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Tone-driven epenthesis in Wamey

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Abstract

This paper argues that tone-driven epenthesis is possible in tonal languages. In Wamey, an epenthetic [ə] is inserted to host a high tone in two contexts: first, to host a tone which would otherwise be left floating due to a restriction on rising tones (/c̣vc̣(H)/ maps to [c̣vc̣ə] due to a ban *[c̣vc̣]); and second, to host a tone which is introduced by word-level morphology but is restricted from associating across a stem boundary. These patterns cannot be attributed to syllable phonotactics, which freely allow all consonants in the coda position. We assemble the evidence for tone-driven epenthesis, focusing on the distribution of final [ə] in lexical stem structure and [ə]-alternating suffixes. A simple OT analysis derives [ə]-epenthesis, utilising common constraints (e.g. *RISE, OCP(H), etc.) together with constraints against associating tone across prosodic boundaries. In total, Wamey epenthesis exemplifies the cultivation of segmental environments for the purpose of realising pitch targets.

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This paper argues that tone-driven epenthesis is possible in tonal languages, contrary to claims in the literature that it is unattested/impossible. In Wamey, an epenthetic [ə] is inserted to host a high tone in two contexts. The first is to host a tone which would otherwise be left floating due to a restriction on rising tones in closed syllables (i.e. /cṽc(H)/ maps to [cṽcá] due to a ban *[cṽc]). The second is to host a tone which is introduced by word-level morphology but is restricted from associating across a stem boundary (i.e. an input /(cṽcṽ)c(H)/ maps to [(cṽcṽ)cá] not *[cṽcṽ)c]). These patterns cannot be attributed to syllable phonotactics, which freely allow all consonants in the coda position. We assemble the evidence for tone-driven epenthesis, focusing on the distribution of final [ə] in lexical stem structure and [ə]-alternating suffixes that pattern as underlyingly consonant-final. A simple OT analysis derives [ə]-epenthesis, using common constraints (e.g. *FLOAT, *RISE, OCP(H), DEP(μ)), together with constraints against associating tone across certain prosodic boundaries. In total, Wamey provides evidence for parallelism between tonal and intonational languages given that intonation-driven epenthesis is established in the literature. This parallelism is predicted under a model where both types of prosodic systems make use of the same phonological substance and autosegmental architecture, and have the same functional pressures to cultivate segmental environments best suited for realising pitch targets.

1. Introducing the issue: The interaction of tone and epenthesis

Pitch is present in the linguistic signal of all spoken languages. Roughly speaking, pitch can be exploited as lexical and grammatical tone in ‘tonal languages’, and as pitch accents and boundary tones in ‘intonational languages’. For both tonal and intonational languages, the basic units of pitch contrast are referred to as *tones*. Such tones may be pre-associated with a specific tone-bearing unit (TBU), such as a mora, or enter the derivation unassociated with any TBU, in which case they are referred to as *floating tones*.

As a null hypothesis, we expect that floating tones in tonal languages and intonational languages should not be ontologically distinct (i.e. comparable representations and behaviour should be able to be identified in both). We refer to this premise as *tone-intonation parallelism*. To exemplify, consider first the tonal language Kalabari (Ijoid: Nigeria), which has a basic distinction between H and L plus downstep (i.e. ↓H). To express the imperative, a floating tone sequence HL is appended to the right edge of the verb and co-occurs with its lexical tone (Harry 2004). For example, a low tone root such as /sò/ ‘cook’ has the imperative form [sṽ] ‘cook!’ with a LHL pattern, where the floating tones dock with the lone TBU.

We can compare this to (American) English, an intonational language. Jeong & Condoravdi (2018) highlight the use of the so-called calling contour (Pike 1945) in

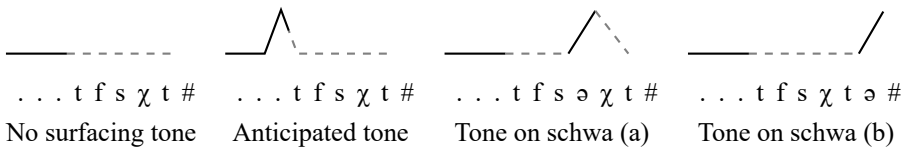


Figure 1. Strategies for realising intonation on a voiceless sequence in Tashlhiyt (Roettger 2017: 98).

certain imperatives (e.g. in the mnemonic imperative *Don't forget to feed the cats!*) Phonologically, this is analysed as a complex $H^*\downarrow H-L\%$ intonation configuration, in essence a H^* pitch accent on the (final) stressed syllable *cats* followed by a downstepped $\downarrow H$. In both Kalabari and English, the tonal inventory can be deconstructed into basic tonemes (H , L , $\downarrow H$), and floating tones are unassociated in the input, target specific positions, co-occur with no segmental exponents and systematically express complex meaning as part of the grammar (here, flavours of imperative).

What happens when there is no appropriate TBU in the targeted location for a floating tone to dock with, or when docking with this TBU would create a banned structure? One strategy in a number of intonational systems is to induce epenthesis of a TBU to host the floating tones, typically some default vowel (e.g. /ə/). Consider the case of intonation in Tashlhiyt (Berber: Morocco), a book-length treatment of which is provided by Roettger (2017). A floating H is found in several intonational contexts, where it serves in part to indicate yes-no and echo questions, as well as contrastive statements (see also Grice *et al.* 2015 for details). One area of focus involves cases where intonational floating tones – what Roettger refers to as the ‘tune’ – target a word which does not have an appropriate TBU to host the tone, referred to as the ‘text’. Such a mismatch is found in words composed entirely of voiceless consonants (e.g. /tfsχt/ ‘you cancelled’).

Roettger identifies three general strategies for tune–text alignment in such cases, as shown in Figure 1. The solid black line indicates pitch over voiced segments, and the dashed grey line, over voiceless segments. In the first strategy, the tune is simply deleted, and no pitch rise is seen. In the second, tone is anticipated on some TBU before the targeted portion (e.g. a vowel of a preceding word). The third option involves the insertion of a default vowel, /ə/, with which the tune associates. This may be at some point within the voiceless sequence (a) or at the end of the sequence (b).

In his discussion, Roettger (2017: 126) interprets schwa insertion as serving as ‘a landing site for a communicatively relevant tone’. Although this is not a categorical pattern (epenthesis sometimes occurs even without a tone), two observations are important. First, insertion is more often observed in sentence modalities with ‘complex tonal movements’, thus showing a correlation between tone and epenthesis. Second, vowel insertion is observed significantly more in phrase-final position than phrase-medially, the former more often being the target of the intonational tune. Taken together, the presence of /ə/ can be understood (in part) as driven by the needs of intonational floating tones.

We refer to patterns such as these as *tone-driven epenthesis*. Tashlhiyt is but one of the languages for which the intonational literature identifies tone-driven epenthesis.

Roettger & Grice (2019) summarise a number of studies which show vowel insertion correlating solely or primarily with intonational properties of the clause, including Galician (Martínez-Gil 1997), Bari Italian (Grice *et al.* 2018) and Tunisian Arabic (Hellmuth 2021).

Having established this, we are now in a position to ask whether tone-driven epenthesis is possible in tonal languages, in which pitch is used for lexical/grammatical functions. There is no *a priori* reason to exclude this possibility based on production, perception or the architecture of the phonology module. To date, this question remains unanswered and is absent from all major surveys of tonal languages (Pike 1948; Fromkin 1978; Yip 2002; Hyman 2011b; Wee 2019, *inter alia*).¹ In fact, Wee (2019: 208) broadly summarises that while it is common for segments to affect tone, ‘[t]here is ... little evidence of reciprocation and very little evidence of tone affecting segments’, which would include vowel epenthesis.²

Equally, the epenthesis literature in general does not address tone-driven epenthesis (Broselow 1982; Itô 1989; Piggott 1995; Blumenfeld 2006; de Lacy 2006, 2007; Hall 2006, 2011; Baković 2007; Moore-Cantwell 2016, *inter alia*). Epenthesis is frequently cited as having three main patterns, as laid out in Broselow (1982). One is *syllabically triggered epenthesis*, where a vowel is inserted for syllable well-formedness (e.g. as a response to a ban on word-final codas (...C# → ...Cə#). A second is *segmentally triggered epenthesis*, responding to a ban on certain configurations of segments (e.g. adjacent sibilants in English *brush*[ə]s; Moore-Cantwell 2016: 239). The third is *minimality-triggered epenthesis* (e.g. a response to a ban on monosyllabic words (#CV# → #ə.CV). These three functions are corroborated in de Lacy (2006: 287 ff.), whose survey of 105 cases of vowel epenthesis shows that all are triggered to ‘satisfy a general phonological requirement such as minimal word restrictions, metrical conditions, and segmental phonotactic restrictions’.

In the few epenthesis studies which address the possibility of tone-driven epenthesis in tonal languages, it is assumed to be either impossible or unattested. Brief mention is found in Blumenfeld (2006: 153 ff.), who pursues a maximally restrictive theory of epenthesis.³ Blumenfeld (2006: 41) hypothesises a number of impossible interactions involving epenthesis, one being that ‘tone conditions cannot affect string structure’ and, therefore, tone ‘cannot force epenthesis/syncope’. Blumenfeld (2006: 5) concludes explicitly that epenthesis is ‘used exclusively as a response to pressures of syllable structure, sonority sequencing, syllable contact and word minimality but cannot be used to avoid violations of other metrical constraints’. He characterises this generalisation as ‘equivalent to saying that in all cases where epenthesis applies, the winner of the alternative grammar without epenthesis contains either a marked consonant cluster or is a subminimal word’ (Blumenfeld 2006: 158).

¹ Direct discussion of tone and epenthesis in tonal studies is chiefly limited to the tonal valuation of epenthetic vowels after they are inserted (e.g. whether by tone spreading or default tone – Hyman & Schuh 1974: 90; McDonough 1996: 249; Yip 2002: 204; Akanlig-Pare & Kenstowicz 2002: 60ff.; Frajzyngier 2003), and more generally the derivational order of epenthesis and tone association (e.g. before or after epenthetic vowel insertion in Japanese; Kubozono 2001). None of this literature discusses epenthesis conditioned by tone.

² As an anonymous reviewer points out, however, one well-known type of segment–tone interaction is the induction of consonant voicing by low tone (e.g. Poser 1981; Hansson 2004; Pearce 2013; Sossoukpe 2017, *inter alia*.)

³ Blumenfeld himself builds on an unpublished handout by de Lacy (2003).

Gleim (2019) summarises this literature and concludes that tone-driven epenthesis in tonal languages is unattested (we return to Gleim and his analysis of Arapaho in §5). He leaves open the question of ‘how to restrict the grammar in such a way that it excludes tone-triggered epenthesis (Gleim 2019: 24), which, of course, presupposes that such epenthesis is impossible.

In the sections which follow, we illustrate that Wamey shows exactly such a pattern and thus fills an empirical gap in the literature. In §2, we lay out the relevant background on Wamey and its phonology. In §3, we present our evidence for tone-driven epenthesis, drawing on root and stem structure, as well as a class of [ə]-alternating suffixes. Here, we also show the preferability of a [ə]-epenthesis analysis to an alternative analysis involving [ə]-deletion. In §4, we provide an OT analysis in which we derive the epenthesis patterns and situate Wamey within a larger theoretical context. In §5, we discuss similar phenomena and other (potential) cases of tone-driven epenthesis in tonal languages, and speculate as to why it is so rare. §6 provides a conclusion.

2. The Wamey language

Wamey (wàè-mèỹ; ISO 639-3 code: cou) belongs to the Tenda subgroup within Niger-Congo.⁴ It is spoken on both sides of the border between Senegal (Salémata Department) and Guinea (Koundara prefecture) by at least 18,000 speakers (Jenkins & Amdahl 2007). The core of Wamey is described in detail in Santos’s (1996) comprehensive grammar (including a 4000-entry lexicon), from which all the data in this paper are taken. Hereafter, we refer to this grammar as S96. We present the relevant preliminaries on Wamey phonology before moving to the issue of tone-driven epenthesis.

2.1. Basic segmental phonology

Wamey has a rich set of segmental contrasts, as shown in Table 1.⁵

Digraphs and trigraphs represent single segments (consonant clusters are highly restricted, which we turn to shortly). Wamey exhibits an extensive mutation system targeting root-initial consonants (Merrill 2018: 302 ff.). The details of the mutation system are irrelevant to the current discussion, but its effects are seen in several of the examples that we cite.

