU). We refer to this as ‘H-obligatoriness’, defined in (2) (we modify this definition later, in §3.4).

(2) ‘H-obligatoriness’ (*preliminary definition*)

a. All phonological phrases must contain a H tone

b. If this is not met, a H is inserted at the end of an all-low phrase

vowel of the word. Conventions for consonants are: <ḅ> = [ɓ], <ḍ> = [ɗ], <jz> = [dʒ]~[z] (depending on dialect), <ny> = [ɲ], <ñ> = [ŋ], <nw> = [ŋʷ], <v> = [β]~[v] (depending on dialect), and <y> = [j].

Nouns in isolation incidentally constitute phonological phrases, hence H-obligatoriness applies here. In larger phrasal contexts where all-low nouns appear with a modifier which bears a high tone, no H is added to the noun, e.g. compare / **ạ̀bị̀** / [**ạ̀bí**] 'books, leaves' with / **ạ̀bị̀ kɪ́rè** / [**ạ̀bị̀ kɪ́rè**] 'all books'.

These nouns contrast minimally with underlying /L-H/ nouns (row b. from Table 2). This /L-H/ pattern is marginal, and we have identified only three words belonging to this pattern: / **ùgó** / 'river eagle', / **òpé** / 'type of lizard', and / **ụ̀mpú** / 'jigger'. In isolation, both /L-H/ nouns and /L-L/ nouns surface identically as [L.H]. Unlike all-low nouns, /L-H/ nouns retain their final high in modificational contexts, e.g. [**ìgó kɪ́rè**] 'all river eagles' (cf. [**ạ̀bị̀ kɪ́rè**] 'all books', above). Note, however, that /L-H/ nouns are subject to variation in their surface pronunciations (both in isolation and in phrasal context). Given their marginality, it is unsurprising that we find such variation.

While we posit nouns with underlying /L-L/ (and marginally /L-H/), we do not posit nouns solely with underlying /L/. An anonymous review asks whether /L-L/ nouns should be rendered simply /L/, where a single tone spreads over both the prefix and the root. Evidence which could differentiate these two possibilities has not been found at this point. We posit /L-L/ to be consistent with the rest of the paradigm: all prefixes and roots are associated with a separate tone. Regardless of analysis, there is no contrast between /L-L/ versus /L/.

Although evidence differentiating /L-L/ from /L/ is lacking, there *is* evidence for a representation /H-H/ (row f. in Table 2), where the prefix and root each bear a separate H tone (rather than simply sharing a single tone, i.e. /H/). In such cases, a downstep is inserted between the two high tones in /H-H/ unmodified forms, such as when spoken

in isolation. For example, in Table 2 above underlying / **ạ́-kí** / ‘cooking pot’ surfaces as [**ạ́ˈkí**]. We refer to this as ‘Downstep-insertion’, characterized in (3).

(3) ‘Downstep-insertion’

a. No phonological phrase ends in a sequence of two independent H tones on the tonal tier

b. To repair this, a downstep is inserted between two phrase-final H tones

As with H-obligatoriness, we revise this characterization slightly in §3.4.

The surface downstep between two H’s at the end of the domain provides the crucial evidence that the underlying representation is /H-H/ (with two H’s) rather than a simpler alternative representation /H/. Under the alternative, the mapping of /H/ to [HˈH] would involve the single H splitting and then downstep being inserted (a type of tonal mitosis – Hyman 2014). There are two primary problems with this alternative analysis. First, there is a contrast between words ending in surface [HˈHH] versus [HHˈH], which would be hard to account for if they were both collapsed underlyingly to a single /H/. We thus need a way to predict where downstep will appear, which we do so by positing two adjacent H tones pre-associated to either the first two or second two TBUs. We expand on this in §2.3 below. Second and relatedly, under certain phrasal contexts the second of these H’s is lowered to L, resulting in surface forms [HLL] and [HHL] respectively (see §3.5). Such lowering does not affect words with a single H tone finally (e.g. LH nouns like / **ùgó** / ‘river eagle’).

Downstep-insertion is also seen in /L-HH/ nouns (row d. from Table 2 above). Here, the sole TBU of the root is associated with two distinct H tones, which we conventionally notate using two acute accents, e.g. / **ò-wé́y** / ‘person’. These forms

surface as [L.H$^{\downarrow}$H], where the final vowel bears a high-to-downstepped high contour tone. An input-output mapping is provided in Figure 1 (tone changes are in red).

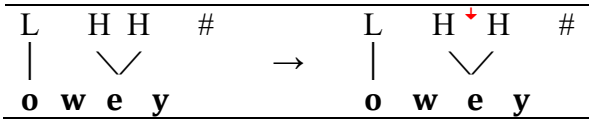

Figure 1: Downstep-insertion in L-HH nouns

Note that the Degema practical orthography (Kari 2008) transcribes /L-HH/ nouns with a double vowel, e.g. / **ò-wé́y** / 'person' is transcribed < **owéēy** >. However, there is no contrastive vowel length in Degema and we interpret any lengthening here as incidental to accommodate the contour (Kari 2004: 383, 386). In fact, there is evidence that they are underlyingly short. When the final vowel in a /L-HH/ word appears in non-phrase-final position, then downstep is not inserted. In this context, the final vowel surfaces as short rather than long, e.g. / **òwé́y kị́rè** / surfaces as [**òwéy kị́rè**] and not *[**òwéey kị́rè**].

Finally, the remaining two patterns from Table 2 – /L-HL/ (row c.) and /H-L/ (row e.) – are rare. Here, the UR and the surface pronunciation are identical. No other tone patterns are attested in 2σ nouns with [prefix-root] nominal structure.[4]

[4] An anonymous reviewer brings up the fact that many nouns which have a tone contour – i.e. /L-HH/ and /L-HL/ nouns – also end in a consonant, e.g. / **àmôny** / 'wall gecko' (IPA [**ə̀mə̰̀ŋ**]). At first glance, this might suggest that the final consonant contributes a mora. However, there are also many words which show a contour tone on an open syllable as well, e.g. / **ə̀kpô** / 'harrier hawk'.

2.2 Three-syllable nouns

Let us now look at 3σ nouns, which consist of a 1σ noun class prefix plus a 2σ root (*n*=448). There are ten main patterns here, summarized in Table 3. Five begin with a prefix that bears low tone (a.-e.) and five with a prefix that bears high tone (f.-j.).

	UR	Surface	Example		Meaning	*n*=
a.	/L-L/	[L.L.H]	**/ ạ̀-gàdà /**	**[ạ̀gàdá]**	'chair'	175
b.	/L-LHL/	[L.L.HL]	**/ ì-gbèlâ /**	**[ìgbèlâ]**	'dandruff'	7
c.	/L-LHH/	[L.L.H$^{\downarrow}$H]	**/ ạ̀-pàpá́ /**	**[ạ̀pàpá$^{\downarrow}$́]**	'groundnuts'	20
d.	/L-HL/	[L.H.L]	**/ à-kpígì /**	**[àkpígì]**	'spider'	16
e.	/L-HH/	[L.H.$^{\downarrow}$H]	**/ ò-gbúró /**	**[ògbú$^{\downarrow}$ró]**	'yam'	79
f.	/H-L/	[H.L.L]	**/ á́-bìlì /**	**[á́bìlì]**	'draughts'	5
g.	/H-LH/	[H.L.H]	**/ é-kùlé /**	**[ékùlé]**	'black kite'	8
h.	/H-LHL/	[H.L.HL]	**/ á́-bàbâny /**	**[á́bàbâny]**	'flounder'	8
i.	/H-H/	[H.$^{\downarrow}$H.H]	**/ ó-bíbí /**	**[ó$^{\downarrow}$bíbí]**	'banana'	68
j.	/H-HL/	[H.H.L]	**/ ú́-kútà /**	**[ú́kútà]**	'bead'	54

Table 3: Tone patterns on 3σ words (1σ prefix + 2σ root) (*n*=448)

The four most common patterns above are /L-L/, /L-HH/, /H-H/, and /H-HL/. For /L-L/ and /H-H/ nouns (rows a. and i.), the first tone is associated to the prefix and the second tone is associated to both syllables of the root. Just as we saw with 2σ nouns (Table 2), /L-L/ nouns surface as [L.L.H] due to H-obligatoriness, and /H-H/ surface as [H.$^{\downarrow}$H.H] with downstep due to Downstep-insertion. This is further illustrated in the input-output mappings in Figure 2.

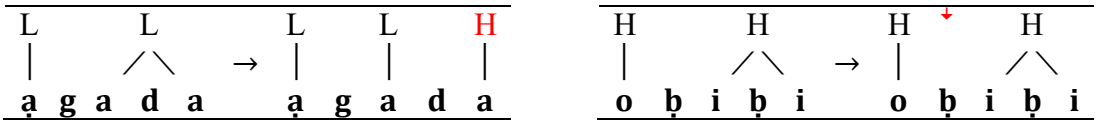

Figure 2: H-obligatoriness with /L-L/ noun, and Downstep-insertion in /H-H/ noun

Nouns of the tonal pattern /H-HL/ surface as [H.H.L]. No downstep is inserted between the high tones (i.e. *[H.$^{\downarrow}$H.L]), demonstrating that the Downstep-insertion rule only applies to separate H tones at the end of the relevant phonological domain (see row j. of Table 3 for an example). Moreover, unlike in 2σ nouns /L-H/ nouns are

unattested. Only /L-HH/ nouns exist with two distinct H tones, which surface as [L.H.ˈH] due to Downstep-insertion. There are no nouns with a surface [L.H.H] pattern, which would derive from underlying /L-H/. However, outside of nouns this pattern is marginally attested, e.g. the numeral / **ịnúmán** / surfaces as [**ịnúmán**] 'eight', and not as *[**ịnúˈmán**].[5]

Returning to Table 3, there are six other tone patterns, having between 5-20 members. Two are somewhat common, namely /L-LHH/ surfacing as [L.L.HˈH], and /L-HL/ surfacing as [L.H.L]. The /L-LHH/ pattern provides further examples of two distinct H tones docking to a single TBU. In isolation, such nouns are subject to Downstep-insertion, e.g. / **àpàpá´** / becomes [**àpàpáˈ´**] 'groundnuts'. When not in domain-final position, such words surface with a simple high tone on a short vowel, i.e. [**àpàpá** …]). The other four – /L-LHL/, /H-L/, /H-LH/, and /H-LHL/ – are

[5] In the dictionary, many nouns *do* appear to show a [L.H.H] surface form, without downstep. However, without exception all of these nouns contain a sequence [iyV] and [uwV], i.e. a high vowel separated from another vowel by a homorganic glide, such as [**ìvíyónw**] 'breast', [**ùvúwó**] 'sun', among others. This can be accounted for straightforwardly if these sequences are interpreted as a single syllable, i.e. such words constitute only two syllables [**ì.víyónw**] rather than three (*[**ì.ví.yónw**]). Underlyingly, such words are represented / **ìvìònw** / without a glide. These would be subject to H-obligatoriness, and the inserted H associates to both vowels in the final syllable.