Of the seven contrastive vowels, Santos identifies /ə, æ/ as ‘weak’ for a number of reasons, such as their inability to be stressed (i.e. bear word-level ‘accent’) and positional restrictions (/ə/ is not allowed in word-initial position, and /æ/ is not allowed in final position) (S96: 40–41, 53, 56). However, all vowels including /ə, æ/ can appear as the sole root vowel (e.g. /lən/ ‘snake’, /sæt/ ‘blood’). Wamey has no underlying

⁴Wamey and the Tenda group are traditionally classified as ‘Atlantic’, a group within Niger-Congo which is an areal cluster rather than a true genetic unit (Merrill 2018; Güldemann 2018: 180). Additional names for the language include *Mey*, *Wey*, *Weỹ*, *Konyagi*, *Koñagi* and *Coniagi*.

⁵A tilde above or below an approximant indicates contrastive nasalisation, and w after a velar consonant indicates labialisation. Consonants are equivalent to their IPA values, except j=[j], ñ=[ɲ], nc=[ɲc], nj=[ɲj], nk=[ɲk], nkʷ=[ɲkʷ], y=[j], y=[j̃], ʃ=[ʃ], l=[l] and rʏ=[rʏ]. Note also that /r/ is a voiced trill but patterns with the voiceless fricatives phonologically in the mutation system. Similarly, /s/ is phonetically coronal [s] but patterns as palatal phonologically.

Table 1. *Segmental contrasts in Wamey.*

Consonants:	LAB	COR	PAL	VEL	LAB-VEL	Vowels:
Stop	p b	t d	c j	k g	kw gw	i e a o u ə æ
Pre-nasalised	mp mb	nt nd	nc nj	nk	nkw	
Nasal	m	n	ɲ	ŋ	ŋw	
Glottalised	ʙ	d̥	y̥			
Fricative	f v	s		x	xw	
Approximant	w	l	y			
Nasal approx.	ɰ	ɭ	ɥ			
Trill		r	ry			

long vowels, and surface long vowels are restricted to contexts in which one vowel assimilates to another vowel in the same word across a morpheme boundary (S96: 44).

Wamey prohibits both consonant clusters and vowel clusters within a morpheme. All consonants may appear in the coda position at all prosodic levels (p-word, p-phrase, utterance), although type and token frequencies vary considerably (S96: 47). If a consonant cluster would arise across a morpheme boundary, Wamey shows three responses, depending on the environment. One response simply allows the marked consonant cluster. This happens in compounding, full reduplication and at clitic boundaries generally in (1)–(3). The relevant portion is in bold. Bear in mind that complex consonants represented by digraphs or trigraphs are single segments (e.g. ⟨nkw⟩ represents /^hk^w/).⁶

(1) *Consonant clusters in compounds*

æ-nkól-**f**æc ‘first crow of the rooster’
 PFX-point-be.daylight (‘premier chant du coq (‘le point du jour’); S96: 594)

(2) *Consonant clusters in reduplication*

- a. vè-njæg-**y**’æg ‘jaw joints’ (‘articulation des mâchoires’; S96: 656)
 b. d̥**nk**w-ryènk̥w ‘first’ (‘premier’; S96: 338)

(3) *Consonant clusters at clitic boundaries (generally)*

- a. úrus=**l**’è ‘at Ourous (city)’ (‘...à Ourous’; S96: 252)
 Ourous=LOC
 b. d̥érál=**x**ú ‘next to you’ (‘à côté de toi’; S96: 266)
 near=2S

The other two responses repair consonant clusters, either by deleting the second consonant (C₂) or inserting [ə] between the consonants, which is the general epenthetic vowel. The more common phenomenon is consonant deletion, as illustrated in Table 2. It is always the consonant of the second morpheme which deletes.

⁶The following abbreviations are used in glosses: 1 = first person; 2 = second person; 3 = third person; ADJ = adjective; ANTER = anterior; ASSOC = associative; CL = (noun) class; DEF = definite; DUR = durative; FACT = factitive; IMP = imperative; INFL = inflection; INT = intensive; INVER = inersive; IPFV = imperfective; LOC = locative; MIN = minimal; NEG = negative; o = object; P = plural; PASS = passive; PAST = past tense; PFX = prefix; S = singular.

Table 2. Cluster repair by deletion of C₂.

Morpheme	Consonant cluster	C ₂ deletion	
a. /-ryǎry/	/i-mót-ryǎry/	[i-mót-ǎry]	'to fight'
ASSOCIATIVE	PFX-make.war-ASSOC		('combattre'; S96: 57)
/-nónd/	/i-gwót-nónd/	[i-gwót-ǎnd]	'make empty'
FACTITIVE	PFX-empty-FACT		('faire vider'; S96: 305)
/-xót/	/i-pàŷ-xót/	[i-pàŷ-ót]	'take back (a dowry)'
INVERSIVE	PFX-pay.dowry-INVER		('reprendre (la dot)'; S96: 296)
b. /-xâw̃/	/njǎdǎ-l-xâw̃/	[njǎdǎ-l-ǎ]	'(that) he gives him'
3S.OBJECT	give-3S-3S.O		('qu'il lui donne'; S96: 59)
c. /-ŋǎ/	/ǎ-tóx=ŋǎ/	[ǎ-tóx=ǎ]	'the tree'
DEF.CL3	CL3-tree=DEF.CL3	~ [ǎ-tóx=ŋǎ]	('l'arbre'; S96: 211)

Nearly all (consonant-initial) derivational suffixes (Table 2a) and inflectional suffixes (Table 2b) show this type of repair. For instance, the inflectional suffix /-xâw̃/ 3S.OBJECT in Table 2b is part of a series of /x/-initial suffixes, all of which show /x/-deletion when adjacent to a consonant. Further, definite clitics which begin with /ŋ w̃ ŷ/ (Table 2c) optionally delete this consonant when consonant-adjacent, a pattern which also holds for demonstratives. We return to these inflectional suffixes and clitics in §3, where we use them to diagnose the underlying representation of preceding morphemes.

The other cluster repair is much more limited and involves [ə]-insertion, as shown in Table 3. These include both derivational suffixes (Table 3a) and inflectional ones (Table 3b). One thing which sets these affixes apart is that three of the four consist of a single consonant only. Therefore, it seems to be the case that deletion is blocked if insufficient phonological substance of the morpheme would remain. The exception is durative /-lél/, which, diachronically, likely consists of a frozen, non-productive suffix /-l/ plus causative factive /-él/, leading to a bigram /-l-él/ whose first morpheme still retains its monoconsonantal behaviour (cf. Wolof *-taan* with the same meaning, also ultimately from two suffixes in combination). As it stands, however, we must classify /-lél/ as an exception. What is important to take from this discussion is that this syllabically driven vowel epenthesis is independent of the tone-driven [ə]-epenthesis we discuss in §3.⁷

⁷Santos additionally identifies two other suffixes as triggering [ə]-insertion, /-má/ 'always' and /-nká/ '(not) early':

- (i) /-yív-má/ → [-yívə́má] 'be always (doing) well' ('être toujours bien'; S96: 58)
 cf. /-mé-má/ → [-mémá] 'be always (doing) bad' ('vivre dans de mauvaises conditions'; S96: 295)
- (ii) /-tòk-nká/ → [-tòkə́nká] '(not) eat early' ('(ne pas) manger tôt'; S96: 58)
 cf. /-nógá-nká/ → [-nógáə́nká] '(not) wake up early' ('(ne pas) se réveiller tôt'; S96: 622)

However, both of these suffixes are marginal and appear with only a couple of roots. Therefore, we take these to be frozen morphology, with no synchronic epenthesis operation for these forms.

Table 3. Cluster repair by [ə]-insertion.

Morpheme	Consonant cluster	[ə]-insertion	
a. /-lé/	/màd- lé /	[màd ə lé]	‘to pass (of a day)’
DURATIVE	get.dark-DUR		(‘passer (pour le jour)’; S96: 58)
/-t/	/i-yǎk- t /	[iyǎk ə t]	‘to accelerate’
INTENSIVE	PFX-be.hot-INT		(‘accélérer’; S96: 296)
b. /-k/	/cǎs- k /	[cǎs ə k]	‘he suffers’
3S.MINIMAL	suffer-3S.MIN		(‘il souffre’; S96: 43)
/-d/~/ -nd/	/péñ- d -ê/	[péñ ə dè]	‘he is pushed’
IMPERFECTIVE	push-IPFV-PASS		(‘il est poussé’; S96: 248)

2.2. Basic tonal phonology

Wamey makes a basic distinction between H and L tone, with contours HL and LH permitted but subject to various restrictions. A minimal triple for a monosyllabic base is shown in (4).

- (4) *Basic tonal contrasts on CVC roots* (S96: 50)
- L -cǎw̃ ‘hiding’ (‘fait de cacher’)
 - H -cǎw̃ ‘urinating’ (‘fait d’uriner’)
 - HL -cǎw̃ ‘domestic animal’ (‘animal domestique’)
 - * LH

A falling HL contour is generally restricted to CVC words (or larger). The only cases of HL on a CV word are reduced forms of interrogatives, [mô] ‘who’ (</mógà/) and [nê] ‘where’ (</négà/). A rising LH contour is not found on the surface in either CV or CVC words (a point we return to).

In multisyllabic words, contours are found predominantly in word-final position, as in (5). Here, we see a contrast between LH and HL contours.

- (5) *Final contours* (S96: 50)
- L.HL kòmbô ‘sorghum’ (‘sorgho’)
 - H.HL ì-támpùl ‘navel’ (‘nombril’)
 - H.LH ǎ-ηómpě ‘falcon’ (‘faucon’)
 - * L.LH

The LH contour must be preceded by an H tone; [L.LH] is unattested. The most common realisation of LH is as a surface mid tone ((5c) would be [ǎηómpě]). For completeness, other tone rules of Wamey are provided in (6); the Greek letter tau represents a TBU.

- (6) *Other tone rules in Wamey*
- Decontouring (applies to inflection only): τ̂τ̂ → τ̂τ̂, τ̂τ̂ → τ̂τ̂,
τ̂τ̂τ̂ → τ̂τ̂τ̂, τ̂τ̂τ̂ → τ̂τ̂τ̂

- b. Three-tone simplification on a single TBU: $\tilde{\tau} \rightarrow \dot{\tau}$, $\tilde{\tau} \rightarrow \acute{\tau}$
 c. Rightward spreading to toneless TBUs: $\acute{\tau}\tau \rightarrow \acute{\acute{\tau}}$
 d. Default low insertion: $\tau \rightarrow \grave{\tau}$

Finally, a crucial part of our analysis involves positing floating tones as part of the lexical representation of certain morphemes. For example, the marker of *mode énonciatif*, a multi-functional morph marking certain classes of non-negative clauses, is realised variably as a prefix /ǎ-/ or as a floating tonal morph (H) (hereafter, a tone within a circle indicates a floating tone). An example is shown in (7), where we gloss it as INFL.

(7) *Floating tone in Wamey*

- a. ǎ-tòk-ónì vǎ-sǎn=v-ǎ → [ǎtòkǎnì vǎsǎnvá]
 INFL-eat-3P CL2-man=CL2-DEF
 ‘The men ate’ (‘ils ont mangé, les hommes’; S96: 217)
 or:
 b. (H)-tòk-ónì vǎ-sǎn=v-ǎ → [tókǎnì vǎsǎnvá]
 INFL-eat-3P CL2-man=CL2-DEF
 ‘The men ate’ (‘ils ont mangé, les hommes’; S96: 217)

In the second example, the floating tone docks with the initial TBU. This pushes the lexical L tone onto the following vowel, resulting in a rising tone [tókǎnì] (a rare case where a contour is not domain-final).

3. Tone-driven [ǎ]-epenthesis

This section lays out the evidence for tone-driven epenthesis, from two areas of Wamey grammar. The first involves the complementary distribution of word-final [ǎ] with \emptyset , which is straightforwardly accounted for if [ǎ]-final roots are actually consonant-final underlyingly. The other involves alternations between [ǎ] and \emptyset in what we term [ǎ]-alternating suffixes.

Before we begin, we emphasise that several of the analytic generalisations should be attributed to Santos’s (1996) grammar itself. In discussing the behaviour of /ǎ/, she states overtly its role in providing ‘support’ for tone: ‘the vowel /ǎ/ supports a high tone after a low tone or a low-high tone after a high tone’, in which case ‘it is always realised even when it is in final word position’ (p. 43), even though forms with final /ǎ/ constitute ‘a base with a final consonant at the structural level’ (p. 189, fn. 3).⁸ Her grammar has unfortunately gone unnoticed in the phonology literature, and we are happy to bring it to the fore. Where she provides analytic generalisations overtly, we state as much, but in most places we go beyond her original study in scope and theoretical modelling, and in other places we make reanalyses.