Supporting evidence for the interpretation as a single syllable comes from allomorphy sensitive to syllable count (Kari 2008, Kari 2016b). The iterative suffix has two forms: -**viriy** and –**Vy** (with an unspecified vowel determined by the stem). If a verb root is of the shape CV, it selects –**viriy**, e.g. **bạ** 'to tap' and **bạ-viriy** 'tap many times, always'. Verbs which are of larger shapes CVC, CVCV, CVCVC, CVCVCV, *etc*. select the -**Vy** allomorph, e.g. **ḅav** 'to smoke' and **ḅav-ay** 'smoke many times, always', **bạba** 'to carry on back' and **bạba-y** 'carry on back many times, always'. Importantly, all verbs of the shape CiyV and CuwV pattern like monosyllabic CV in selecting –**viriy**, and thus do not pattern as disyllabic, e.g. **ḅiye** 'to give birth' and **ḅiye-viriy** 'give birth many times, always', and **gụwa** 'to mix' and **gụwa-viriy** 'to mix many times, always'. Such patterns are predicted if verbs like **ḅiye** are underlyingly monosyllabic / **ḅie** /.

relatively rare, having under 10 members. These show that if there are more tones than TBUs, a contour is formed at the right edge, i.e. /L-LHL/ maps to surface [L.L.HL].[6]

2.3 Four-syllable nouns

There are also a sizeable number of four-syllable nouns, which consist of a 1σ class prefix plus a 3σ root (*n*=132). There are six main tonal patterns, summarized in Table 4. Four begin with a low-toned prefix (a.-d.) and two with a high-toned prefix (e.-f.).

	UR and surface	Example	Meaning	*n*=
a.	/L-L/ [L.L.L.H]	**/ ẹ̀-tàb̀ìlà /** **[ẹ̀tàb̀ìlá]**	'tilapia'	50
b.	/L-LHH/ [L.L.H.ˈH]	**/ ò̩-b̀ìtílá /** **[ò̩b̀ìtíˈlá]**	'eel'	9
c.	/L-HH/ (a) [L.H.ˈH.H]	**/ ò-dúmíná /** **[òdúˈmíná]**	'sheep'	9
d.	/L-HH/ (b) [L.H.H.ˈH]	**/ ù-b̀úrúmá /** **[ùb̀úrúˈmá]**	'indigo'	7
e.	/H-LHL/ [H.L.H.L]	**/ ó-pùrópò /** **[ópùrópò]**	'pig'	19
f.	/H-H/ [H.ˈH.H.H]	**/ í-gbákírí /** **[íˈgbákírí]**	'squirrel'	15

Table 4: Tone patterns on 4σ nouns (1σ prefix + 3σ root) (*n*=132)

[6] Additionally, there are seven marginal tone patterns for 3σ nouns which appear with only one or two nouns. Examples are below:

(i.) /L-LHLH/ [L.LH.LH] e.g. / **ò-tŭtŭ** / [**òtŭtŭ**] 'Senegal coucal'

(ii.) /L-HL/ (b) [L.HL.L] e.g. / **ẹ̀-bêndè** / [**ẹ̀bêndè**] 'maize with dents'

(iii.) /L-HLH/ [L.H.LH] e.g / **è-kpébìó** / [**èkpébìyó**] 'cricket'

(iv.) /H-LHL/ (b) [H.LH.L] e.g. / **ú-sănd̀ì** / [**úsănd̀ì**] 'earthworm'

(v.) /H-LHLH/ [H.LH.LH] e.g. / **í-d̩ŭd̩ŭ** / [**íd̩ŭd̩ŭ**] 'collection of birds that signal breaking of day'

(vi.) /H-HL/ (b) [H.H.HL] e.g. / **ó̩-kúnyâm** / [**ó̩kúnyâm**] 'monkey banana'

(vii.) /H-HLH/ [H.HL.H] e.g. / **ó-gbôfó** / [**ógbôfó**] 'gap tooth'

Some of these patterns are labeled with (b) to distinguish them from more common patterns with the same underlying tone string (those in Table 3). For example, nearly all nouns with underlyingly /H-HL/ surface as [H.H.L] (e.g. / **ú̩-kútà** / [**ú̩kútà**] 'bead'), but one surfaces as [H.H.HL] (/ **ó̩-kúnyâm** / [**ó̩kúnyâm**], vi. above).

The most common patterns are /L-L/ (surfacing as [L.L.L.H]), /H-LHL/ ([H.L.H.L]), and /H-H/ ([H.ꜜH.H.H]). The /L-L/ and /H-H/ patterns show the expected effects of H-obligatoriness and Downstep-insertion in surface forms. The other three patterns all involve two distinct H tones which fall on the root: /L-LHH/ [L.L.H.ꜜH], /L-HH/ (a) [L.H.ꜜH.H], and /L-HH/ (b) [L.H.H.ꜜH]. The latter two show a contrast which appears in enough nouns that it cannot be taken as negligible. We account for this contrast by positing pre-association of one of the H's to either the last two TBUs of the root (the (a) pattern in Figure 3) or the first two TBUs (the (b) pattern).

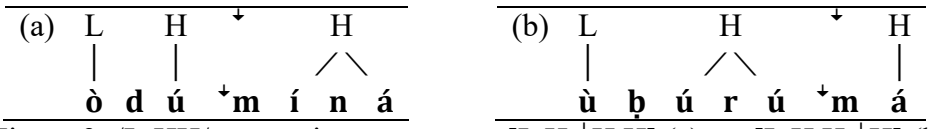

Figure 3: /L-HH/ tone string contrasts – [L.H.ꜜH.H] (a) vs. [L.H.H.ꜜH] (b)

As stated in §2.1 above, such data support an analysis for multiple H tones in the root, rather than a single H that spreads over all the TBUs. If these surface patterns would both derive from underlying /L-H/ (rather than the posited /L-HH/), there would be no explanation as to why there is a contrast here in downstep placement. This contrast in H association is only found if the prefix bears a L. There is no contrast if the prefix bears a high tone, e.g. a contrast between [H.ꜜH.H] nouns (attested) versus *[H.H.ꜜH] (unattested) in 3σ nouns, or [H.ꜜH.H.H] (attested) versus *[H.H.ꜜH.H] (unattested) or *[H.H.H.ꜜH] (unattested) in 4σ nouns.[7]

[7] While the Degema dictionary (Kari 2008) lists several nouns of the shape [H.H.ꜜH] – e.g. entries < **ạ́fárī** > 'sardine type', < **ạ́rírī** > 'worm in the eye', < **ésélē** > 'straight', among others – these are errors and should be corrected. The forms are actually pronounced [H.ꜜH.H], the expected pattern. Therefore the orthographic form should be < **ạ́fārí** >, corresponding to its actual pronunciation [**ạ́ꜜfárí**].

Moreover, surface forms with two downsteps are also unattested, i.e. *[H.ꜜH.ꜜH] or *[H.ꜜH.ꜜH.H]. This indicates that there is no noun with underlying */H-HH/, i.e. a contiguous string of three independent H tones, one associated to the prefix and two H's associated to the root. We call this the '3H-ban':

(4) 3H-ban – No noun contains a contiguous string of three independent H tones on the tonal tier

Finally, there are also nine marginal tone patterns on four-syllable nouns, which appear on five or less nouns each. These will not play a role in the rest of our analysis.[8]

2.4 Classless nouns

A minority of Degema nouns occur without a noun class prefix, which we refer to as 'classless' nouns. These have a wider range of tone patterns, but their numbers are too small to make any clear generalizations. In this section, we summarize patterns with 2σ and 3σ classless nouns, all of which are consonant-initial.[9]

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[8] These marginal patterns are the following:

(i.)	/L-LHL/ (a)	[L.L.H.L]	(*n*=3)	e.g. / **ù̩-ḍòndílì** / [**ù̩ḍòndílì**] 'skink'
(ii.)	/L-LHL/ (b)	[L.L.L.HL]	(*n*=1)	e.g. / **ò̩-vìlèvêl** / [**ò̩vìlèvêl**] 'cockroach'
(iii.)	/L-LHL/ (c)	[L.L.HL.L]	(*n*=1)	e.g. / **à̩-bàdâbà** / [**à̩bàdâbà**] 'dry plantain leaves'
(iv.)	/L-HL/ (a)	[L.H.L.L]	(*n*=5)	e.g. / **è-lésìkì** / [**èlésìkì**] 'red-eyed turtle dove'
(v.)	/L-HL/ (b)	[L.H.H.L]	(*n*=2)	e.g. / **ò-kírérè** / [**òkírérè**] 'species of sardine'
(vi.)	/L-HLH/	[L.H.L.H]	(*n*=4)	e.g. / **ò-síkìrí** / [**òsíkìrí**] 'sugar'
(vii.)	/H-LHL/ (b)	[H.L.L.HL]	(*n*=1)	e.g. / **ó-vìrìgôny** / [**óvìrìgôny**] 'dragonfly'
(viii.)	/H-LHH/	[H.L.H.ꜜH]	(*n*=2)	e.g. / **á̩-nyìnyírá** / [**á̩nyìnyíꜜrá**] 'kind of edible plant leaves'
(ix.)	/H-HL/	[H.H.H.L]	(*n*=4)	e.g. / **ó̩-bónínyà** / [**ó̩bónínyà**] 'umbrella tree'

Note that all four /H-HL/ nouns map to [H.H.H.L], and that *[H.H.L.L] surface forms are unattested.

[9] There are only three 1σ classless nouns – [**gə̩̀m**] 'cork, floater', [**ḍə̩̀ny**] 'red colobus monkey', and [**nwə̩̀ny**] 'an amount' (e.g. of money). Further, there are five 4σ classless nouns, three of which show internal reduplication – [**bélébèlè**] 'a type of masquerade', [**kpò̩kúkpòkú**] 'a type of catfish', [

The tone patterns on 2σ classless nouns are in Table 5 below (*n*=33).

	UR	Surface	Example		Meaning	*n*=
a.	/L/	[L.H]	/ **tùgbè** /	[**tùgbé**]	'land crab trap'	5
b.	/LHL/	[L.HL]	/ **sùkûl** /	[**sùkûl**]	'school'	6
c.	/LHLH/	[LH.LH]	/ **jzĭmjzĭm** /	[**jzĭmjzĭm**]	'whale'	2
d.	/HL/ (a)	[H.L]	/ **vạ́là** /	[**vạ́là**]	'sail'	16
e.	/HL/ (b)	[H.HL]	/ **nyạ́nwôm** /	[**nyạ́nwôm**]	'rockfowl'	1
f.	/HLHL/	[HL.HL]	/ **gbậ́mgbâm** /	[**gbậ́mgbâm**]	'cannon'	1
g.	/HH/	[H.↓H]	/ **tọ́ló** /	[**tọ́↓ló**]	'mesh'	2

Table 5: Tone contrasts in 2σ classless nouns (*n*=33)

Only three of these occur on five or more nouns: /HL/ (a) mapping to [H.L] (the most common), /L/ mapping to [L.H] (due to H-obligatoriness), and /LHL/ mapping to [L.HL]. The others are restricted to one to two nouns each. Many of these classless nouns are transparent borrowings from English (e.g. / **sùkûl** / 'school', / **kọ́pù** / 'cup') or from a neighboring language Kalabari [ijn] which has no noun class system. Borrowings from Kalabari include / **jzĭmjzĭm** / 'whale', / **tọ́ló** / ([**tọ́↓ló**]) 'mesh', / **vạ́là** / 'sail' (ultimately from Portuguese *vela*), among others (see Blench 2008 for Kalabari data).

There is an even smaller number of 3σ classless nouns (*n*=9).

(5) 3σ classless nouns (*n*=9)

a.	/L/	[L.L.H]	/ **ḍàrànè** /	[**ḍàràné**]	'salvation'
b.	/LHL/	[L.H.L]	/ **fịláwà** /	[**fịláwà**]	'flower' (< Eng.)
c.	/HL/	[H.L.L]	/ **ḍíhìlè** /	[**díhìlè**]	'umbrella anthill'
d.	/HLH/	[H.L.H]	/ **fífòlí** /	[**fífòlí**]	'type of skin disease'
e.	/HLHL/	[HL.H.L]	/ **nwệrésì** /	[**nwệrésì**]	'pigeon' (< Kal.)

kpùtùkpùtú] 'motorcycle', [**púrùnwángàm**] 'fiddler crab', and [**bìlàkólò**] 'hatched egg shell'. We will not discuss their tone patterns.

Only the /HLHL/ form (e.) shows an unexpected tone pattern compared to regular 3σ or 4σ nouns (clearly related to the Kalabari word [**nwáẹ̀ṛ́ésị̀**] ‘pigeon’).

2.5 Local summary of tone contrasts

Table 6 summarizes the tone contrasts found on regular nouns which appear with a noun class prefix (*n*=947). These are broken down by their syllable count and tone pattern. This table reveals that nearly 80% of nouns in the lexicon bear one of three underlying tone patterns: /L-L/, /H-H/ and /L-HH/.

	2σ (*n*=367)	3σ (*n*=448)	4σ (*n*=132)	Total (*n*=947)	
/L-L/	229	175	50	454	47.9%
/H-H/	88	68	15	171	18.1%
/L-HH/	27	79	16	122	12.9%
/H-HL/	0	55	4	59	6.2%
/L-HL/	8	24	12	44	4.6%
/H-LHL/	0	10	20	30	3.2%
/L-LHH/	0	20	9	29	3.1%
/H-L/	12	5	0	17	1.8%

Table 6: Summary of regular nouns (w/ prefix) by syllable count and tone pattern

The other tone patterns not shown in this table constitute only 21 nouns (or 2.2% of the database).

Further, we established three constraints on tone patterns, summarized in (6).

(6) Constraints on tone patterns:

a. H-obligatoriness – All phonological phrases must contain a H tone; if this is not met, a H is inserted at the end of an all-low phrase

b. Downstep-insertion – If a phonological phrase ends in a sequence of two independent H tones on the tonal tier, a downstep is inserted

c. 3H-ban – No noun contains a contiguous string of three independent H tones on the tonal tier

The first two constraints together ensure that all surface patterns have at least one pitch change at the phrase level.

Moreover, although rare it is possible for multiple tones to associate to a single TBU, resulting in falling contours (e.g. / **ọ̀gbôny** / 'clay soil') or rising contours (e.g. / **jzǐmjzǐm** / 'whale'). A particularly notable pattern involves distinct H tones associating to a single TBU, e.g. in nouns such as / **ò-wé́y** / 'person' or / **ạ̀-pàpá́** / 'groundnuts', where the multiple H's are indicated by two acute accent marks. When these are pronounced in isolation, the final TBU surfaces with a high-downstepped high contour due to the regular application of Downstep-insertion, i.e. as [**òwé$^{\downarrow}$́y**] and [**ạ̀pàpá$^{\downarrow}$́**], respectively.

The fact that a single TBU can be associated with two tones of the same identity (i.e. both H) is a clear violation of the Obligatory Contour Principle (OCP) which bans adjacent identical elements (Leben 1973; Goldsmith 1976). However, the ongoing typologizing of tone systems has shown that many languages permit OCP violations at some level of representation. Even early on in the development of the OCP, several analyses were posited with explicit OCP violations, e.g. Odden (1982) for Shambala [ksb] and Clements' (1984: 288) discussion of 'geminate tone melodies' in Kikuyu [kik] (see Snider 2020 for a brief history of OCP violability). Given the widespread adoption of Optimality Theory (Prince and Smolensky 2004 [1993]), constraints such as the OCP can be interpreted as violable, and moreover, there can be no restrictions on underlying structure (i.e., Richness of the Base). Thus, underlying representations like /L-HH/ seen here cannot be automatically ruled out.

3 Tonal effects in the noun phrase

Having established the basic lexical tone contrasts in Degema, in this section we systematically describe the core tone patterns which appear on nouns within noun phrases (NPs). Our results are based on surveying the surface tonal patterns of the major lexical tone contrasts in 33 distinct NP contexts, based on the judgments of the second author, a native speaker. We shall see that the tone of nouns is systematically altered in NPs, and the surface pattern depends on which modifiers the noun appears with. NP modifiers can be grouped into three primary groups based on their tonal effect: an outer modifier class (§3.3), a tone-raising inner modifier class (§3.4), and a tone-lowering inner modifier class (§3.5). We explain each of these in turn below.

3.1 NP modification

We begin by establishing the linear order of modifiers in the NP, in Table 7. Here, NP modifiers are classified separately if we have overt evidence for ordering restrictions, e.g. possessive pronouns linearly precede determiners. The modifiers are placed into positional slots according to their linear orientation and distance from the head noun.

[-1]	[0]	[+1]	[+2]	[+3]	[+4]
-Nominals -Quantifiers -Numerals	HEAD NOUN	-Nominals -Numerals -Adjectivals	-Possessive pronouns	-Demonstratives -Determiners (DEF, QUES)	-Quantifiers -Relative clauses

Table 7: Basic order of modifiers within the NP

'Nominals' appear before or after the head noun depending on the specific nominal modifier. Those which appear before the head noun include descriptive nominals which may in other languages be adjectives (e.g. / **ì-gòdò** / 'long'). Those which appear after the head noun include nominals that are part of noun compound and possessive noun structures, e.g. head / **ẹ̀kò** / 'pillar' + modifier / **ụ́váy** / 'house' → [**ẹ̀kó ụ́vày**] 'pillar

of a house' (Kari 2004: 363). A related category are 'adjectivals' (e.g. / **ḍégìnà** / 'old'), which always follow the head noun. Adjectivals are distinct from descriptive nominals in that adjectivals do not occur with a noun class prefix when they are modificational (cf. **ḍégìnà** to the nominal **ì-gòdò** 'long' with a prefix).[10]

An example illustrating the order of modifiers after the head noun is in (7), specified as to which positional slot they belong to.

(7) Example illustrating order of modifiers in the NP

[**ą́kpò ḍégíná ívà nǫ́ònw náà nṵ̀ ì=sóm=n ófìyèñìnè kį́rè nṵ̀ mì=ḍé=n úḍéè yǫ̀**]

ą́kpò	**ḍégíná**	**ívà**	**nǫ́ònw**	**náà**	**nṵ̀**	**ì=sóm=n**
skewers	old	two	his	this	[REL	3PL=be.good=FAC
[0]	[+1]	[+1]	[+2]	[+3]	[+4]	

ófìyèñìnè	**kį́rè**	**nṵ̀**	**mì=ḍé=n**	**úḍéè**	**yǫ̀**
difference]RC	all	[REL	1SG=buy=FAC	yesterday	DEF]RC
	[+4]	[+4]			

'all these two old skewers of his, that are better, that I bought yesterday'

(Kari 2004: 102-103)

In general, the same tonal effects are triggered by all semantically-related modifiers of the same positional slot (e.g. by all possessive pronouns, in slot [+2]). For reasons of space and complexity, we only discuss the tonal effects of modifiers which appear *after*

[10] Semantically, descriptive nominals (appearing before the noun) denote height, shape, texture, and size, while adjectivals (after the noun) denote color, age, quality, and temperature (Kari 2004: 87-89).

the head noun (those in slots [+1] to [+4]). An Appendix is provided which briefly summarizes the tonal effects from pre-nominal modifiers (slot [-1]) on head nouns.

3.2 Our baseline: Tone patterns of unmodified nouns

Our baseline for comparison will be the tone patterns of unmodified nouns. This was the form of the noun seen in isolation in §2 above, and often the form seen at the end of phrases, e.g. in conjunction with **nù** 'and' or disjunction with **ómòkáà** 'or'. For example, in (8) the unmodified form of the noun / **ạ́-kí** / 'pot' is found in the context **ìnùm nù** __ 'something and __', where it surfaces as [**ạ́ˈkí**] (due to Downstep-insertion).

(8) Unmodified form of noun used with conjunction **nù** 'and'

/ **ì-nùm nù ạ́-kí** / → [**ìnùm nù ạ́ˈkí**] 'something and a pot'

Table 8 provides a representative sample of unmodified (surface) forms across a range of tonal contrasts, exemplified with both 2σ and 3σ nouns (note certain gaps, indicated with a dash). These forms will act as the baseline for comparison of nouns modified within an NP. As established, the only two tone changes are H-obligatoriness affecting forms with all low tones, and Downstep-insertion between two final H tones.