⁸In the original: ‘la voyelle /ǎ/ supporte un ton haut derrière un ton bas ou un ton bas haut derrière un ton haut. Dans ce cas, elle est toujours réalisée, même lorsqu’elle est en position finale de mot’; ‘rappelons qu’une base à finale /ǎ/ au niveau phonologique est une base à consonne finale au niveau structurel’ (see also pp. 55, 71, 75–76).

Table 4. *Complementary distribution of CVCə and CVC roots.*

Tone	CVCə	CVC	
L	*c̀vc̀ə̀	-cə̀w̃	‘hiding’
H	*c̀vc̀ə̀	-cə̀w̃	‘urinating’
HL	*c̀vc̀ə̀	-cə̀w̃	‘domestic animal’
LH	-nkə̀w̃ə̀	*-c̀vc̀	‘dance’ (n.)

3.1. Evidence from root and stem structure

The first piece of evidence for tone-driven epenthesis in Wamey involves the phonological patterns of roots/stems. Recall from (4) that CVC roots surface as H, L or HL but not as LH. CVC patterns are actually in complementary distribution with CVCə roots with a final schwa (e.g. [i-nkə̀w̃ə̀] ‘dance’ (n.), [ə̀-mbə̀ỹə̀] ‘leper’, [à-lə̀nkw̃ə̀] ‘imbecile’, [i-còkə̀] ‘to weld’, [i-mènə̀] ‘to fish’, [dòlə̀] ‘today’, [tàmpə̀] ‘enslaved’, among many others). All other tone patterns are unattested on CVCə roots. This complementarity is shown in Table 4. The initial hyphen indicates that these forms normally appear with noun class prefixes.

This complementarity is categorical across Santos’s lexicon. We digitised this lexicon and coded all lexical roots and stems for segmental structure, syllabic structure and tone patterns ($n = 3518$). We counted monomorphemic nouns, verbs, adjectives, adverbs, ideophones, temporals/locatives and numerals as lexical roots. If they were provided by Santos, we included proper nouns, such as names of villages and certain Wamey names. We also included a large number of multi-morphemic lexical stems which contain derivational morphology, a point we return to below. Both these and plain lexical roots constitute morphological stems, hereafter simply referred to as stems. We set aside any noun class prefixes (including the infinitive prefix /i-/), which are always outside the stem. We excluded grammatical morphemes such as conjunctions, connectives, demonstratives, interrogatives, pronouns, prepositions, quantifiers and relative markers from our database. We also excluded complex constructions such as set phrases/idioms, reduplicated words and compounds. A copy of this database is found in the supplementary materials. Note that adjectives marked with the adjectival suffix are in their own section of the database.

Let us first examine monosyllabic CV and CVC stems compared to bisyllabic CVCə stems which end in [ə̀]. Table 5 shows that while LH sequences are banned in CV and CVC stems, they represent the primary pattern found in CVCə stems.⁹

Parallel patterns are found for longer lexical stems. Just as CVC and CVCə stems are in complementary distribution, so are CVCVC and CVCVCə. Table 6 shows the number of these longer stems with each tone pattern. As in Table 5, patterns with final L.H appear only on ə̀-*final* stems, and ə̀-*final* stems never host any other tone pattern.¹⁰

⁹The two [H.LH] stems are [n̄n̄ə̀] ‘nothing’ (‘rien’; S96: 625) and [tək̄ə̀] ‘already’ (‘déjà’; S96: 648). These are at least historically derived from simpler roots; namely, /-n̄in/~/-n̄ə̀/~/-ȳin/~/-ȳə̀/ ‘thing’, and /-tək̄/ ‘arrive’.

¹⁰The two exceptional CVCVC forms with a [H.LH] pattern are [ə̀-ntə̀pòt] ‘tadpole’ and [i-léj̄ik] ‘larceny’ (S96: 583; cf. [i-dé] ‘to steal’). These end in a final LH rising tone, where our analysis predicts that it should end in high-toned [ə̀]. We suspect that their exceptionality is due to their diachronic origins. A small number of transparently derived words also show a final rising tone (e.g. [pə̀mp̄ələ̀x] ‘mean’ (adj., ‘méchant’; S96: 638; < [i-pə̀mp̄ə̀l] ‘wickedness’)).

Table 5. Comparison of one-syllable and one-syllable-plus-schwa stems.

CV (<i>n</i> = 107)			CVC (<i>n</i> = 1352)			CVCə (<i>n</i> = 179)					
H	ćv̂	56	H	ćvc	576	H	ćvcá	0	H.HL	ćvĉ	0
L	c̀v̂	50	L	c̀vc	741	L	c̀vcə	0	L.HL	c̀vĉ	0
HL	ĉv̂	1	HL	ĉvc	35	H.L	ĉvcə	0	H.LH	ĉvĉ	2
LH	ĉv̂	0	LH	ĉvc	0	L.H	ĉvcá	177	L.LH	ĉvĉ	0

Table 6. Comparison of (*C-final*) two-syllable and two-syllable-plus-schwa stems.

CVCVC (<i>n</i> = 717)				CVCVCə (<i>n</i> = 61)				
H.H	ćvćvc	239	H.H.H	ćvćvcá	0	L.H.HL	c̀vc̀vĉ	0
L.L	c̀vc̀vc	104	L.L.L	c̀vc̀vcə	0	H.L.HL	ćvc̀vĉ	0
H.L	ćvc̀vc	19	H.L.L	ćvc̀vcə	0	L.H.LH	c̀vc̀vĉ	0
L.H	c̀vćvc	245	L.H.H	c̀vćvcá	0	H.L.LH	ćvc̀vĉ	0
H.HL	ćvĉvc	26	H.H.L	ćvĉvcə	0	H.H.HL	ćvĉvĉ	0
L.HL	c̀vĉvc	82	L.H.L	c̀vĉvcə	0	L.L.HL	c̀vĉvĉ	0
H.LH	ćvĉvĉ	2	H.L.H	ćvĉvĉá	19	H.H.LH	ćvĉvĉ	0
L.LH	c̀vĉvĉ	0	L.L.H	c̀vĉvĉá	42	L.L.LH	c̀vĉvĉ	0

This complementarity also holds for the small number of three-syllable (plus schwa) stems in our database (*n* = 12) (i.e. CVCVCVC versus CVCVCVCə stems). All such CVCVCVCə stems end as expected with a low tone on the penult and a high tone on the final [ə] (e.g. the [L.L.L.H] stem [-nkàrə̀yá̀l̂] ‘sand’, the [L.H.L.H] stem [-gèkólèr̂] ‘snuffbox’, and the [H.H.L.H] stem [-ŷá̀l̂é̀nkò̀n̂] ‘*cram-cram* grain’). In these [ə]-final stems, the [ə] cannot be attributed to any syllabically or segmentally triggered epenthesis. As stated above, all consonants are permitted in the coda position. For all stems with a final schwa, there are equivalent words which end in the consonant before that schwa. This is shown in Table 7 with plain stops (palatal /c/ in row Table 7a), prenasal stops (/nd/ in Table 7b), implosives (/b/ in Table 7c), fricatives (/s/ in Table 7d) and sonorants (/l/ in Table 7e). All rows show that if the syllable ends in a low, high or falling tone, no [ə] is inserted.

A straightforward interpretation of this complementarity is that CVC and CVCə structures derive from a common underlying structure conditioned by tone. Logically, the common structure could be underlying /CVC/, in which case [CVCə] is derived via epenthesis, or /CVCə/ with [CVC] derived via deletion. There is no contrast in the language between /CVC/ and /CVCə/ stems, which compounds the difficulty in choosing between the two analyses (on this fundamental difficulty as it pertains to consonant epenthesis, see Morley 2015).

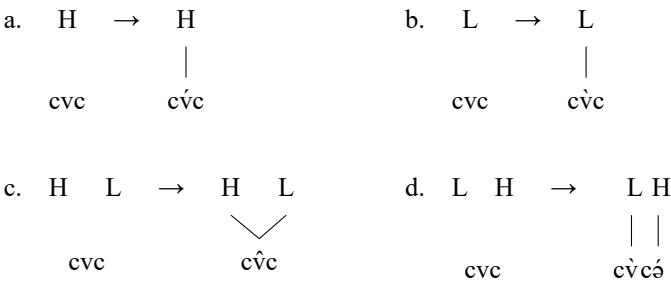
The simpler of the two involves positing less underlying structure, which is the epenthesis account advocated in this paper. The four basic tone patterns – H, L, HL and LH – as they appear on CVC stems are illustrated in (8). Inputs with H, L or HL

Table 7. *Lack of final [ə] epenthesis in other tone contexts.*

	[...c̀vć]	cf.	[...c̀vc]	[...c̀vc]	[...c̀vc]
a.	[i-kòć]		[i-kàc]	[i-ḡàb́oc]	[kùmp̀oc]
	‘to finish an animal’		‘skin’	‘to take a big share’	‘pumpkin and peanut dish’
b.	[i-kònd́]		[ə-ncàend]	[i-ḡàḡ́ond]	[i-tònd]
	‘to stack up’		‘shell’	‘to teach’	‘type of arrow for birds’
c.	[ə-kòb́]		[i-còb]	[i-gwàl̀é́b]	[ə-kàb]
	‘type of owl’ (<i>Otus leucotis</i>)		‘to stick on’	‘to talk a lot’	‘rubber vine’
d.	[i-cùś]		[i-dàes]	[i-kàrós]	[ù-xùwás]
	‘to take out (with utensil)’		‘to laugh’	‘to scrape’	‘sock’
e.	[à-vàĺ]		[i-b̀ol]	[i-tàmból]	[i-kàỳol]
	‘shoemaker’		‘to refuse’	‘to climb to the top’	‘to be back-to-back’

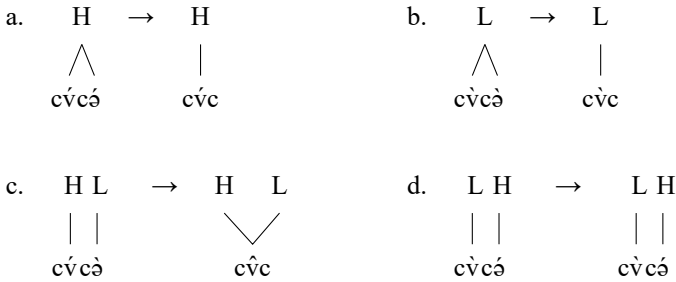
sequences associate straightforwardly with the vowel. However, due to constraints on rising tones, a LH sequence cannot associate both tones with the TBU. To preserve all tones in the input, an epenthetic schwa is inserted to host what would otherwise be a floating H.

(8) *Interpretation as underlying /CVC/ with [ə]-insertion to host the H tone*



In what follows, we analyse the underlying structure of such words to be /c̀vc(H)/ with a pre-linked low tone and an underlying floating high tone (circled), rather than as underlying /c̀vc/ with both tones pre-linked. Regardless of analysis, as stated, there is no contrast between these two representations in CVC stems.

We can refer to the alternative as tone-driven /ə/-retention, as shown in (9). Here, underlying /ə/ is deleted in word-final position unless it would result in a floating tone or a rising tone. Under this alternative (which we reject), there is no epenthesis; therefore, Wamey does not constitute a true counterexample to the aforementioned claims in the literature.

(9) *Alternative interpretation (rejected): Tone-driven /ə/-retention*

Therefore, we must adjudicate between two competing sets of underlying representations:

(10) *Competing sets of URs*

- a. URs under tone-driven [ə]-epenthesis: /c'vc/ /c'vcə/ /c'vcH/ /c'vc(H)/
- b. URs under tone-driven /ə/-retention: /c'vc'á/ /c'vcə/ /c'vc'á/ /c'vc'á/

Before beginning to compare these two, we stress an important commonality: the occurrence of final [ə] on the surface is entirely determined by tonal factors and insensitive to segmental ones.¹¹

One piece of evidence in favour of epenthesis comes from the general shape of monomorphemic roots in the lexicon. In the alternative /ə/-retention analysis, there are no C-final roots. Therefore, we might expect /CVCV/ roots in general to be common, with a full range of final vowels and tonal patterns. However, this is not the case in Wamey. Of the unambiguously vowel-final /CVCV/ stems in the lexicon ($n = 621$; cf. 1352 CVC stems), the vast majority end in /a/ (478 out of 621, or 77%). Most of these are decomposable into a CVC root plus a derivational -V suffix and are transparently related to a CVC base; some others contain frozen morphology. The anticausative/middle suffix /-á/ is particularly common and, like its equivalent in other Atlantic languages, is often used to form denominal verbs.

(11) *CVCV stem as /CVC/ root plus suffixal /-V/*

- a. -á MIDDLE -kùb-á 'hunchbacked, crooked' (< -kùb 'bend')
- b. -á DEVERBAL i-f'ónk-á 'hitching post' (< -p'ánk 'leash animal to post')
- c. -á 'do alone' -tòk-á 'eat alone' (< -tòk 'eat')
- d. -ì (frozen suffix) -b'áél-ì 'mobilise' (< -b'áél 'frighten, be afraid')

Further, those CVCV structures which cannot be morphologically segmented are overwhelmingly loanwords, mostly from Malinke. Many of these loanwords are additionally exceptional in that they lack an overt noun class prefix.

¹¹ While tone-driven epenthesis has been claimed to be unattested/impossible in tonal languages, there have been numerous cases identified of tone-driven vowel retention. We discuss this in §5.1 below.

Table 8. CV roots by final vowel: Lack of final /ə/.

Vowel	CV roots	Example	CVC roots
/i/	19	ì-ḃí ‘to resume, recover’	84
/e/	19	ì-vé ‘dog’	109
/æ/	3	ì-ñǎé ‘to be very’	375
/a/	20	ì-ḃá ‘to be small’	129
/u/	25	ì-mbú ‘hippopotamus’	125
/o/	21	ì-kó ‘knee’	104
/ə/	1	à-jǎ ‘(grand)son of’ (‘(petit) fils de’)	426

(12) *Examples of borrowed roots in Wamey ending in vowels*

- a. Malinke: dǒkú ‘work’, kírýí ‘gun, rifle’, gǎrà ‘indigo’
- b. Pajade: ḃésù ‘mead’, làwó ‘friend’, kǎntíká ‘scarf’
- c. Arabic: ḃũñá ‘reward’, dũníyá ‘material world’, sédé ‘witness (n.)’
- d. French, Portuguese: dámiyè ‘checkerboard’, kójírǎ ‘spoon’, kǎlérǎ ‘cooking pot’
- e. Wanderwörter: kǔrú ‘cola nut’, kǎmè ‘hundred’, kóryí ‘money’

Another point concerns CV roots, which are very rare ($n = 108$). This is summarised in Table 8. Unlike the CVCV roots, these are mostly native roots in which it is likely that an earlier root-final consonant was deleted. A striking gap can be seen here. While vowels are generally evenly distributed, there is a near-complete lack of CV roots ending in [ə].¹² We can compare this to CVC roots, where [ə] is the most frequent vowel.

The only exception is the bound root /-jǎ/ ‘(grand)son of’, which can never appear on its own, as shown in (13). It might even be analysed as a prefix rather than a root.

(13) à-jǎ yǐnǎ ‘son of Hyena’ (‘fils de Hyène’; S96: 253)

Under the alternative /ə/-retention analysis, final /ə/ is deleted unless it is retained to host tone. In (13), for instance, the underlying final /ə/ would not be deleted, because this would result in a banned floating high tone. Therefore, under the alternative, it is unexplained why there is not a comparable number of /Cə/ roots, where the final /ə/ should always surface transparently to host a tone.

In contrast, under tone-driven [ə]-epenthesis these facts are straightforwardly unified via a constraint banning word-final [ə] at the prosodic stem-level. This prosodic constituent would equally apply to CV and CVCV stems regardless of tonal pattern.¹³ Under this analysis, surface [ə] in [CVCə] patterns emerge only at a later stage where the (prosodic) word is evaluated. Underlyingly, roots in Wamey are canonically CVC,

¹²Final /æ/ is also rare, but this is independently ruled out by a dispreference for word-final /æ/ regardless of tonal factors (S96: 40–41).

¹³For a discussion on how to model this restriction, especially in light of Richness of the Base, see §4.

and deviations from this template come about through synchronic/diachronic morphological processes. In fact, the canonical root shape in this Atlantic linguistic area is CVC, as found, for example, in Wolof, Fula and, most notably, the two remaining Tenda languages Bassari and Bedik related to Wamey. These languages have CVC roots wherever Wamey has [CVCə].

To summarise, in surface CVCV roots, the final vowel is overwhelmingly [ə], which appears only in the appropriate tonal context. This is easily explained if the [ə] is inserted to allow for the realisation of the underlying tones. If, on the other hand, the [ə] is present underlyingly, there is no explanation for why other vowels are not also attested in this position proportionate to their occurrence in other positions. The ə-epenthesis analysis simply treats underlying CVCV roots as uncommon and non-canonical, which aligns with the historical and areal facts. The /ə/-retention analysis must treat CVCV roots as the norm but does not provide any independent reason why /ə/ is overwhelmingly preferred as the underlying root-final vowel. In fact, the evidence from CV roots shows that underlying /ə/ is specifically banned in this position unless it serves a tonal purpose.

3.2. Evidence from C deletion in enclitic determiners

If [c̀v̀c̀ə] forms are actually /c̀v̀c̀(Ḩ)/ at the stem-level, as we advocate, then they should also pattern as consonant-final in morphophonological processes. This is indeed the case. Consider the following data involving definite marker enclitics which appear after all other elements in the noun phrase. The definite marker has the form /=(C)ǎ/ with an underlying rising tone. The identity of the consonant is dictated by noun class agreement, as demonstrated in (14).

(14) *Definite marker noun class agreement* (S96: 209)

- a. v̀i-líyá=vǎ
CL8-tool=DEF.CL8
'the tools'
- b. fǎë-rə̀mp=fá
CL15-tortoise=DEF.CL15
'the tortoise'
- c. gǎ-tóx=gǎ
CL20-tree=DEF.CL20
'the big tree' (augmentative)

For most noun class contexts, the consonant of the definite marker is fixed and obligatory. However, if the noun class prefix begins with /w/, /y/, /ỹ/ or a vowel, or if it is null, then the corresponding definite marker has two variants which occur in free variation: =Cǎ and =ǎ. The =Cǎ variant has the form [=ŋǎ], [=ỹǎ] or [=wǎ], depending on the noun class. This free variation is demonstrated in (15).

(15) *Definite markers: =Cǎ and =ǎ variants* (S96: 211)

- a. wǎë-sǎ̀l=wǎ́á ~ wǎë-sǎ̀l=á
CL11-guinea.fowl=DEF.CL11
'the guinea fowls'

Table 9. *Variants of definite clitics in different contexts (S96: 211).*

	Final σ	Stem	=Că form	=ă form	Translation
a.	CV	/i-bú/	i-bú=ŋă	*	‘the baobab fruit’ (‘le pain de singe’)
b.	CVCV	/i-líyá/	ì-líyá=ÿă	*	‘the tool’ (‘l’outil’)
c.	CVC	/æ-tóx/	æ-tóx=ŋă	æ-tóx=ă	‘the tree’ (‘l’arbre’)
d.	CVC+(H)	/wæ-mbəl(H)/	wæ-mbəl=ŋă	wæ-mbəlă=ă	‘the milk’ (‘le lait’)

Table 10. *Derivation with definite enclitics.*

	Input	wæ- mbəl(H)=ŋă	æ- tóx=ŋă	i- líyá=ÿă
1.	Consonant deletion:	wæ-mbəl(H)=_ă	æ-tóx=_ă	—
2.	[ə]-epenthesis:	wæ-mbələ=ă	—	—
3.	Assimilation:	wæ-mbəlă=ă	—	—
	Surface	[wæ-mbəlă=ă]	[æ-tóx=ă]	[i-líyá=ÿă]

b. æ-tóx=ŋă ~ æ-tóx=ă
 CL3-tree=DEF.CL3
 ‘the tree’

c. ø-ràsə]=ÿă ~ ø-ràsə]=ă
 CL7B-axe=DEF.CL7B
 ‘the axe’

This variation is possible only after a consonant. If the stem ends in a vowel, only the =Că form is found. This is shown in Table 9 with vowel-final CV stems (Table 9a) and CVCV stems (Table 9b). Importantly, Santos is explicit that the same variation found in CVC stems is found for those CVC stems analysed with a floating (H) (e.g. /-mbəl(H)/ [mbələ] ‘milk’) despite the fact that the latter surface with a final schwa in context (Table 9c–d; S96: 209). The importance of such data is clear: these stems pattern as consonant-final, suggesting that surface forms with final [ə] are derived.

Table 10 shows the interaction of the three phonological processes present here: consonant deletion in the clitic, [ə]-epenthesis and assimilation of this vowel. The optional consonant deletion applies first in these simplified derivations, which accounts for why inputs such as /mbəl(H)/ also condition deletion.

In this table, notice that an epenthetic vowel is still inserted after consonant deletion to host the otherwise floating tone. This then assimilates to the following vowel and is one of the few places in the language where a surface long vowel is seen. We return to this fact in §4.3.

Consider now the competing analysis involving /ə/-deletion, as shown in Table 11. Here, we must adopt a far less phonologically natural operation, whereby certain intervocalic consonants delete but only if the first vowel is /ə/. Further, as discussed in §2.1, there are several independently motivated operations which repair CC clusters

Table 11. Alternative derivation with definite enclitics (rejected).

	Input	wæ- mbə̀lɔ́ =ɲǎ	æ- tɔ́xɔ́ =ɲǎ	i- líyá =ỹǎ
1.	Consonant deletion:	wæ-mbə̀lɔ́= ǎ	æ-tɔ́xɔ́= ǎ	—
2.	/ə/-deletion:	—	æ-tɔ́x ǎ	—
3.	Assimilation:	wæ-mbə̀lǎ=ǎ	—	—
	Surface	[wæ-mbə̀lǎ=ǎ]	[æ-tɔ́x=ǎ]	[i-líyá=ỹǎ]

Table 12. Summary of [ə]-alternating suffixes.

	[C]-final	[Cə]-final	Gloss	Santos's gloss
a.	[-k]	[-kɔ́]	3S.MIN(IMAL)	'indice personnel minimal (ps. min.)'
	[-n]	[-nɔ́]	2P.IMP(ERATIVE)	'impératif (deuxième personne du pluriel)'
b.	[-ǎx]	[-ǎxɔ́]	ADJ(ECTIVAL)1	'adjectif'
	[-ák]	[-ákɔ́]	ADJ(ECTIVAL)2	'adjectif'
	[-ǎk]	[-ǎkɔ́]	ANTER(IOR)	'modalité verbale d'antériorité'
	[-(ry)ǎry]	[-(ry)ǎryɔ́]	ASSOC(IATIVE)	'associatif'
	[-(x)ǎ]	[-(x)ǎɔ́]	LOC(ATIVE)	'locatif'

that arise from morphological concatenation. One of these is the deletion of the second consonant, as in the first step of the derivation in Table 10. In contrast, the derivation in Table 11 must propose a novel and idiosyncratic deletion process triggered only by a preceding /ə/.

In total, [c̀v̀c̀] stems pattern as consonant-final, not as vowel-final. This supports an underlying (segmental) representation as /CVC/, which entails that surface [ə] is inserted rather than deleted.

3.3. Evidence from [ə]-alternating suffixes

Further evidence for the epenthesis analysis comes from bound morphology, specifically from what we call [ə]-alternating suffixes, which display an alternation between [C]-final and [Cə]-final variants. The relevant suffixes are summarised in Table 12. For each pair, the variants are predictable based on the phonological context; therefore, they should not be considered suppletive allomorphs.

The suffixes in Table 12a alternate between shapes [C] and [Cɔ́], the latter of which bears a high tone. The first, [-k]~[-kɔ́], is roughly equivalent to third singular subject marking in perfective aspect, which we gloss as 3S.MINIMAL following Santos's terminology ('indice personnel minimal'). The second, [-n]~[-nɔ́], marks imperatives with plural addressees. The data in (16) are representative examples which illustrate the conditioning factor: the [C] form appears if the preceding vowel is high-toned, while

the [Cá] variant appears if the preceding vowel is low-toned (the preceding syllable is underlined, and the [ə]-alternating suffix is in bold).

(16) *Illustration of suffix forms in Table 12a*

- a. 3S.MINIMAL [-k]~[-ká]
- i. After H: ì-cáés ‘to suffer’ > cáésá-k ‘he suffers’ (‘il souffre’; S96: 43)
 - ii. After L: ì-tòk ‘to eat’ > tókà-ká ‘he ate’ (‘il a mangé’; S96: 43)
- b. 2P.IMPERATIVE [-n]~[-nó]
- i. After H: yáð-áry-àkà-n ‘give!’ (‘donnez donc!’; S96: 554)
 - ii. After L: tòk-áryi-nó ‘eat!’ (‘mangez!’; S96: 220)

The second group of affixes (Table 12b) is identical in its distribution. All of these additionally consist of a low vowel [æ] or [a], and some have an initial consonant (subject to deletion). The first two are adjectival suffixes [-áx]~[-àxá] (ADJ1) and [-ák]~[-àká] (ADJ2). ADJ1 and ADJ2 are in complementary distribution, with ADJ2 appearing after [a]-final stems. Representative examples of these variant pairs are provided in (17). As with the first group of suffixes, the [vc] variant occurs if the stem ends in a high tone, while the [vcá] one appears if the stem ends in a low tone.