	UR		Examples		Unmodified (surface) form	
a.	/L-L/	2σ	/ **ù̩-bì** /	'book'	[L.H]	**ù̩bí**
		3σ	/ **à̩-gàdà** /	'chair'	[L.L.H]	**à̩gàdá**
b.	/L-H/	2σ	/ **ù-gó** /	'river eagle'	[L.H]	**ùgó**
		3σ	-	-	-	**-**
c.	/L-HL/	2σ	/ **à-môny** /	'wall gecko'	[L.HL]	**àmôny**
		3σ	/ **à-kpígì** /	'spider'	[L.H.L]	**àkpígì**
d.	/L-LHH/	2σ	-	-	-	**-**
		3σ	/ **à̩-pàpá́** /	'groundnut(s)'	[L.L.H↓H]	**à̩pàpá↓́**
e.	/L-HH/	2σ	/ **ò-wé́y** /	'person'	[L.H↓H]	**òwé↓́y**
		3σ	/ **à̩-kpátá** /	'bird nest'	[L.H.↓H]	**à̩kpá↓tá**
f.	/H-L/	2σ	/ **ú-gò** /	'butterfly'	[H.L]	**úgò**
		3σ	/ **á̩-bìlì** /	'draughts'	[H.L.L]	**á̩bìlì**
g.	/H-LH/	2σ	-	-	-	**-**
		3σ	/ **é-kùlé** /	'black kite'	[H.L.H]	**ékùlé**
h.	/H-H/	2σ	/ **á-kí** /	'cooking pot'	[H.↓H]	**á̩↓kí**
		3σ	/ **ó-ḅíḅí** /	'banana'	[H.↓H.H]	**ó↓ḅíḅí**
i.	/H-HL/	2σ	-	-	-	**-**
		3σ	/ **í-súvèny** /	'nose'	[H.H.L]	**ísúvèny**

Table 8: Our baseline for comparison – The unmodified forms of nouns

3.3 The outer modifier class

One class of NP modifiers are referred to as 'outer modifiers', so called because its members appear outermost within the NP, specifically the [+4] slot (Table 7 above). Examples are in (9), and consist of quantifiers and relative clauses (RCs).[11] These are illustrated with the /L-HH/ noun / **ò-wé́y** / 'person' (PL: **è-**). Note in (9d) that RCs are introduced with the general relativizer/marker of subordination **nṵ́** REL 'that', and that RCs often end in **yò̩** (transparently related to **yò̩** DEF 'the').

[11] Additionally, the same tone patterns occur on nouns in cleft constructions, and before the disjunction marker **kóòm** 'or', e.g. in [__ **kóòm ìnùm** ?] '__ or something?'. See Kari (2004: 16, 24, 70, 105, 164) for details on these constructions.

(9) Outer modifier class (appearing in slot [+4] in the NP)

a. / **kɨ́rè** / ‘all’ [**èwéy kɨ́rè**] ‘all people’

b. / **káà** / (~ **kɑ́à**) ‘also’[12] [**òwéy káà**] ‘also a person’

c. / **kpɛ̀ny** / ‘only’ [**òwéy kpɛ̀ny**] ‘only a person’

d. / **nʉ́** CLAUSE **yò** / ‘that CLAUSE’ (relative clause)

òwéy [**nʉ́ ò=ɖé=n ítónw yò**]$_{RC}$ **ò=yí=↓té**

person [REL 3SG=buy=FAC cloth DEF]$_{RC}$ 3SG=come=PRF

‘the person [who bought the cloth]$_{RC}$ has come’

(Kari 2004: 51)

The tonal effects on the head noun in the context of outer modifiers are shown schematically in Table 9, for both 2σ (rows a.-e.) and 3σ nouns (f.-m.). Outer modifiers are divided into two columns: low-toned **kpɛ̀ny** ‘only’ versus the others which begin with H. Tone changes from the UR are in red. For easy comparison, we also provide the surface tonal patterns of unmodified nouns, the rightmost subscripted column.

[12] Note that / **káà** / ‘also’ harmonizes in ATR value with the value of the noun (Kari 2007: 91). The other outer modifiers do not vary in their ATR value.

	UR of noun	[___ **kpẹ̀ny**]	[___ **kı́rè**], [___ **káà**], [___ **nṵ**…], *etc.*	Cf. unmodified
a.	/L-L/	[L.H]	[L.L]	[L.H]
b.	/L-H/	[L.H]	[L.H]	[L.H]
c.	/L-HH/	[L.H]	[L.H]	[L.H˖H]
d.	/H-L/	[H.L]	[H.L]	[H.L]
e.	/H-H/	[H.H]	[H.H]	[H.˖H]
f.	/L-L/	[L.L.H]	[L.L.L]	[L.L.H]
g.	/L-LHH/	[L.L.H]	[L.L.H]	[L.L.H˖H]
h.	/L-HL/	[L.H.L]	[L.H.L]	[L.H.L]
i.	/L-HH/	[L.H.H]	[L.H.H]	[L.H.˖H]
j.	/H-L/	[H.L.L]	[H.L.L]	[H.L.L]
k.	/H-LH/	[H.L.H]	[H.L.H]	[H.L.H]
l.	/H-H/	[H.H.H]	[H.H.H]	[H.˖H.H]
m.	/H-HL/	[H.H.L]	[H.H.L]	[H.H.L]

Table 9: Tone patterns on nouns (2σ and 3σ) with outer modifier class

The first observation to make is that /L-L/ nouns (rows a., f.) surface as [(L.)L.H] when they appear with the low-toned modifier **kpẹ̀ny** 'only'. Otherwise they surface as [(L.)L.L] if the outer modifier begins with a high tone. Examples showing this difference are in (10).

(10) /L-L/ surfacing as [(L.)L.L] and [(L.)L.H]

a. / **è-sèn** / 'fish' (PL: **ì-**)

[**ìsèn kı́rè**] 'all fish'

[**èsèn káà**] 'also a fish'

[**èsèn nṵ mị̀=dɛ́=˖ɛ́n**] 'a fish that I bought'

cf. [**èsén kpẹ̀ny**] 'only fish'

b. / **ạ̀-gàdà** / 'chair' (PL: **ị̀-**)

[**ị̀gàdà kı́rè**] 'all chairs'

[**ạ̀gàdà kạ́à**] 'also a chair'

[**ạ̀gàdà nṵ mị̀=dɛ́=˖ɛ́n**] 'a chair that I bought'

cf. [**ạ̀gàdá kpẹ̀ny**] 'only a chair'

Second, observe that for nouns underlyingly ending in two H tones, there is no downstep in the context of the outer modifiers. This is illustrated with /L-LHH/ (11a) and /H-H/ nouns (11b).

(11) No downstep inserted on nouns ending in two H's with outer modifiers

a. /L-LHH/: / **ạ̀-pàpá́** / 'groundnut(s)' (cf. unmodified [**ạ̀pàpá˖́**])

[**ạ̀pàpá kɪ́rè**] 'all groundnuts'

[**ạ̀pàpá kạ́à**] 'also groundnuts'

[**ạ̀pàpá kpẹ̀ny**] 'only groundnuts'

b. /H-H/: / **ạ́-kí** / 'pot' (PL: **ɪ́**-), / **ọ́-mó** / 'child', / **ó-bḭ́bḭ́** / 'banana' (PL: **í**-)

[**ɪ́kí kɪ́rè**]	'all pots'	[**íbḭ́bḭ́ kɪ́rè**]	'all bananas'
[**ọ́mó kạ́à**]	'also a child'	[**óbḭ́bḭ́ káà**]	'also a banana'
[**ọ́mó kpẹ̀ny**]	'only a child'	[**óbḭ́bḭ́ kpẹ̀ny**]	'only a banana'

[**ạ́kí nṵ́ mɪ̀=ḍé=˖én**] 'a pot that I bought'

[**óbḭ́bḭ́ nṵ́ mɪ̀=ḍé=˖én**] 'a banana that I bought'

Thus, an account of outer modifiers must capture three things: (i) downstep is not inserted, (ii) H-obligatoriness applies only if the outer modifier is low-toned, and (iii) the obligatory H appears on the final TBU of the noun (as opposed to on the modifier **kpẹ̀ny** itself).

To this end, our analysis assumes a version of the prosodic hierarchy, where prosodic categories are hierarchically nested. This is shown in Figure 4 (after a version in Selkirk 2011).

Intonational phrase	ι
	|
Phonological phrase	φ
	|
Phonological word	ω
	|
Foot	Ft
	|
Syllable	σ

Figure 4: Prosodic hierarchy (after Selkirk 2011)

The two relevant prosodic categories for the Degema data are the phonological phrase (φ) and the phonological word (ω).

The first component of our analysis is that outer modifiers with a H map to a separate ω but that low-toned **kpẹ̀ny** does not. Second, a head noun plus an outer modifier map to a single φ. To capture this, we assume that each outer modifier is associated with a prosodic subcategorization frame (Inkelas 1990; Paster 2006; Bennett *et al*. 2018; Tyler 2019; Rolle and Hyman 2019), specifically a frame which requires a φ as its mother node. This is shown in (12).

(12) Analysis of outer modifiers as having a φ subcategorization frame

a. (__ (**kḭ́rè**)ω)φ

b. (__ (**káà**)ω)φ

c. (__ (**nṵ́**)ω …)φ

d. (__ **kpẹ̀ny**)φ

To see what this analysis buys us, let us examine /L-L/ and /H-H/ nouns modified by outer modifiers **káà** ‘also’, **kpẹ̀ny** ‘only’, and relativizer **nṵ́** ‘that…’, in (13).

(13) Analysis of outer modifiers as forming a φ

a. / **L-L** **kạ́à** / → ((**L.L**)ω (**kạ́à**)ω)φ

/ **L-L** **nṵ́** … / → ((**L.L**)ω (**nṵ́**)ω …)φ

/ **L-L** **kpè̩ny** / → ((**L.H**)ω **kpè̩ny**)φ

b. / **H-H** **kạ́à** / → ((**H.H**)ω (**kạ́à**)ω)φ

/ **H-H** **nṵ́** … / → ((**H.H**)ω (**nṵ́**)ω …)φ

/ **H-H** **kpè̩ny** / → ((**H.H**)ω **kpè̩ny**)φ

In (13a), a /L-L/ noun surfaces as [L.L] with H-toned modifiers but [L.H] with L-toned ones. We interpret this as due to the effects of H-obligatoriness, supporting the φ being the domain for this constraint. However, with **kpè̩ny** notice that the H is inserted on the final phonological word (the head noun) rather than on the phrase-final modifier. Our analysis is that H cannot associate to **kpè̩ny** here because it is not a phonological word. No high tone is inserted with the other outer modifiers because these modifiers are the final phonological words of the phrase, and they contain a high tone already.[13]

In contrast, notice in (13b) above that when a /H-H/ noun appears with an outer modifier no downstep is inserted. Such data reveal that the domain where Downstep-

[13] We envision two alternatives to our claim that the low-toned outer modifier **kpè̩ny** does not constitute a phonological word. One is that **kpè̩ny** is a word but that H-obligatoriness is sensitive to the distinction between lexical and non-lexical words. H-obligatoriness would be revised to state that if the last *lexical* word is all-low and is followed only by low tones, then H is added. This would not apply to the *functional* word **kpè̩ny**. A second alternative also involves a revision of H-obligatoriness, and would state that H cannot be added to a *monosyllabic* low-toned word. Therefore, it has to associate to the previous word, the lexical head noun which is always multisyllabic. We do not debate these alternatives here.