(17) *Illustration of suffix forms in Table 12b*

- a. ADJECTIVAL1 [-áx]~[-àxá]
- i. After H: ì-yáék ‘be hot’ > wà-nkà wà-yáék-áx ‘hot water’ (‘de l’eau chaude’; S96: 183)
 - ii. After L: ì-gùk ‘be sliced’ > wà-wád wà-wùk-àxá ‘sliced mangoes’ (‘des mangues talées’; S96: 107)
- b. ADJECTIVAL2 [-ák]~[-àká] (ADJ2 is used after [a])
- i. After H: ì-dáñá ‘to sit down’ > dáñá-ák ‘seated’ (‘assis’; S96: 200)
 - ii. After L: ì-bávà ‘to (still) be green’ (of fruit) > bávà-àká ‘still green’ (‘encore vert’; S96: 115)
- c. ASSOCIATIVE [-(ry)áery]~[-(ry)àeryá]
- i. After H: ì-cónk ‘to discuss’ > ì-cónk-áery ‘to argue with (s.o.)’ (‘se disputer avec (qqn)’; S96: 306)
 - ii. After L: ì-nàÿ ‘to be big’ > ì-nàÿ-àeryá ‘to be big like (s.o.)’ (‘être grand comme’; S96: 306)

The patterns of both sets of suffixes corroborate the static distribution with lexical stems detailed in §3.1. If a word-final [ə] is present, it is always high-toned and appears after a low. There are no instances of final word shapes *[cvcà], *[cvcá] and *[cvcà] involving these suffixes.

Parallel to the argument involving definite enclitics above, we can probe the underlying representation of [ə]-alternating suffixes based on how they condition the affixes which follow them. As expected under our analysis, these suffixes pattern as underlyingly consonant-final. The relevant data involve the interaction with another class

Table 13. /x/-alternating suffixes.

	UR	Tone	Gloss	After V	After C	Santos's gloss
a.	/-xów̃/	H	1S.O	[-xo(w̃)]	[-o(w̃)]	'1°ps.sg.o'
	/-xín/	HL	2S.O	[-xi(n)]	[-i(n)]	'2°ps.sg.o'
	/-xâw̃/	HL	3S.O	[-xa(w̃)]	[-a(w̃)]	'3°ps.sg.o'
	/-xəfún/	H.L	1P.O	[-xəfu(n)]	[-əfu(n)]	'1°ps.pl.o'
	/-xûn/	HL	2P.O	[-xu(n)]	[-u(n)]	'2°ps.pl.o'
	/-xəliw̃/	H.L	3P.O	[-xəli(w̃)]	[-əli(w̃)]	'3°ps.pl.o'
b.	/-xôw̃/	HL	PAST	[-xo(w̃)]	[-o(w̃)]	'passé'

of suffixes, in which an initial /x/ is deleted. We call these */x/-alternating suffixes*. An example is /-xâw̃/, which indexes third singular objects (3S.O). If it appears after a consonant, the initial /x/ deletes, as shown in (18a). In contrast, if it appears after a vowel, the /x/ surfaces, as in (18b).

(18) *The /x/-alternating suffix /-xâw̃/*

- a. $y\acute{o}d\acute{e}l\text{-}\underline{u}n\text{-}\mathbf{x\grave{a}w\tilde{}}$ -lá → [y^ho^hd^he^hl-un-**â**-lá] 'you didn't give it to him'
 give-NEG-2P-3S.O-NEG ('vous ne le lui avez pas donné'; S96: 261)
- b. \textcircled{H} -péñ-əbú- $\mathbf{x\grave{a}w\tilde{}}$ → [péñ-əbú-**xâ**] 'I pushed him'
 INFL-push-1S-3S.O ('je l'ai poussé'; S96: 57)

Table 13 lists two classes of /x/-alternating suffixes consisting of a full set of object-indexing suffixes (Table 13a) and the past-tense suffix /-xôw̃/ (Table 13b). Note that all of these suffixes have final consonants (n or w̃) which surface only before a vowel; this alternation is irrelevant to the current discussion.

Let us now look at the interaction of [ə]-alternating suffixes with /x/-alternating suffixes. For consistency, we use only the suffix [-k]~[-kə] 3S.MINIMAL in these data, which we take to be representative of the [ə]-alternating class. Table 14 shows verb forms with /-k/ followed by each /x/-alternating suffix. In all cases, /-k/ conditions the deletion of /x/, suggesting that /-k/ is underlyingly consonant-final.

We can contrast [ə]-alternating suffixes such as /-k/ 3S.MIN with other suffixes of the same relative morphological class and position. For example, /-ə́rú/ indexes second-person singular subjects and also directly precedes the relevant /x/-alternating suffixes. In contrast to third-person /-k/, second-person /-ə́rú/ underlyingly ends in a vowel; therefore, it conditions the /x/-initial variant without deletion. This is shown in (19) where the /-ə́rú/ is underlined and the /x/-alternating suffix is in bold.

(19) *No deletion of /x/ after a vowel*

- a. dǎk-dǎ báwò ə-pə̀yǎ-ə́rú- $\mathbf{x\acute{o}w\tilde{}}$ [dǎkə̀dǎ báwò əpə̀yǎ-rú-**xó**]
 dare-IPFV.1S.NEG because INFL-warn-2S-1S.O
 'I won't dare since you warned me' ('je n'oserai pas puisque tu m'as prévenu'; S96: 399)

Table 14. [ə]-alternating suffixes pattern as consonant-final.

Underlying	Surface	Gloss	Santos’s gloss (S96: 253, 235)
a. / $\textcircled{\text{H}}$ -yǝd- <u>k</u> -xów̃/	[njǝdǝ- <u>k</u> -ó]	‘he gave me’	‘il m’a donné’
/ $\textcircled{\text{H}}$ -yǝd- <u>k</u> -xîn/	[njǝdǝ- <u>k</u> -î]	‘he gave you’	‘il t’a donné’
/ $\textcircled{\text{H}}$ -yǝd- <u>k</u> -xâw̃/	[njǝdǝ- <u>k</u> -â]	‘he gave him/her’	‘il lui a donné’
/ $\textcircled{\text{H}}$ -yǝd- <u>k</u> -xǝfûn/	[njǝdǝ- <u>k</u> -ǝfû]	‘he gave us’	‘il nous a donné’
/ $\textcircled{\text{H}}$ -yǝd- <u>k</u> -xûn/	[njǝdǝ- <u>k</u> -û]	‘he gave you (all)’	‘il vous a donné’
/ $\textcircled{\text{H}}$ -yǝd- <u>k</u> -xǝlîw̃/	[njǝdǝ- <u>k</u> -ǝlî]	‘he gave them’	‘il leur/les a donné’
b. / $\textcircled{\text{H}}$ -yǝd- <u>k</u> -xǝw̃/	[njǝdǝ- <u>k</u> -ǝ]	‘he had given’	‘il avait donné’

- b. gé $\textcircled{\text{H}}$ -tùmp-ǝrú-xâw̃ → [gé tùm̩p-ǝrú-xâ, ...]
 if INFL-twist-2S-3S.O
 ‘if you twisted it, ...’ (‘si tu l’as tordu, ...’; S96: 241)

Given these distributions, we posit the underlying representations in (20) for the [ə]-alternating suffixes. All bear an underlying floating $\textcircled{\text{H}}$ tone, even those which contain a TBU (such as /-æx $\textcircled{\text{H}}$ / in (20b)).¹⁴

- (20) *Underlying representations of the [ə]-alternating suffixes in Table 12 as C-final with floating $\textcircled{\text{H}}$*
- a. /-k $\textcircled{\text{H}}$ / 3S.MINIMAL
 - /-n $\textcircled{\text{H}}$ / 2P.IMPERATIVE
 - b. /-æx $\textcircled{\text{H}}$ / ADJECTIVAL I
 - /-ak $\textcircled{\text{H}}$ / ADJECTIVAL 2
 - /-æk $\textcircled{\text{H}}$ / ANTERIOR
 - /-ryæry $\textcircled{\text{H}}$ / ASSOCIATIVE
 - /-xæ $\textcircled{\text{H}}$ / LOCATIVE

An alternative would posit underlying representations with a final /ǝ/ to which the high tone is pre-linked, parallel to the alternative representations for stem structure in the previous section. Alternative URs would be as in (21).

- (21) *Alternative URs (rejected)*
- a. /-kǝ/ 3S.MIN
 - b. /-æxǝ/ ADJ I
- etc.

Under this alternative, we must account for the fact that these suffixes condition /x/-deletion on /x/-alternating suffixes. An anonymous reviewer suggests that underlying

¹⁴Evidence that these suffixes do not have a pre-linked tone comes from comparison to other suffixes. While suffixes such as /-æx $\textcircled{\text{H}}$ / alternate between high and low on their vowel (i.e. [-æx] vs. [-æxǝ]), suffixes with pre-linked tone surface with this tone in all tonal contexts (e.g. /-(x)ǝt/ INVERSIVE, /-ǝx/ DISTANTIATIVE and /-ǝl/ RECIPROCAL). See Santos (1996: 314) for a summary of underlying tone values on (derivational) suffixes.

morpheme-final /ə/ might not pattern with other vowels due to /ə/’s status as ‘weak’ and more easily deleted when in marked positions. This alternative would be as in (22), where both /ə/ and /x/ are deleted.

- (22) *Alternative underlying representation (rejected)*
 /**(H)**-yǎd-**kǎ-xǒw̃**/ → [njǎdǎ-**k-ǒ**]
 INFL-give-3S.MIN-PAST ‘he had given’

Under the alternative, it is predicted that [x] should delete whenever it is adjacent to [ə]. However, there are several places where this is not the case. One such environment involves a small set of suffixes expressing imperfective aspect, one [-d]~[-dǎ] glossed as IPFV1 and another [-nd]~[-ndǎ] glossed as IPFV2.¹⁵ They constitute a type of [ə]-alternating suffix, where the [-C] variant is used following a high-toned stem (as in (23a) and (24a)), while the [-Cǎ] variant is used with a low-toned stem (as in (23b) and (24b)).

- (23) IPFV1 [-d]~[-dǎ]
- a. [yǎt-ǎlá bí mô kǎrǎsǎ-d]
 know-1S.NEG who dig.up-IPFV1
 ‘I don’t know who will be dug up’ (‘je ne sais pas qui sera creusé’; S96: 240)
- b. [nk-wǎr nkè-dǎ]
 be.sufficient be-IPFV1
 ‘it will be enough’ (‘ce sera suffisant’; S96: 238)
- (24) IPFV2 [-nd]~[-ndǎ]
- a. [njǎd-ǎkǎ-nd]
 give-ANTER-IPFV2
 ‘he would give’ (‘il donnerait’; S96: 235)
- b. [yǎd-ǎryi-ndǎ]
 give-IMP-IPFV2
 ‘give again!’ (‘donne encore!’; S96: 235)

However, their behaviour diverges from other [ə]-alternating suffixes in that they do not condition the deletion of /x/. Examples are in (25)–(26), where these imperfective suffixes are compared to /k/ 3S.MIN. For clarity, the /x/-alternating suffix is in bold.

- (25) *Contrast in the realisation of /-xǒw̃/ PAST*
- a. [njǎdǎ-**dǎ-xǒ**] *[…d-ǒ]
 INFL\give-IPFV1-PAST
 ‘he gave’ ~ ‘he was giving’ (‘il donnait’; S96: 235)
- b. [njǎd-ǎkǎ-**ndǎ-xǒ**] *[…nd-ǒ]
 INFL\give-ANTER-IPFV2-PAST
 ‘he would have given’ (‘il aurait donné’; S96: 234)

¹⁵They are transparently related by consonant mutation. According to Santos, the /-dǎ/ variant is used in *l’énociatif non antérieur*, and /-ndǎ/ is used elsewhere (S96: 113–114, 198 ff., 221 ff., 238 ff., 383–384).