An anonymous reviewer asks what the prosodic category of **kpè̩ny** would be under our analysis. We simply posit that it consists of prosodic structure (i.e. syllable/foot structure) which is dominated directly by a phonological phrase; see Figure 5, to come.

insertion applies cannot simply be the phonological word. Like for H-obligatoriness, we claim that the domain for Downstep-insertion is also the φ. Note, however, that because no outer modifiers end in two high tones, it is not possible to directly test this in this context.[14]

For comparison sake, we show in (14) unmodified forms in the context **ìnùm nù** __ 'something and __', which also appear within a phonological phrase. Because these end a phonological phrase, they show the effects of H-obligatoriness and Downstep-insertion (note that phonological word boundaries are not shown).

(14) Domain for H-obligatoriness and H-downstep as the φ

a. / **ì-nùm nù è-sèn** / → (**ìnùm nù èsén**)φ 'something and fish'

/ **ì-nùm nù ạ̀-gàdà** / → (**ìnùm nù ạ̀gàdá**)φ 'something and a chair'

b. / **ì-nùm nù ą́-kí** / → (**ìnùm nù ą́ꜜkí**)φ 'something and a pot'

/ **ì-nùm nù ó-ḅíḅí** / → (**ìnùm nù óꜜḅíḅí**)φ 'something and a banana'

3.4 The tone-raising inner modifier class

We now turn to a larger class of NP modifiers, which we call the 'tone-raising inner modifier' class. These are so called because its members appear closer to the head noun – i.e. in more inward slots [+1] and [+3], compared to the outer modifier class in slot [+4] – and a high tone appears at the right edge of the noun with certain lexical tonal contrasts. This modifier class is diverse, consisting of adjectivals, numerals, nominals in possessive constructions and compound constructions, and the definite determiner. Some examples are in (15), illustrated with /L-L/ nouns, which always surface as [L.H].

[14] Although the relativizer **nú** has a high tone and can follow high-toned nouns, because **nú** heads a relative clause it never appears on its own, and therefore never appears at the end of the φ.

(15) Tone-raising inner modifiers (with low-toned nouns / **ẹ̀-nàm** / ‘meat, animal’, / **ù̩-bì̩** / ‘leaf, book’)

a.	Adjectivals (slot [+1]):	[**ẹ̀nám ḍégìnà**]	‘old meat’
		[**ù̩bí̩ bìbì**]	‘a black book’
b.	Numerals (slot [+1]):	[**ù̩bí̩ tṵ́tù**]	‘first book’
		[**ù̩bí̩ ọ́vù**]	‘one book’
c.	Nominals (slot [+1]):	[**ẹ̀nám ẹ́jzì**]	‘bush animal; mushroom’
		[**ù̩bí̩ ọ́mò**]	‘a child’s book’
d.	Definite (slot [+3]):	[**ù̩bí̩ yọ̀**]	‘the book’

As stated, adjectivals are distinct from descriptive nominals in that adjectivals do not appear with a noun class prefix when they modify a noun. Two adjectivals have a HL lexical tone pattern – / **ḍégìnà** / ‘old’ and / **ḍíyèr** / ‘bad’ – while the rest have an all-low pattern. Further, numerals include the ordinal / **tṵ́tù** / ‘first’ and cardinal numerals in attributive position. While the adjectivals maintain their lexical tone in context, the numerals uniformly become [H.L.(L)] when they modify nouns (the lexical tone on numerals is detectable when in isolation – Kari 2004: 323).[15]

All tone-raising inner modifiers trigger the same tonal effects on the head noun. Table 10 shows the tonal effects on the head noun with these modifiers.

[15] Additional adjectivals belonging to this class include / **rù̩bò** / ‘(the) other’, / **vìvì** / ‘another’, / **fù̩fù** / ‘white’, / **wọ̀wò** / ‘fresh’, / **nìnì** / ‘cold’, / **tù̩tù** / ‘hot’, and /**gì̩nà** / ‘big’. Additional numerals include / **ẹ́vù** ~ **í̩vù** / ‘some’, / **ìvà** / ‘two’, / **i̩sày** / ‘three’, / **ìnì** / ‘four’, / **ìsùwòn** / ‘five’, / **ì̩yísá** / ‘six’ [**ì̩yí˖sá**], / **ìsíyévá** / ‘seven’ [**ìsíyé˖vá**], / **i̩númán** / ‘eight’ [**i̩númán**], and / **ìgbèny** / ‘ten’.

	UR	[___ **ḍíyèr**] ‘a bad __’, [__ **bìbì**] ‘a black __’, [___ **ívà**] ‘two __’, [__ **yǫ̀**] ‘the __’, *etc*.	Cf. unmodified
a.	/L-L/	[L.H]	[L.H]
b.	/L-H/	[L.H]	[L.H]
c.	/L-HH/	[L.H]	[L.H^{+}H]
d.	/H-L/	[H.L]	[H.L]
e.	/H-H/	[H.H]	[H.$^{+}$H]
f.	/L-L/	[L.L.H]	[L.L.H]
g.	/L-LHH/	[L.L.H]	[L.L.H^{+}H]
h.	/L-HL/	[L.H.L]	[L.H.L]
i.	/L-HH/	[L.H.H]	[L.H.$^{+}$H]
j.	/H-L/	[H.L.L]	[H.L.L]
k.	/H-LH/	[H.L.H]	[H.L.H]
l.	/H-H/	[H.H.H]	[H.$^{+}$H.H]
m.	/H-HL/	[H.H.H]	[H.H.L]

Table 10: Tone patterns on nouns (2σ and 3σ) with tone-raising inner modifier class

There are two tone changes which take place in the context of tone-raising inner modifiers. First, all-low nouns surface with a final H, which we interpret as due to the H-obligatoriness constraint. This change takes place whether the following modifier surfaces with a high or a low tone (compare this to the outer modifier class from Table 9, where these two types diverged). Second, a /H-HL/ noun surfaces as [H.H.H] in this context, again regardless of the tones on the modifier. An example set illustrating this change from /H-HL/ → [H.H.H] is in (16), with a variety of tone-raising inner modifiers.

(16) Tone-raising inner modifiers – Tone change on 3σ noun /H-HL/ → [H.H.H]

a. / **ụ́-kútà** / ‘bead’ → [**ụ́kútá yọ̀**] ‘the bead’

b. / **ú-dédèny** / ‘periwinkle’ → [**údédény ọ́vù**] ‘one periwinkle’

c. / **ú-mómò** / ‘house fly’ → [**úmómó ḍíyèr**] ‘a bad house fly’

/ **í-súvèny** / ‘nose’ → [**ísúvény rụ̀bò**] ‘(the) other nose’

d. / **ụ́-kútà** / ‘bead’ → [**ụ́kútá ójzì**] ‘a thief’s bead’

/ **ó-wótù** / ‘house rat’ → [**ówótú ɓèkéèny**]

‘Togo hare’ (lit. white person house rat)

(Kari 2008: 113)

This tone change holds for all /H-HL/ nouns, including four-syllable nouns which surface as [H.H.H.H]:

(17) Tone-raising inner modifiers – Tone change on 4σ noun /H-HL/ → [H.H.H.H]

a. / **í-gírírì** / ‘shame’ → [**ígírírí yọ̀**] ‘the shame’

b. / **ọ́-bónínyà** / ‘umbrella tree’ → [**ọ́bónínyá yọ̀**] ‘the umbrella tree’

c. / **ọ́-húlóhòl** / ‘fever’ → [**ọ́húlóhól ḍíyèr**] ‘bad fever’

In contrast, (18) below shows that unlike with /H-HL/ no tone change takes place in other lexical contrasts which also end in string H L, e.g. nouns with underlying tone contrasts /H-L/ (18a), /H-LHL/ (18b), /L-LHL/ (18c), /L-HL/ (18d), or /HL/ in a classless noun (18e). The tonal effect is only found when both the noun class prefix and the first tone of the root each bear a separate H.

(18) Lack of effect from tone-raising inner modifier with other tone contrasts

a. /H-L/:

/ **ú-gò** / ‘butterfly’ → [**úgò bìbì**] ‘black butterfly’

/ **ạ́-kòm** / ‘malaria’ → [**ạ́kòm ḍíyèr**] ‘bad malaria’

/ **ạ́-kpàtà** / ‘measles’ → [**ạ́kpàtà ọ́mò**] ‘(the) child’s measles’

b. /H-LHL/: / **á-mìlíḅà** / → [**ámìlíḅà yọ̀**] ‘the night heron’

c. /L-LHL/: / **ì-gbèláà** / → [**ìgbèláà yọ̀**] ‘the dandruff’

d. /L-HL/: / **ò-kírérè** / → [**òkírérè ḍíyèr**] ‘bad sardine’

e. /HL/: / **ḍíhìlè** / → [**ḍíhìlè yọ̀**] ‘the umbrella-shaped anthill’

We refer to this change from /H-HL/ to [H.H.H(.H)] as seen in (17) as ‘Final-H-spreading’, defined in (19).

(19) Final-H-spreading: For a word-final sequence of tones H H L in the context of a tone-raising inner modifier, the L deletes and H spreads to the end of the word

Moving to our analysis of tone-raising inner modifiers, we again exploit prosodic subcategorization but of a different type than seen with outer modifiers. We propose that tone-raising inner modifiers subcategorize for a recursive φ structure, where one φ appears as the sister of the modifier, and another φ appears as the mother of the entire sequence. This is shown in (20). The relevant adjectivals, numerals, and nominals slot into this frame in a modifying context. Note that these modifiers would also form phonological words, not indicated.

(20) Analysis of tone-raising inner modifiers as forming recursive φ's

a. Definite determiner: ((__)φ **yọ̀**)φ

b. Adjectivals: ((__)φ **ḍíyèr**)φ

c. Numerals: ((__)φ **ọ́vù**)φ

d. Compounds/possessives: ((__)φ [*nominal*])φ

This analysis assumes that recursive prosodic constituency is possible, building on much recent evidence for its existence (e.g. Bennett 2018; Ito and Mester 2021). A consequence of recursive structure is that we can distinguish different layers of φ and localize phonological distributions to one (or more) of those layers. Ito and Mester (2021) classify recursive φ structures based on whether they appear as the most deeply embedded φ layer in which case they are [+min], or the outermost φ layer in which case they are [+max]. This is schematized in (21).