- c. cf. [njádð-k-ô] *[…ká-xò]
 INFL \gíve-3S.MIN-PAST
 ‘he had given’ (‘il avait donné’; S96: 235)

(26) *Contrast in the realisation of /-xâw̃/ 3S.OBJECT*

- a. [mól yó-dǎ-xà] *[…d-à]
 who carry-IPFVI-3S.O over.there
 ‘who will take her over there?’ (‘qui la transportera là-bas?’; S96: 513)
- b. [nũyá-ákó-ndǎ-xà] *[…nd-à]
 receive-ANTER-IPFV2-3S.O
 ‘he could receive it’ (‘il pourrait la recevoir’; S96: 363)
- c. cf. [njádð-k-â] *[…ká-xà]
 INFL \gíve-3S.MIN-3S.O
 ‘he gave him/her’ (‘il lui a donné’; S96: 253)

In preserving /x/, the imperfective suffixes pattern with the vowel-final suffixes, as in (19).

There are two ways to interpret the special behaviour of imperfective suffixes. The first is to assume that these suffixes are underlyingly /d/ and /nd/, and trigger a segmentally driven [ə]-epenthesis rule to break up consonant clusters. Here, their representations would be identical to those of other [ə]-alternating suffixes (e.g. /-k/ 3S.MIN). Recall from §2.1 that segmentally driven [ə]-epenthesis is sensitive to the morphological identity; therefore, the special behaviour of the imperfective suffixes would simply be another case of such morphological sensitivity.

Alternatively, we could attribute their behaviour to a difference in underlying structure. Here, the imperfective suffixes would underlyingly end in /ə/; therefore, they would not condition [x]-deletion, because they end in a vowel underlyingly. This analysis is sketched in (27).

(27) *Possibly distinct representations of [ə]-alternating suffixes*

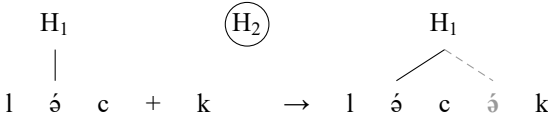
- a. Imperfective: /-ndǎ/ → [-nd]~[-ndǎ]
 b. Other [ə]-alternators: /-k(H)/ → [-k]~[-ká]

These two analyses of imperfective suffixes both unequivocally tolerate patterns where [ə] does not condition deletion of a following /x/. Therefore, this undermines the position that /x/ deletes because it is adjacent to a weak vowel [ə], as opposed to our more phonologically natural interpretation that /x/ deletes when it is adjacent to a consonant.

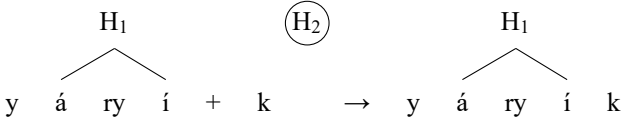
3.4. Deriving the final [ə] in suffixes

To conclude this section, we briefly outline how the [C]-final and [Cə]-final variants are derived, shown with a series of input–output mappings. For reasons of space, we show only derivations with /-k(H)/ 3S.MIN. Our discussion here is fully formalised in §4 within an OT framework.

(30) *Derivation of [lácák] ‘farted’*



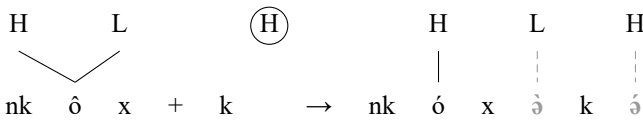
(31) *Derivation of [yáryík] ‘be baptised’*



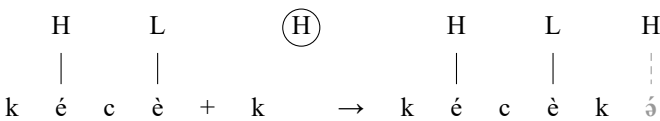
The surface forms here are [lácák] and [yáryík], rather than *[lácáká] and *[yáryíká]. This indicates that the second high tone (the floating (H₂)) does not trigger epenthesis in this context. To account for this, we assume a simple rule of high-tone deletion: when a string of high tones, H₁ H₂, appears domain-finally, the second is deleted (a type of OCP dissimilation rule). Inserting [ə] here would not circumvent any OCP violation.

Derivations for HL stems are in (32) and (33). These are derived in the same way as the L stems: spreading of the root tone, followed by epenthesis to host the floating (H) tone due to a restriction on rising tones.

(32) *Derivation of [nkóxáká] ‘stayed away’*

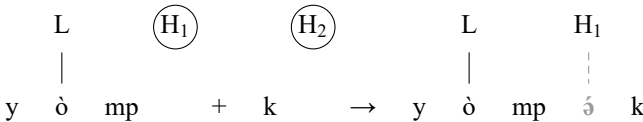


(33) *Derivation of [kécèká] ‘made (fence)’*

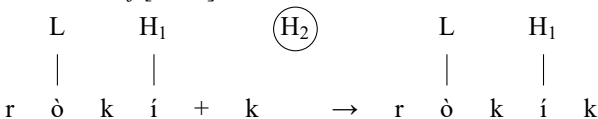


Likewise, derivations for LH stems are in (34) and (35), in which the two adjacent high tones constitute an OCP violation and the second is deleted. Note that in (34), the surface form is [yòmpák] rather than a conceivable alternative such as *[yòmpáká].

(34) *Derivation of [yòmpák] ‘well-stretched’*



(35) *Derivation of [ròkík] ‘has been eaten’*



4. OT analysis

In this section, we develop an analysis in Optimality Theory (OT) to derive the insertion of epenthetic [ə] based on the interaction of segmental and tonal constraints. The OT analysis aims to show that a small set of familiar constraints can generate the attested Wamey patterns, showing that all the ingredients needed to generate tone-driven epenthesis are already present in the theory. We begin by deriving the patterns with simple stems, before moving on to derivations in three more complex contexts: data with nominal enclitics, [ə]-alternating suffixes and [x]-alternating suffixes. The complete set of constraints, plus their crucial orderings, are found in the supplementary materials.

4.1. Stems

The most basic pattern involves the isolation form of a stem which sponsors a floating $\textcircled{\text{H}}$, in (36). Here, the input is given as a pre-linked low tone, plus a floating high which triggers [ə]-epenthesis in the surface form. We adopt a two-step derivation involving stem-level, followed by word-level phonology.

(36) *Derivation of [yɔmpə]* ‘slack’ (‘ne pas être bien tendu’; S96: 659)

$$/y\textcircled{\text{H}}\text{omp}/ \xrightarrow{\text{(stem-level)}} y\textcircled{\text{H}}\text{omp} \xrightarrow{\text{(word-level)}} [y\textcircled{\text{H}}\text{omp}\text{ə}]$$

While this is in the spirit of derivational OT models (e.g. Stratal OT; Kiparsky 2015, *inter alia*), we are not explicitly arguing for one model over another *per se* in this paper.¹⁷

First, a key component is that forms such as $/y\textcircled{\text{H}}\text{omp}/$ do not undergo tone-driven epenthesis in the stem-level phonology but only at word-level phonology. The simple constraint set in (37) can derive the correct input–output mappings at these two stages. These involve a faithfulness constraint MAXTONE and three markedness constraints NORISE, NOFLOAT and NOEDGESCHWA.

(37) *Constraint set (to be continued in (40) for stem-level phonology and in (43), (51) and (53) for word-level phonology)*

- a. NORISE (abbreviated *R): A closed syllable cannot bear an LH tone sequence
- b. NOFLOAT (* $\textcircled{\text{T}}$): Each tone must be associated with a TBU
- c. MAXTONE (MAX(T)): Do not delete tones
- d. NOEDGESCHWA (* $\textcircled{\text{ə}}_{|\Phi}$): ə does not appear at the edge of a prosodic constituent

The constraint NOEDGESCHWA is abbreviated as * $\textcircled{\text{ə}}_{|\Phi}$, which is meant to restrict [ə] from appearing at either the right or left edge of any prosodic constituent (whether prosodic stem, prosodic word, prosodic phrase, etc.). The subscript Φ denotes a prosodic constituent in general. This is motivated by the fact that [ə] in word-initial

¹⁷Moreover, our analysis is part of the growing literature examining phonological reflexes of word-internal hierarchical relations/syntax (Marvin 2002; Guekguezian 2017; Newell *et al.* 2017, *inter alia*), although we take no explicit stance on the details of these works.

position is banned regardless of tonal environment, as discussed in §2.1. The tableau in (38) shows stem-level phonology using these constraints, where * \textcircled{T} is crucially ranked below the others. In this tableau, the morpheme is placed within a prosodic stem, denoted with a subscript Σ (for a cross-linguistic overview of the prosodic stem, see Inkelas 2014; Downing & Kadenge 2020, *inter alia*). Epenthetic material is in grey, as throughout.

(38) Stem-level phonology: /y δ mp \textcircled{H} / \rightarrow y δ mp \textcircled{H}

L \textcircled{H} (y' δ mp) Σ	* $\textcircled{\text{a}} \textcircled{\text{f}}$	*R	MAX(T)	* \textcircled{T}
L \textcircled{H} a. (y' δ mp) Σ				*
L b. (y' δ mp) Σ			*!	
H c. (y' \acute{o} mp) Σ			*!	
L H d. (y' δ mp) Σ		*!		
L H e. (y' δ mp $\acute{\delta}$) Σ	*!			
L f. (y' δ mp δ) Σ	*!		*	

Candidates (38e) and (38f) violate the first constraint by placing [ə] at a prosodic constituent edge, (38d) has a rising tone on a closed syllable, and candidates (38b) and (38c) delete a tone. Fully faithful candidate (38a) is optimal, even though it still retains the floating tone.

It is at word-level phonology that [ə] is epenthesised, as shown in (39). Crucially, here the constraints * $\textcircled{\text{a}}|\textcircled{\text{f}}$ and * \textcircled{T} are re-ranked.

(39) *Word-level phonology: $y\hat{o}mp(\hat{H}) \rightarrow [y\hat{o}mp\acute{a}]$*

$\begin{array}{c} L \quad (\hat{H}) \\ \\ ((y \acute{o} mp)_{\Sigma})_{\omega} \end{array}$	* \hat{T}	*R	MAX(T)	* $\acute{a} \phi$
$\begin{array}{c} L \quad H \\ \quad \vdots \\ \text{a. } ((y \acute{o} mp \acute{a})_{\Sigma})_{\omega} \end{array}$				*
$\begin{array}{c} L \\ \quad \diagdown \\ \text{b. } ((y \acute{o} mp \acute{a})_{\Sigma})_{\omega} \end{array}$			*!	*
$\begin{array}{c} L \\ \\ \text{c. } ((y \acute{o} mp)_{\Sigma})_{\omega} \end{array}$			*!	
$\begin{array}{c} H \\ \quad \diagup \\ \text{d. } ((y \acute{o} mp)_{\Sigma})_{\omega} \end{array}$			*!	
$\begin{array}{c} L \quad H \\ \quad \diagup \\ \text{e. } ((y \acute{o} mp)_{\Sigma})_{\omega} \end{array}$			*!	
$\begin{array}{c} L \quad (\hat{H}) \\ \\ \text{f. } ((y \acute{o} mp)_{\Sigma})_{\omega} \end{array}$	*!			

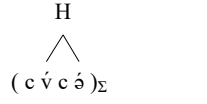
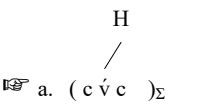
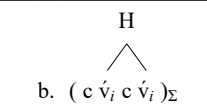
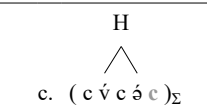
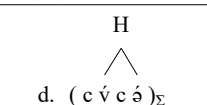
Candidates (39b)–(39e) all violate constraints which are still highly ranked, namely *R and MAX(T). Further, because * \hat{T} is re-ranked, candidate (39f) is suboptimal, and candidate (39a) is optimal despite its insertion of [ə]. This tableau illustrates the ease with which tone-driven epenthesis can be modelled in OT.

In addition to inputs such as $/y\hat{o}mp(\hat{H})/$, we must also entertain underlyingly $/\acute{a}/$ -final inputs; for example, a hypothetical (abstract) input $/c\acute{v}c\acute{a}/$. This is due to the standard principle in OT of Richness of the Base (Prince & Smolensky 2004: §9.3), which states that we cannot prohibit any input shapes. This is where our demarcation into stem-level vs. word-level phonology is crucial. The tableau in (41) shows that inputs such as $/c\acute{v}c\acute{a}/$ are mapped to $c\acute{v}c$ outputs at stem-level phonology, deleting the final $/\acute{a}/$. This tableau involves three additional constraints, which are defined in (40).