(21) Schema of prosodic structure and recursion (Ito and Mester 2021)

a. (**A**)φ = (**A**)$_{φ[+max,+min]}$

b. (((**A**)φ **B**)φ **C**)φ = (((**A**)$_{φ[-max,+min]}$ **B**)$_{φ[-max,-min]}$ **C**)$_{φ[+max,-min]}$

In (21a), there is only one φ and it is therefore simultaneously both [+max] and [+min]. In contrast, (21b) shows a recursive structure with three φ layers. Here, only the innermost φ is [+min] which consists only of the element **A**, while only the outermost φ is [+max] (containing all three elements **A**, **B**, and **C**). Intermediate φ layers are rendered [-max] and [-min].

With these possibilities in mind, let us return to the tone-raising inner modifier patterns. Input-output mappings with a L-L 3σ noun are provided in (22). The inner φ

is labeled [-max,+min] while the outer one is labeled [+max,-min]. The effects of H-obligatoriness are clearly seen in this context.

(22) Analysis of tone-raising inner modifiers as triggering recursive φ's

a. / **L-L ḍíyèr** / → ((**L.L.H**)$_{φ[-max,+min]}$ **ḍíyèr**)$_{φ[+max,-min]}$

b. / **L-L bìbì** / → ((**L.L.H**)$_{φ[-max,+min]}$ **bìbì**)$_{φ[+max,-min]}$

These data require us to revise our definition of H-obligatoriness slightly. To demonstrate this, we provide a comparison of the tone-raising inner modifiers to unmodified nouns and outer modifiers. We show this is in Figure 5, representing the prosodic structure as hierarchical prosodic trees (rather than 'flat' structure). As throughout, tone changes from the UR are in red.

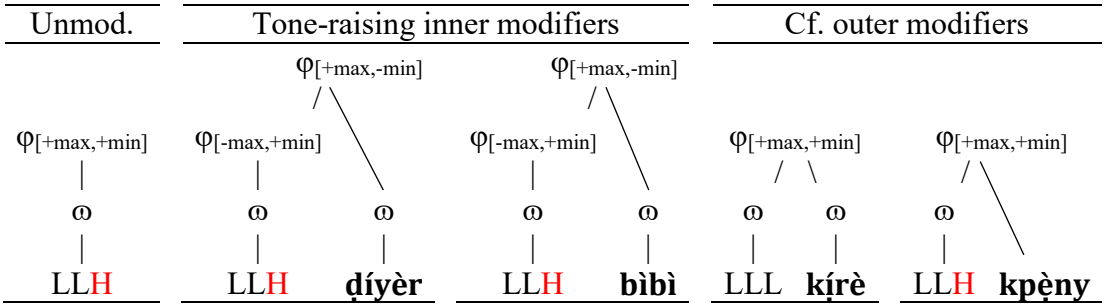

Figure 5: Prosodic tree representations – Unmodified, raising inner, and outer mod.

Examining these together, we see that the environment for H-obligatoriness is the φ$_{[+min]}$. Unmodified contexts are [+min] by virtue of not being in a recursive structure. Crucial evidence that it must be [+min] comes from [LLH **bìbì**] contexts where the inner modifier is all low-toned (the middle column above). The phonological word in the outer φ is *not* subject to H-obligatoriness, which is captured by our analysis as this constitutes the [-min] layer. Our revision of H-obligatoriness is in (23).

(23) H-obligatoriness (*final definition*)

a. For all $\varphi_{[+min]}$ phonological phrases, the final phonological word must contain a H tone

b. If this is not met, a H is inserted at the end of the last word

We can now also localize the two other operations – Downstep-insertion and Final-H-spreading – to specific prosodic layers. We repeat the prosodic tree representations in Figure 6 below, using /H-H/ and /H-HL/ 3σ nouns.

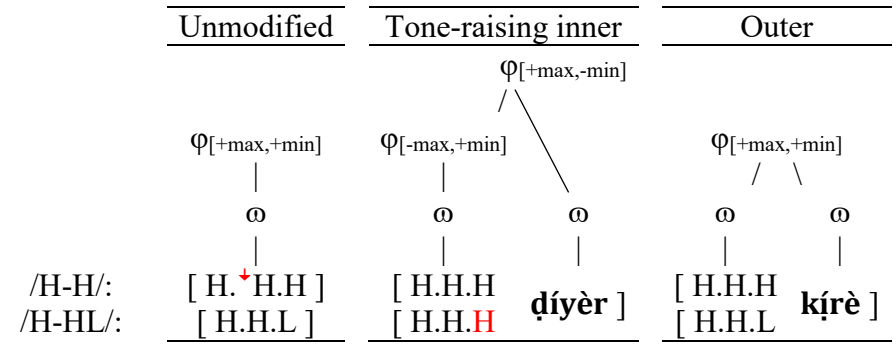

Figure 6: Prosodic tree representations with /H-H/ and /H-HL/ 3σ nouns

These representations show that Downstep-insertion only applies to [+max] phonological phrases, as it applies in unmodified contexts but not raising inner contexts (it incidentally does not apply in outer contexts because the two H's are not phrase-final). In contrast, we see that Final-H-spreading applies at the end of [-max] phrases, and does not apply otherwise. We update our definitions of these operations to reflect this, in (24)-(25):

(24) Downstep-insertion (*final definition*)

a. No $\varphi_{[+max]}$ phonological phrase ends in a sequence of two independent H tones on the tonal tier

b. To repair this, a downstep is inserted between two $\varphi_{[+max]}$-final H tones

(25) Final-H-spreading (*final definition*)

a. No $\varphi_{[\text{-max}]}$ phonological phrase ends in a sequence H H L on the tonal tier

b. To repair this, the L deletes and the last H spreads to the end of its word

3.5 The tone-lowering inner modifier class

The final class are 'tone-lowering inner modifiers', so called because they appear inward (slots [+1], [+2], and [+3]) and a L appears at the right of the head noun for most lexical tone contrasts. Examples of these modifiers are in (26), where /L-L/ nouns surface faithfully as [L.L]. This modifier class consists of two (monosyllabic) adjectivals (26a), all possessive pronouns (26b), all demonstratives (26c), interrogative determiners translated as 'which' (26d), and the latter half of coordination with **nṵ̀** 'and' (26e).

(26) Tone-lowering inner modifiers (with low-toned nouns / **ù̩-bì̩** / ‘leaf, book’, / **è-sèn** / ‘fish’)

a. Adjectivals ([+1]): / **ví** / ‘good’ → [**ù̩bì̩ ví**] ‘a good book’
/ **fà̩ny** / ‘new’ → [**ù̩bì̩ fà̩ny**] ‘a new book’

b. Poss. pronouns ([+2])[16]: / **mɛ́è** / ‘my’ → [**ù̩bì̩ mɛ́è**] ‘my book’
/ **nénì** / ‘our’ → [**èsèn nénì**] ‘our fish’

c. Demonstratives ([+3]): / **yɔ́ò** / ‘that’ → [**ù̩bì̩ yɔ́ò**] ‘that book’
/ **ná̩à** / ‘this’ → [**ù̩bì̩ ná̩à**] ‘this book’

d. Interrogative det. ([+3]): / **vénì** / ‘which particular’ → [**ù̩bì̩ vénì**]
‘which particular book’

e. Coordination with / **nù̩** / ‘and’: [**èsèn nù̩ ìnúm**] ‘fish and something’

The tonal effects of tone-lowering inner modifiers on the head noun are summarized in Table 11. This table is split into three sets of rows – 2σ nouns (a.-e.), 3σ (f.-m.), and 4σ (n.-p.) – and two columns based on whether the modifier begins with a H tone (the majority) or a L tone (i.e. **nù̩** ‘and’).

[16] The complete list of possessive pronouns are **méè** ‘my’ (~ **mɛ́è**, harmonizing with the ATR value of the noun), **wɔ́ò** ‘your’ (SG), **nɔ́ònw** ‘his/her’, **nénì** ‘our’, **máàny** (~ **má̩àny**) ‘your’ (PL), and **bá̩àw** (~ **bá̩àw**) ‘their’. See Kari (2007) for details on ATR harmony with these and other functional words.

	UR	/ __ **yǫ́ò** / 'that', / __ **ví** / 'good', *etc.*	/ ___ **nù** (*noun*) / 'and (*noun*)'	Cf. unmodified
a.	/L-L/	[L.L]	[L.L]	[L.H]
b.	/L-H/	[L.H]	[L.L]	[L.H]
c.	/L-HH/	[L.HL]	[L.HL]	[L.H˖H]
d.	/H-L/	[H.L]	[H.L]	[H.L]
e.	/H-H/	[H.L]	[H.L]	[H.˖H]
f.	/L-L/	[L.L.L]	[L.L.L]	[L.L.H]
g.	/L-LHH/	[L.L.HL]	[L.L.HL]	[L.L.H˖H]
h.	/L-HL/	[L.H.L]	[L.H.L]	[L.H.L]
i.	/L-HH/	[L.H.L]	[L.H.L]	[L.H.˖H]
j.	/H-L/	[H.L.L]	[H.L.L]	[H.L.L]
k.	/H-LH/	[H.L.H]	[H.L.L]	[H.L.H]
l.	/H-H/	[H.L.L]	[H.L.L]	[H.˖H.H]
m.	/H-HL/	[H.H.L]	[H.H.L]	[H.H.L]
n.	/L-HH/ (a)	[L.H.L.L]	[L.H.L.L]	[L.H.˖H.H]
o.	/L-HH/ (b)	[L.H.H.L]	[L.H.H.L]	[L.H.H.˖H]
p.	/H-H/	[H.L.L.L]	[H.L.L.L]	[H.˖H.H.H]

Table 11: Tone patterns on nouns (2σ/3σ/4σ) with tone-lowering inner modifiers

The first tone change we see is that if the head noun ends in two distinct H tones, the second H becomes L (rows c., e., g., i., l., n.-p.). We exemplify this in (27) with the tone-lowering inner modifier **yǫ́ò** 'that'. With this modifier and others which begin with a H, lowering is only triggered if the noun ends in two H tones (27a) and does not apply if it ends in only one (cf. 27b).

(27) Tone-lowering inner modifiers condition /…HH/ to […HL]

a.	H-H	/ **ą́-kí** /	'pot'	→ [**ą́kì yǫ́ò**]	'that pot'
	H-H	/ **ó-bíbí** /	'banana'	→ [**óbìbì yǫ́ò**]	'that banana'
	L-HH	/ **ò-wé´y** /	'person'	→ [**òwêy yǫ́ò**]	'that person'
b.	L-H	/ **ù-gó** /	'river eagle'	→ [**ùgó yǫ́ò**]	'that river eagle'
	H-LH	/ **é-kùlé** /	'black kite'	→ [**ékùlé yǫ́ò**]	'that black kite'

Contextual data like these help support an analysis of the underlying forms in (27a) as ending in two H tones in the first place. Recall that a competing analysis entertained in

§2 was as a single /H/. Given that there is no contrast between /H/ and /H-H/ in Degema, an underlyingly representation /H/ would indeed be simpler. However, the /H/ analysis would not explain the distribution of lowering in (27).