(40) Continued constraint set (for stem-level phonology)

- a. DEP CONSONANT (DEP(C)): Do not insert a consonant
- b. *SPREAD(FEATURE) (*SPR(F)): Do not spread a segmental feature to another segment
- c. MAX VOWEL (MAX(V)) Do not delete a vowel

(41) Stem-level phonology: /cvcó/ → cvc

 H / \ (c v c ó) _Σ	*ə _φ	*R	MAX(T)	DEP(C)	*SPRF	MAX(V)	* <u>T</u>
 H / \ a. (c v c) _Σ						*	
 H / \ b. (c v _i c v _i) _Σ					*!		
 H / \ c. (c v c ó c) _Σ				*!			
 H / \ d. (c v c ó) _Σ	*!						

The fully faithful candidate (41d) violates high-ranked *ə|_φ, while candidates (41b) and (41c) both violate newly introduced constraints against consonant deletion and feature spreading. Candidate (41a) is optimal even though it violates MAX(V). None of the candidates violate tonal constraints *R, MAX(T) or *T, which play no role in this tableau.

A two-step grammar accounts for the shape of stems and their mapping to words when no word-level suffixes are additionally added. The fact that stem-level phonology eliminates any stem-final /ə/ accounts for the /Cə/ gap in CV roots, as shown in §3.1. Recall that the only exception was a root /jə/ ‘(grand)son of’. However, its exceptional status can be straightforwardly derived from the fact that it is a bound root which never appears on its own, unlike other nouns. If we treat this as a type of lexical affix, we can assume that it does not go through stem-level phonology, and thus it is predicated that its final /ə/ is not ruled out.

4.2. [ə]-alternating suffixes

Next, let us examine more complex data involving [ə]-alternating suffixes. We will illustrate this with the subject agreement suffix /-k(H)/ 3S.MIN, which alternates

between forms [-k] and [-ká] depending on its tonal environment. We must derive the three (word-level) input-output mappings exemplified in (42) (data repeated from Table 15).

- (42) *Word-level input-output mappings with [ə]-alternating suffixes*
- L-toned stem: ròk + k(H) → [ròkə-ká] (*ròkək, ròkəká)
 - H-toned stem: lác + k(H) → [lácá-k] (*lácáká)
 - L(H)-toned stem: yòmp(H) + k(H) → [yòmpə-k] (*yòmpəká)

We must add four new constraints to the word-level phonological grammar, in (43).

- (43) *Continued constraint set for word-level phonology (to be continued in (51) and (53))*
- *CONSONANTCLUSTER (*CC): Consonants are not adjacent in a prosodic word (ω)
 - ALIGN(\bullet, Φ) (AL(\bullet, Φ)): Align (colourless) epenthetic material to a prosodic constituent edge (Φ)
 - *CROSS-STEM-R(T- μ) (* μ - Σ -T): Do not associate a stem-external tone (T) with a stem-internal mora (μ) across a right-edge stem boundary (Σ)
 - OCP(H): H tones are not adjacent on the tone tier within a prosodic word (ω)

*CONSONANTCLUSTER and OCP(H) are standard markedness constraints. ALIGN(\bullet, Φ) is an alignment constraint which requires that any epenthetic material (e.g. an epenthetic [ə]) be aligned to some prosodic constituent edge. This will help dictate the optimal position of epenthetic schwas below. Further, *CROSS-STEM-R(T- μ) states that a tone must not be associated with a TBU (the mora, μ) across the right edge of a prosodic stem boundary. This will dictate, in part, the optimal host for floating tones.¹⁸

The tableau in (44) shows how adding the first three of these constraints derives the correct mapping with a low-toned stem (i.e. ròk + k(H) → [ròkə-ká]).

¹⁸The *CROSS-STEM-R(T- μ) constraint brings up a well-known precedence problem in autosegmental phonology (Archangeli & Pulleyblank 1994; Jurgec 2011: 31, *inter alia*): by itself, a floating tone is not technically before or after a counterpart segment, since they are on separate autosegmental tiers. In our analysis, therefore, it is crucial that there be prosodic constituency on both the tonal and the segmental tier (i.e. in (44) the two tiers share prosodic stem (Σ) and prosodic word (ω) constituency). That prosodic constituency be subject to violable constraints rather than fixed universals is in line with modern work on the prosodic hierarchy (e.g. Match Theory; Selkirk 2011). Further, an anonymous reviewer presents a morphological alternative whereby an output incurs violations if phonological structure from distinct morphemes is associated (e.g. if the structure of the suffix is associated with the root). Under this conceptualisation, what is banned is association between morphemes rather than association across prosodic constituents. We reject this alternative because in (44) the floating tone is associated with an epenthetic vowel, which, by definition, has no morphological affiliation, and in later tableaux (e.g. (54)) we see that structure from one morpheme is able to associate with another morpheme.

(44) *Word-level phonology: røk-k(H) → [røkəká]*

	$\left(\begin{array}{c} \left(\begin{array}{c} L \\ \\ \mu \\ \\ røk \end{array} \right) \begin{array}{c} H \\ \\ k \end{array} \\ \Sigma \end{array} \right)_{\omega}$	*CC	*T	AL(•,Φ)	*μ-) _Σ -T	MAX(T)	*ə Φ
a.	$\left(\begin{array}{c} \left(\begin{array}{c} L \\ \diagdown \\ \mu \mu \\ \\ røkə \end{array} \right) \begin{array}{c} H \\ \\ k \end{array} \\ \Sigma \end{array} \right)_{\omega}$						**
b.	$\left(\begin{array}{c} \left(\begin{array}{c} L \\ \diagdown \\ \mu \mu \\ \\ røkə \end{array} \right) \begin{array}{c} k \end{array} \\ \Sigma \end{array} \right)_{\omega}$					*!	*
c.	$\left(\begin{array}{c} \left(\begin{array}{c} L \\ \\ \mu \mu \\ \\ røkə \end{array} \right) \begin{array}{c} H \\ \diagdown \\ k \end{array} \\ \Sigma \end{array} \right)_{\omega}$				*!		*
d.	$\left(\begin{array}{c} \left(\begin{array}{c} L \\ \\ \mu \mu \\ \\ røkə \end{array} \right) \begin{array}{c} H \\ \diagdown \\ \mu \end{array} \\ \Sigma \end{array} \right)_{\omega}$				*!		*
e.	$\left(\begin{array}{c} \left(\begin{array}{c} L \\ \\ \mu \\ \\ røk \end{array} \right) \begin{array}{c} H \\ \\ \mu \\ \\ ək \end{array} \\ \Sigma \end{array} \right)_{\omega}$			*!			
f.	$\left(\begin{array}{c} \left(\begin{array}{c} L \\ \diagdown \\ \mu \mu \\ \\ røkə \end{array} \right) \begin{array}{c} H \\ \\ k \end{array} \\ \Sigma \end{array} \right)_{\omega}$		*!				*
g.	$\left(\begin{array}{c} \left(\begin{array}{c} L \\ \\ \mu \\ \\ røk \end{array} \right) \begin{array}{c} H \\ \\ \mu \\ \\ k \end{array} \\ \Sigma \end{array} \right)_{\omega}$	*!					*

Candidate (44g) is ruled out by *CC because its consonant cluster is not repaired in the output, while candidate (44f) is ruled out because the floating tone of the suffix remains floating. Candidates (44c)–(44e) are ruled out by the more complex constraints. In candidate (44e), [ə] is inserted to break up the cluster but is placed outside the prosodic stem rather than inside it. Therefore, it does not align with the edge of any prosodic constituent it is contained within and is suboptimal. Further, in

candidates (44c) and (44d) the floating tone associates with [ə] within a prosodic stem. By crossing a right-edge prosodic stem boundary, this violates *μ-)Σ-T. Finally, candidate (44b) deletes the floating H, which violates MAX(T), leaving candidate (44a) [ròkə-ká] as optimal even though it has inserted two epenthetic vowels at constituent edges (violating *ə|_Φ).¹⁹

In short, (44) shows that if a floating tone cannot dock ‘backwards’ into the stem, then an epenthetic vowel is inserted to host it. This shows that there are two contexts where tone-driven epenthesis arises: to avoid a rising tone on a closed syllable and to avoid docking a word-level floating tone to an inner constituent, the prosodic stem.

Further, the tableaux in (45) and (46) show the input–output mappings with a high-toned stem (lác) and a stem with a floating tone (yòm_p(H)), respectively. Both of these stems end in a high tone and thus illustrate the role of OCP(H) in the grammar.

(45) *Word-level phonology: lác-k(H) → [lácək]*

	OCP(H)	AL(•,Φ)	*μ-)Σ-T	MAX(T)	*ə _Φ
$\left(\left(\begin{array}{c} H_1 \\ \\ \mu \\ \\ l \end{array} \right) \begin{array}{c} H_2 \\ \\ \mu \\ \\ c \end{array} \right)_{\Sigma} k \omega$					
a. $\left(\left(\begin{array}{c} H_1 \\ \\ \mu \\ \\ l \end{array} \right) \begin{array}{c} \mu \\ \\ \delta \\ \\ c \end{array} \right)_{\Sigma} k \omega$				*	*
b. $\left(\left(\begin{array}{c} H_1 \\ \\ \mu \\ \\ l \end{array} \right) \begin{array}{c} \mu \\ \\ \delta \\ \\ c \end{array} \right)_{\Sigma} \begin{array}{c} \mu \\ \\ \delta \\ \\ k \end{array} \omega$				*	**!
c. $\left(\begin{array}{c} \mu \\ \\ \mu \\ \\ l \end{array} \begin{array}{c} \mu \\ \\ \delta \\ \\ c \end{array} \right)_{\Sigma} k \omega$			*!*	*	*
d. $\left(\begin{array}{c} H_1 \\ \\ \mu \\ \\ l \end{array} \begin{array}{c} \mu \\ \\ \delta \\ \\ c \end{array} \right)_{\Sigma} \begin{array}{c} \mu \\ \\ \delta \\ \\ k \end{array} \omega$		*!		*	
e. $\left(\left(\begin{array}{c} H_1 \\ \\ \mu \\ \\ l \end{array} \right) \begin{array}{c} \mu \\ \\ \delta \\ \\ c \end{array} \right)_{\Sigma} \begin{array}{c} H_2 \\ \\ \mu \\ \\ \delta \end{array} \omega$	*!				**
f. $\left(\left(\begin{array}{c} H_1 \\ \\ \mu \\ \\ l \end{array} \right) \begin{array}{c} \mu \\ \\ \delta \\ \\ c \end{array} \right)_{\Sigma} k \omega$	*!		*		*
g. $\left(\left(\begin{array}{c} H_1 \\ \\ \mu \\ \\ l \end{array} \right) \begin{array}{c} \mu \\ \\ \delta \\ \\ c \end{array} \right)_{\Sigma} \begin{array}{c} H_2 \\ \\ \mu \\ \\ \delta \end{array} \omega$	*!		*		**

¹⁹Note that there must be some undominated constraint prohibiting deleting /-k/ and other monoconsonantal suffixes (as well as the exceptional affix /-lé/ described in §2.1), which we assume but do not show in this or other tableaux.