Moreover, recall the two types of /L-HH/ four-syllable words, labelled (a) and (b) in Table 11 above (rows n.-o.). These two have distinct surface patterns in their unmodified forms, specifically [L.H.˖H.H] where the first H is associated only to one TBU versus [L.H.H.˖H] where it is associated with two. With tone-lowering inner modifiers, this tonal contrast remains by virtue of only the final H changing to L. This is demonstrated in (28).

(28) /L-HH/ tonal contrast is maintained due to lowering affecting only the final H

a. / **òdúmíná** / [**òdú˖míná**] → [**òdúmìnà yǫ́ò**] 'that sheep'

b. / **ùḅúrúmá** / [**ùḅúrú˖má**] → [**ùḅúrúmà yǫ́ò**] 'that indigo'

Returning to the tone patterns in Table 11, there is one further tone change with the marker of coordination **nù** 'and', the only low-toned modifier. Whenever **nù** appears with a noun, the final tone is L even for those which end in a single H tone, e.g. /L-H/ or /H-LH/ nouns. This is shown in (29), in the context of __ **nù ìnúm** '__ and something'.

(29) All final H's become L in the context of low-toned **nù** 'and'

a. L-H / **ùgó** / → [**ùgò nù ìnúm**] 'a river eagle and something'

b. H-LH / **ǫ́pòlí** / → [**ǫ́pòlì nù ìnúm**] 'gun powder and something'

c. H-H / **ụ́tány** / → [**ụ́tàny nù ìnúm**] 'a tree and something'

d. L-HH / **ògbúró** / → [**ògbúrò nù ìnúm**] 'yam and something'

Now turning to our analysis of tone-lowering inner modifiers, we propose that these modifiers subcategorize for a recursive phonological word (ω) structure, in (30).

(30) Analysis of tone-lowering inner modifiers as recursive ω's

a. ((__)ω **ví**)ω

b. ((__)ω **méè**)ω

c. ((__)ω **nù** …)ω

In (30) the recursive ω's are [-max,+min] and [+max,-min], respectively. This is shown in (31) with the tone-lowering inner modifier **ví**, with H-H and H-LH 3σ nouns.

(31) Analysis of lowering inner modifiers within recursive ω's

a. / **H-H ví** / → ((**H.L.L**)$\omega_{[-max,+min]}$ **ví**)$\omega_{[+max,-min]}$

b. / **H-LH ví** / → ((**H.L.H**)$\omega_{[-max,+min]}$ **ví**)$\omega_{[+max,-min]}$

To account for these data, we posit 'HH-dissimilation' which bans two adjacent and independent H tones at the end of a $\omega_{[-max]}$ layer. This results in the second H lowering. We must localize this rule specifically to this $\omega_{[-max]}$ layer because it does not apply to words in isolation, which would constitute non-recursive $\omega_{[+max,+min]}$ constituents.

(32) 'HH-dissimilation'

a. No phonological word of the layer $\omega_{[-max]}$ ends in two distinct H tones

b. To repair this, the second H dissimilates to L (i.e. …HH → …HL)

This can be seen as another repair in Degema involving adjacent domain-final H's, an OCP violation (as discussed in §2.5 above). There are two ways these are repaired: Downstep-insertion at the phrase level, and HH-dissimilation at the word level.

Moreover, unlike with other tone-lowering inner modifiers, **nù** 'and' is low-toned and triggers a special lowering operation even for single final H's (cf. 31b). H-H and

H-LH 3σ nouns are illustrated in prosodic trees in Figure 7, using the context __ **nụ̀ ìnúm** '__ and something' from (29).

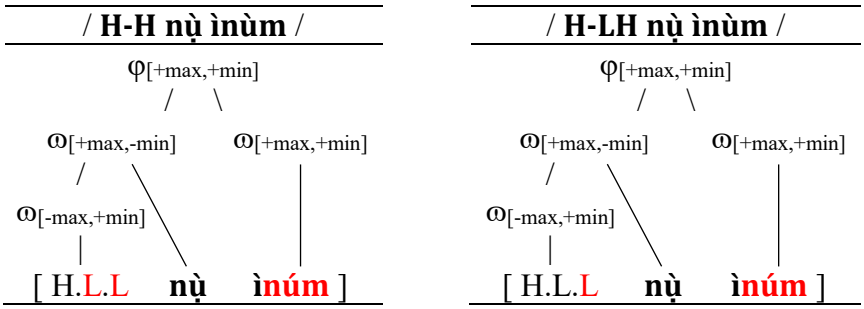

Figure 7: Prosodic tree representations of tone-lowering inner modifiers

To account for these patterns, we posit another constraint which refers to the $\omega_{[-max]}$, but crucially one which applies *over* the prosodic boundary rather than strictly within it. Here, a $\omega_{[-max]}$-final H becomes L if it is followed by L in the same (recursive) word. We refer to this descriptively as 'H-to-L-assimilation'.

(33) 'H-to-L-assimilation'

a. No phonological word of the layer $\omega_{[-max]}$ ends in H tone if followed by a L tone in the same phonological word

b. To repair this, the second H assimilates to the word-final L

i.e. **H**)$\omega_{[-max]}$ **L**)ω → **L**)$\omega_{[-max]}$ **L**)ω

There is one final discussion point concerning tone-lowering inner modifiers. While **nụ̀** 'and' is generally the only lexically low-toned modifier of this class, in context the high-toned modifier **vó** 'which' (and to a lesser extent **ví** 'good' and **fạ́ny** 'new') can also surface with low tone. When such modifiers surface low, their tonal behavior directly matches that of **nụ̀** in triggering H-to-L-assimilation.

Consider the data in (34) involving the interrogative determiner **vó** 'which' forming a question phrase **ọ́kù vó** 'how' (lit. 'which way, method').

(34) H- and L-toned variants of **vó** ‘which’

a. **ọ́kù vó nṵ́ ì=jzá=àn** ?

method which that 3PL=stay=FAC

‘How are things?’ (a salutation)

b. **ọ́kù vò** ?

method which

‘How (is it)?’ (a shortened salutation)

(Kari 2004: 43, 264)

When this modifier is found in a clefted position (34a), it retains its high tone. In contrast, in the utterance-final position in (34b), it surfaces as low. Lowering of **vó** can be accounted for via an independent process whereby utterance final H’s become L to indicate a question (see Kari 2004: 13 and thereafter for details). When it surfaces as L, it also triggers H-to-L-assimilation just like **nù** in the examples in (28). This is shown in (35) with a variety of H-final nouns.

(35) H-to-L-assimilation before low-toned [**vò**] ‘which’ in questions

a. / **ùgó** / ‘river eagle’ → [**ùgò vò**] ‘which river eagle?’

b. / **jzĭmjzĭm** / ‘whale’ → [**jzĭmjzìm vò**] ‘which whale?’

c. / **ọ́ḍòkó** / ‘conch’ → [**ọ́ḍòkò vò**] ‘which conch?’

d. / **ékùlé** / ‘black kite’ → [**ékùlè vò**] ‘which black kite?’

e. / **ìmbésìkó** / ‘swift’ → [**ìmbésìkò vò**] ‘which swift?’

The data point in (35a) is especially intriguing, as it represents one of the very few places where a phrase surfaces without a pitch change. This salient exceptionality no doubt helps to cue this phrase as a question, which suspends H-obligatoriness.

At this point, we do not currently have enough data to surmise exactly when the high-toned adjectivals **ví** 'good' and **fạ́ny** 'new' surface as low-toned. However, in the tokens we collected where they do surface low-toned, they trigger H-to-L-assimilation as would be expected from a low-toned modifier of this class. This variation is illustrated in (36), involving two tone-lowering inner modifiers. When the modifier **ví** surfaces H then so does the final tone of the head noun **ékùlé** 'black kite', but when it surfaces L then so does the final tone of the noun.

(36) / **ékùlé ví méè** / → [**ékùlé ví méè**] ~ [**ékùlè vì méè**] 'my good kite'

3.6 Local summary of tonal effects

This section has classified NP modifiers based on their systematic tonal effect on the head noun, based on a survey of all major lexical tone contrasts in 33 distinct NP contexts. The results reveal three distinct classes of modifiers based on their tonal effects: outer modifiers and two classes of inner modifiers, one called 'tone-raising' and the other 'tone-lowering'. Tone changes are for the most part predictable based on the morphosyntactic slot the modifier appears in, though not completely. There are four positional slots after the head noun, labeled [+1] to [+4]. Outer modifiers appear in slot [+4] in the NP (i.e. the position furthest from the head noun, hence outer), tone-raising inner modifiers appear in slots [+1] and [+3] (i.e. more inward), and tone-lowering inner modifiers appear in slots [+1], [+2], and [+3].

The tonal effects of the three classes are schematized below in Table 12. For outer and tone-lowering inner modifiers, the precise effects depend on whether the modifier itself begins with a H or a L tone. This is illustrated with four types of 3σ nouns which best exemplify these tonal effects, namely lexical tone contrasts /L-L/, /H-HL/, /H-H/,

and /H-LH/. We provide a comparison to the unmodified forms, as well, where there is no modifier affecting tone (the rightmost column).

Noun	Outer modifier (H)	Outer modifier (L)	Inner modifier: Raising (H/L)	Inner modifier: Lowering (H)	Inner modifier: Lowering (L)	No modifier (unmodified form)
/L-L/	[L.L.L]	[L.L.H]	[L.L.H]	[L.L.L]	[L.L.L]	[L.L.H]
/H-HL/	[H.H.L]	[H.H.L]	[H.H.H]	[H.H.L]	[H.H.L]	[H.H.L]
/H-H/	[H.H.H]	[H.H.H]	[H.H.H]	[H.L.L]	[H.L.L]	[H.↓H.H]
/H-LH/	[H.L.H]	[H.L.H]	[H.L.H]	[H.L.H]	[H.L.L]	[H.L.H]

Table 12: Summary of key tone changes on the head noun in the examined contexts

Here, we see that each of the modification contexts (the columns) provides a unique set of realizations of the four noun types (the rows).

Our analysis of these data is that members of the three modifier classes are prespecified with a prosodic subcategorization frame, recapped in (37). Outer modifiers such as the quantifier **kịrè** 'all' form a single phonological phrase (φ) with the head noun. In contrast, the inner modifiers each form distinct types of recursive prosodic structures. Tone-raising inner modifiers such as the adjective **ḍíyèr** 'bad' form recursive φ's, while tone-lowering inner modifiers such as the possessive pronoun **nénì** 'our' form recursive phonological words (ω's).

(37) Three types of subcategorization frames for NP modifiers

a. Outer modifier: (__ **kịrè**)φ 'all __'

b. Tone-raising inner modifier: ((__)φ **ḍíyèr**)φ 'bad __'

c. Tone-lowering inner modifier: ((__)ω **nénì**)ω 'our __'

Adding all this together, we account for the tonal patterns seen in Table 12 above by exploiting a consequence of recursive prosodic structure: phonological distributions can be localized to specific 'layers', such as to the most embedded (i.e. [+min]) or the

least embedded layer (i.e. [+max]). We summarize the tonal effects based on their localization to specific prosodic layers in (38).

(38) Tonal effects localized to distinct prosodic layers

a. H-obligatoriness: (… (**L**)ω)φ[+min] → (… (**LH**)ω)φ[+min]

b. Downstep-insertion: (… **HH**)φ[+max] → (… **H**ꜜ**H**)φ[+max]

c. Final-H-spreading: ((**H-HL**)φ[-max] …)φ → ((**HHH**)φ[-max] …)φ

d. HH-dissimilation: ((… **HH**)ω[-max] …)ω → ((… **HL**)ω[-max] …)ω

e. H-to-L-assimilation: ((… **H**)ω[-max] **L**)ω → ((… **L**)ω[-max] **L**)ω

In total, all tonal changes in the NP can be accounted for by positing specific markedness constraints forbidding certain tone sequences localized to specific prosodic constituents. No other structure is required here, such as other alternative prosodic structures – e.g. the clitic group (Nespor and Vogel 1986) or the composite group (Vogel 2019), *inter alia* – or floating tones not pre-associated to TBU's in the input.

4 Conclusion

This paper has presented the first systematic study of tone in nouns and noun phrases in Degema. We pursued three lines of inquiry: (i) what are the attested and unattested surface tone patterns on nouns in isolation (and their frequencies), (ii) what underlying representations are justified (i.e. lexical tone contrasts), and (iii) how is the underlying tone on nouns systematically altered within multi-morphemic noun phrases?

To address our questions, we created a database of approximately 1000 non-derived nouns. We found that nouns across syllable shape showed three main lexical tone contrasts, accounting for nearly 80% of the lexicon: /L-L/ (48% of nouns), /H-H/ (18%), and /L-HH/ (13%). This last case is theoretically important in that it includes

cases where two separate H tones associate to the same tone-bearing unit, in violation of the Obligatory Contour Principle (OCP). In isolation, we showed that nouns were subject to two basic tone rules which altered their underlying forms: downstep was inserted between two final H's (e.g. /H-H/ → [H$^{!}$H]), and a H was inserted at the end of an all-low sequence (e.g. /L-L/ → [LH]). The combined effect of these rules was that virtually all noun phrases have a pitch change.

Further, we catalogued tone changes found on nouns in 33 distinct modificational contexts within the NP. Our findings led us to divide NP modifiers into three classes based on their systematic tonal effects: two classes of inner modifiers (one with lowering effects and one with raising effects), and a single class of outer modifiers. Under our analysis, tonal effects were attributed to whether modifiers plus the head noun formed phonological phrases (φ) or phonological words (ω), and whether they formed recursive prosodic structures, e.g. of the type ((**A**)φ **B**)φ. By positing recursive structure, we were able to localize tonological constraints to the outermost prosodic layer (e.g. $\varphi_{[+max]}$), innermost layer (e.g. $\varphi_{[+min]}$), non-inner or outermost (e.g. $\varphi_{[-max]}$), or to the prosodic category as a whole (i.e. all layers of a φ). In total, our analysis makes predictions for future work on Degema tone, such as in the interaction of multiple modifiers, modifiers in isolation, and noun phrases in larger sentential contexts.

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6 Appendix: Tonal effects in associative marking

There is one prominent tonal effect that happens in NPs which we did not discuss in the body of the text, which we refer to as 'associative marking'. Associative marking appears in a variety of constructions, such as with pre-nominal modifiers (introduced in §3.1). Sub-types include descriptive nominals (e.g. / **ọ̀-gòdò** / 'long', / **ò-mbòkò** / 'wide', *inter alia*), the quantifier / **íkpólà** / 'many', and the numeral / **ìyòw** / 'twenty'. Examples are in (39) below with the head noun / **ò-wé́y** / 'person' (PL: **è-**). Associative marking is in red.

(39) Associative marking with pre-nominal modifiers (in red)

a. Numeral: / **ìyòw èwé́y** / → [**ìyów éwèy**] ‘twenty people’

b. Quantifier: / **íkpólà èwé́y** / → [**íkpólá éwèy**] ‘many people’

c. Modifying nominals (e.g. possession and compounds):

/ **ạ̀sùèy òwé́y** / → [**ạ̀súwéy ówèy**] ‘the person’s behavior’

/ **ùtòm òwé́y** / → [**ùtóm ówèy**] ‘because of a person, for the sake of a person’ (lit. ‘head of a person’)

Notice that there are changes to both words in the construction. Associative marking changes the lexical tones of the second word only, e.g. the /L-HH/ noun changes to [HL]. Additionally, there are other tonal changes to the first word (as shown, but not in red), which can be attributed to the tonal restrictions localized to specific prosodic constituents (as already detailed above).

Table 13 schematizes the tonal changes on the second word with associative marking. There are three types of nouns here: 2σ (rows a.-e.), 3σ (f.-m.), and 4σ (n.-s.).

	UR	[**ìyów** ___] ‘twenty ___’, [**íkpólá** ___] ‘many ___’, *etc.*	Cf. unmodified
a.	/L-L/	[H.L]	[L.H]
b.	/L-H/	[L.H]~[HL.H]	[L.H]
c.	/L-HH/	[H.L]	[L.H˖H]
d.	/H-L/	[H.L]	[H.L]
e.	/H-H/	[H.L]	[H.˖H]
f.	/L-L/	[H.L.L]	[L.L.H]
g.	/L-LHH/	[H.L.H˖H]	[L.L.H˖H]
h.	/L-HL/	[L.H.L]~[HL.H.L]	[L.H.L]
i.	/L-HH/	[H.L.L]	[L.H.˖H]
j.	/H-L/	[H.L.L]	[H.L.L]
k.	/H-LH/	[H.L.H]	[H.L.H]
l.	/H-H/	[H.L.L]	[H.˖H.H]
m.	/H-HL/	[H.H.L]	[H.H.L]
n.	/L-LHH/	[H.L.H.˖H]	[L.L.H.˖H]
o.	/L-HL/	[L.H.H.L]~[HL.H.H.L]	[L.H.H.L]
p.	/L-HH/ (a)	[H.L.L.L]	[L.H.˖H.H]
q.	/L-HH/ (b)	[H.L.L.L]	[L.H.H.˖H]
r.	/H-LHH/	[H.L.H.˖H]	[H.L.H.˖H]
s.	/H-H/	[H.L.L.L]	[H.˖H.H.H]

Table 13: Form of nouns with pre-nominal modifier class

A number of patterns emerge here. First, in the majority of patterns associative marking manifests as a HL marking at the left edge of the word. If the noun begins with H, this is always retained. If the noun begins with L, however, there are two distinct patterns depending on the lexical tones of the target word. One pattern appears with /L-H/ (row b.) and /L-HL/ nouns (h., o.), which has two variants. In one variant, the initial L becomes falling, and in another variant these same phrases are pronounced without an initial H. This variation is shown in (40) with a /L-HL/ noun.

(40) / **ìngélè** / ‘metal gongs’ → [**ìyów îngélè**] ~ [**ìyów ìngélè**] ‘twenty gongs’

The second pattern appears with nouns with lexical tones /L-L/ (rows a. and f.), /L-HH/ (c., i., p., q.), and /L-LHH/ (g., n.). Here, a H replaces the initial L entirely, e.g. / **ị̀gàdà** / → [**ìyów ígàdà**] ‘twenty chairs’.

Furthermore, if the lexical tones of the target are /H-H/ or /L-HH/, the initial tone is replaced by the associative H (vacuously for H-H) and all remaining H tones are replaced by L, resulting in a [HL] pattern. This is shown in (41) with targets of various lengths (two to five syllables).

(41)

a. /H-H/ [H⁺H] → [… HL]

/ **ị́-kí** /	[**ị́⁺kí**]	→ [**ìyów ịkì**]	‘twenty pots’
/ **í-ḅíḅí** /	[**í⁺ḅíḅí**]	→ [**ìyów íḅìḅì**]	‘twenty bananas’
/ **ị́-ḅíkíríḅí** /	[**ị́⁺ḅíkíríḅí**]	→ [**ìyów ịḅìkìrìḅì**]	‘twenty black ants’

b. /L-HH/ [LH⁺H] → [… HL]

/ **è-wé́y** /	[**èwé⁺́y**]	→ [**ìyów éwèy**]	‘twenty people’
/ **ì-gbúró** /	[**ìgbú⁺ró**]	→ [**ìyów ígbùrò**]	‘twenty yams’
/ **ì-dúmíná** /	[**ìdú⁺míná**]	→ [**ìyów ídùmìnà**]	‘twenty sheep’
/ **ì-ḅúrúmá** /	[**ìḅúrú⁺má**]	→ [**ìyów íḅùrùmà**]	‘twenty indigoes’

This [HL] pattern does not happen in other possible contexts, such as with low-initial /L-LHH/ contexts, or high-initial /H-LH/, /H-LHL/, /H-LHH/ contexts, shown in (42).

(42)

a.	L-LHH:	/ **ạ̀-pàpá́** /	→ [**ìyów ạ́pàpá⁺́**]	‘twenty groundnuts’
b.	H-LH:	/ **í-kùlé** /	→ [**ìyów íkùlé**]	‘twenty black kites’
c.	H-LHL:	/ **í-mìlíḅà** /	→ [**ìyów ímìlíḅà**]	‘twenty night herons’
d.	H-LHH	/ **ị́-nyìnyírá** /	→ [**ìyów ịnyìnyí⁺rá**]	‘twenty edible leaves’

Finally, Table 13 above showed that the only lexical tone contrast which does not at least optionally surface with a left edge [HL] associative marking is /H-HL/ targets (row m.). This always surfaces as [H.H.L] and never as *[H.L.L], as shown in (43).

(43) H-HL: / **ị́-kútà** / → [**ìyów ị́kútà**] 'twenty beads' (*[…**ị́kùtà**])

7 Glossing/Abbreviations

σ = syllable, ω = phonological word, φ = phonological phrase; L = Low tone, H = High tone, ˬH = Downstepped high tone; ATR = advanced tongue root, NP = noun phrase, OCP = Obligatory Contour Principle, RC = relative clause, TBU = tone-bearing unit, UR = underlying representation; DEF = definite, FAC = factative tense/aspect (≈ perfective), PL = plural, PRF = perfect aspect, REL = relativizer, SG = singular