(46) *Word-level phonology: yòmp(H) + k(H) → [yòmpáʔk]*

$\left(\left(\begin{array}{c} L \ H_1 \\ \\ \mu \\ \\ yòmp \end{array} \right) \begin{array}{c} H_2 \\ \\ \mu \\ \\ k \end{array} \right)_{\Sigma} \omega$	OCP(H)	AL(●,Φ)	*μ-) _Σ -T	MAX(T)	*ə _Φ
a. $\left(\left(\begin{array}{c} L \ H_1 \\ \\ \mu \ \mu \\ \\ yòmp \ \grave{a} \end{array} \right) \begin{array}{c} H_2 \\ \\ \mu \\ \\ k \end{array} \right)_{\Sigma} \omega$				*	*
b. $\left(\left(\begin{array}{c} L \ H_1 \\ \\ \mu \ \mu \\ \\ yòmp \ \grave{a} \end{array} \right) \begin{array}{c} H_1 \\ \\ \mu \\ \\ k \ \grave{a} \end{array} \right)_{\Sigma} \omega$				*	**!
c. $\left(\left(\begin{array}{c} L \\ \\ \mu \ \mu \\ \\ yòmp \ \grave{a} \end{array} \right) \begin{array}{c} H_2 \\ \\ \mu \\ \\ k \ \grave{a} \end{array} \right)_{\Sigma} \omega$				*	**!
d. $\left(\left(\begin{array}{c} L \\ \\ \mu \ \mu \\ \\ yòmp \ \grave{a} \end{array} \right) \begin{array}{c} H_2 \\ \\ \mu \\ \\ k \end{array} \right)_{\Sigma} \omega$			*!	*	*
e. $\left(\left(\begin{array}{c} L \\ \\ \mu \\ \\ yòmp \end{array} \right) \begin{array}{c} H_2 \\ \\ \mu \\ \\ \grave{a} \ k \end{array} \right)_{\Sigma} \omega$		*!		*	
f. $\left(\left(\begin{array}{c} L \ H_1 \\ \\ \mu \ \mu \\ \\ yòmp \ \grave{a} \end{array} \right) \begin{array}{c} H_2 \\ \\ \mu \\ \\ k \ \grave{a} \end{array} \right)_{\Sigma} \omega$	*!				**

Considering these tableaux together, each input contains two adjacent high tones. High-ranked OCP(H) rules out all candidates that do not delete one of these tones.²⁰ Next, AL(●,Φ) eliminates those candidates which insert an epenthetic [ə] outside the prosodic stem, and *μ-)_Σ-T eliminates those whereby a word-level floating tone docks inward into the prosodic stem. The remaining candidates all violate the lower-ranked MAX(T) by deleting one of the input tones. The optimal candidates in each are those which violate *ə|_Φ the least, essentially the candidates which have the fewest epenthetic schwas. Here, the floating tone is deleted as part of a general pattern generated by the

²⁰OCP(H) as it is formulated here is actually too powerful if we consider other Wamey data which show that pre-linked high tones frequently become adjacent under morphological concatenation. One straightforward response would be to counteract OCP(H) with a faithfulness constraint preserving underlyingly linked high tones, which would not apply to floating tones. For space reasons, we do not settle this matter in this paper.

ranking OCP(H) \gg MAX(T); therefore, there is no reason to insert an epenthetic [ə] to host it.²¹

4.3. Definite enclitics

Next, consider data involving the definite enclitic from §3.2. The input–output mappings are repeated in (47) with a definite enclitic /= $\eta\check{a}$ /. Recall that output forms in this context have two forms, one with the initial consonant of the enclitic and one where it has been deleted.

- (47) *Definite enclitics* (repeated from Table 9)
- | | | |
|--|--|------------|
| a. / \check{a} -t \acute{o} x= $\eta\check{a}$ / | \rightarrow [\check{a} -t \acute{o} x= $\eta\check{a}$] \sim [\check{a} -t \acute{o} x= \check{a}] | ‘the tree’ |
| b. /w \check{a} -mb \acute{e} l($\textcircled{\text{H}}$)= $\eta\check{a}$ / | \rightarrow [w \check{a} -mb \acute{e} l \acute{o} = $\eta\check{a}$] \sim [w \check{a} -mb \acute{e} l \acute{a} = \check{a}] | ‘the milk’ |

(47b) shows that in both contexts, the floating tone of the stem triggers an epenthetic host. As we showed in §3.2, this variation is not found in underlyingly vowel-final roots (e.g. /i-b \acute{u} = $\eta\check{a}$ / \rightarrow [i-b \acute{u} = $\eta\check{a}$] ‘the baobab fruit’).

To account for this variation, we posit that definite enclitics have two prosodic parses: one where they form their own phonological word (ω) and one where they form a recursive word (Bennett 2018; Ito & Mester 2021, *inter alia*). This is exemplified in (48).

- (48) *Two prosodic parses with definite enclitics*
- | | |
|--------------------|---|
| a. Separate words: | (\check{a} -t \acute{o} x) $_{\omega}$ ($\eta\check{a}$) $_{\omega}$ |
| b. Recursive word: | ((\check{a} -t \acute{o} x) $_{\omega}$ \check{a}) $_{\omega}$ |

That consonant clusters are allowed in (48a) but not in (48b) is in line with other facts about when clusters are permitted (e.g. compounds, reduplication and with other clitics (see §2.1)).

To see how this works, consider the tableaux in (49) and (50), which generate the forms in (48). We add a constraint MAX(C) to the grammar, prohibiting deletion of underlying consonants. For simplicity, we do not include the noun prefix in these tableaux.

²¹Note that [ə]-alternating affixes such as /= \check{a} x($\textcircled{\text{H}}$)/ ADJ1 still need to be explained (i.e. data such as /c \acute{a} p($\textcircled{\text{H}}$)- \check{a} x($\textcircled{\text{H}}$)/ \rightarrow [c \acute{a} p- \acute{a} x] ‘split’ versus /t \acute{e} s- \check{a} x($\textcircled{\text{H}}$)/ \rightarrow [t \acute{e} s- \acute{a} x \acute{o}] ‘sick’). In the latter example, we cannot appeal to constraints on crossing stem boundaries to account for why the floating tone does not dock with / \check{a} x/. A straightforward analysis would involve van Oostendorp’s (2007: 138) constraint ALTERNATION (‘if an association line links two elements of colour α , the line should also have colour α ’), used to ban association of floating material with the morph which sponsors it.

(49) *Word-level phonology: táx=ŋǎ → [táx=ŋǎ]*

$\begin{pmatrix} \text{H} \\ \\ \mu \\ \\ \text{t} \acute{\text{a}} \text{x} \end{pmatrix} \omega \quad \begin{pmatrix} \text{L H} \\ \vee \\ \mu \\ \\ \eta \check{\text{a}} \end{pmatrix} \omega$	*CC	*ə ϕ	MAX(C)
<p>☞ a.</p> $\begin{pmatrix} \text{H} \\ \\ \mu \\ \\ \text{t} \acute{\text{a}} \text{x} \end{pmatrix} \omega \quad \begin{pmatrix} \text{L H} \\ \vee \\ \mu \\ \\ \eta \check{\text{a}} \end{pmatrix} \omega$			
<p>b.</p> $\begin{pmatrix} \text{H} \\ \\ \mu \\ \\ \text{t} \acute{\text{a}} \text{x} \end{pmatrix} \omega \quad \begin{pmatrix} \text{L H} \\ \vee \\ \mu \\ \\ \check{\text{a}} \end{pmatrix} \omega$			*!
<p>c.</p> $\begin{pmatrix} \text{H} \\ \backslash \\ \mu \mu \\ \quad \\ \text{t} \acute{\text{a}} \text{x} \acute{\text{a}} \end{pmatrix} \omega \quad \begin{pmatrix} \text{L H} \\ \vee \\ \mu \\ \\ \eta \check{\text{a}} \end{pmatrix} \omega$		*!	
<p>d.</p> $\begin{pmatrix} \text{H} \\ \backslash \\ \mu \mu \\ \quad \\ \text{t} \acute{\text{a}} \text{x} \acute{\text{a}} \end{pmatrix} \omega \quad \begin{pmatrix} \text{L H} \\ \vee \\ \mu \\ \\ \check{\text{a}} \end{pmatrix} \omega$		*!	*

(50) *Word-level phonology: táx=ŋǎ → [táx=ǎ]*

	$\left(\left(\begin{array}{c} \text{H} \\ \\ \mu \\ \\ \text{t} \acute{\text{a}} \text{x} \end{array} \right) \begin{array}{c} \text{L H} \\ \vee \\ \mu \\ \\ \acute{\text{a}} \end{array} \right)_{\omega}$	*CC	* $\text{ə} \Phi$	MAX(C)
a.	$\left(\left(\begin{array}{c} \text{H} \\ \\ \mu \\ \\ \text{t} \acute{\text{a}} \text{x} \end{array} \right) \begin{array}{c} \text{L H} \\ \vee \\ \mu \\ \\ \acute{\text{a}} \end{array} \right)_{\omega}$	*!		
☞ b.	$\left(\left(\begin{array}{c} \text{H} \\ \\ \mu \\ \\ \text{t} \acute{\text{a}} \text{x} \end{array} \right) \begin{array}{c} \text{L H} \\ \vee \\ \mu \\ \\ \acute{\text{a}} \end{array} \right)_{\omega}$			*
c.	$\left(\left(\begin{array}{c} \text{H} \\ \diagdown \\ \mu \mu \\ \quad \\ \text{t} \acute{\text{a}} \text{x} \acute{\text{a}} \end{array} \right) \begin{array}{c} \text{L H} \\ \vee \\ \mu \\ \\ \acute{\text{a}} \end{array} \right)_{\omega}$		*!	
d.	$\left(\left(\begin{array}{c} \text{H} \\ \diagdown \\ \mu \mu \\ \quad \\ \text{t} \acute{\text{a}} \text{x} \acute{\text{a}} \end{array} \right) \begin{array}{c} \text{L H} \\ \vee \\ \mu \\ \\ \acute{\text{a}} \end{array} \right)_{\omega}$		*!	*

Consonant clusters violate *CC if and only if they occur within a prosodic word. In (49) the two morphemes form separate words; therefore, none of the candidates violates *CC, even when the cluster is present. Therefore, the faithful candidate (49a) is optimal. With the recursive structure in (50), in contrast, the faithful candidate (50a) violates *CC and is eliminated. Next, candidates which epenthesise [ə] to break up the cluster violate the constraint against [ə] at a prosodic boundary (* $\text{ə}|\Phi$). In (50), the optimal candidate is (50b), which violates MAX(C) to satisfy *CC; in (49), candidate (49b) is eliminated by MAX(C) because the faithful candidate (49a) does not violate *CC.

Let us now move to the more complicated data with floating tones. The tableau in (52) shows such data, with the variant involving separate words. We add three more constraints to the word-level grammar, as defined in (51).

- (51) *Continued constraint set for word-level phonology (to be continued in (53))*
- a. *CROSS-WORD-L(T-μ) (*T-(ω-μ): Do not associate a word-external tone (T) with a word-internal mora (μ) across a left-edge word boundary ((ω)
 - b. *CROSS-WORD-L(μ-V) (*μ-(ω-V): Do not associate a word-external mora (μ) with a word-internal vowel (V) across a left-edge word boundary ((ω)
 - c. DEP(μ): Do not insert a mora (μ)

The constraints in (51a) and (51b) have a structure parallel to *CROSS-STEM-R(T-μ) in (43c) but refer to other phonological units and constituent edges.

(52) *Word-level phonology: mbàl(H)=ŋǎ → [mbàlǎ=ŋǎ]*

	$\begin{pmatrix} L & H \\ & \\ \mu & \\ & \\ mb\grave{a}l & \\ \omega & \omega \end{pmatrix}$	$\begin{pmatrix} L & H \\ & \\ \mu & \\ & \\ \eta & \grave{a} \\ \omega & \omega \end{pmatrix}$	*R	* $\text{\textcircled{T}}$	*T-(ω-μ)	*μ-(ω-V)	MAX(T)	* $\text{\textcircled{\phi}}$	MAX(C)	DEP(μ)
☞ a.	$\begin{pmatrix} L & H \\ & \\ \mu & \mu \\ & \\ mb\grave{a}l & \grave{a} \\ \omega & \omega \end{pmatrix}$	$\begin{pmatrix} L & H \\ & \\ \mu & \\ & \\ \eta & \grave{a} \\ \omega & \omega \end{pmatrix}$							*	*
b.	$\begin{pmatrix} L & H \\ & \\ \mu & \mu \\ & \\ mb\grave{a}l & \grave{a} \\ \omega & \omega \end{pmatrix}$	$\begin{pmatrix} L & H \\ & \\ \mu & \\ & \\ \eta & \grave{a} \\ \omega & \omega \end{pmatrix}$						*	*!	*
c.	$\begin{pmatrix} L \\ \\ \mu \\ \\ mb\grave{a}l \\ \omega \end{pmatrix}$	$\begin{pmatrix} L & H \\ & \\ \mu & \\ & \\ \eta & \grave{a} \\ \omega & \omega \end{pmatrix}$						*!		
d.	$\begin{pmatrix} L & H \\ & \\ \mu & \mu \\ & \\ mb\grave{a}l & \\ \omega & \omega \end{pmatrix}$	$\begin{pmatrix} L & H \\ & \\ \mu & \\ & \\ \eta & \grave{a} \\ \omega & \omega \end{pmatrix}$				*!				*
e.	$\begin{pmatrix} L & H \\ & \\ \mu & \\ & \\ mb\grave{a}l & \\ \omega & \omega \end{pmatrix}$	$\begin{pmatrix} L & H \\ & \\ \mu & \\ & \\ \eta & \grave{a} \\ \omega & \omega \end{pmatrix}$			*!					
f.	$\begin{pmatrix} L & H \\ & \\ \mu & \\ & \\ mb\grave{a}l & \\ \omega & \omega \end{pmatrix}$	$\begin{pmatrix} L & H \\ & \\ \mu & \\ & \\ \eta & \grave{a} \\ \omega & \omega \end{pmatrix}$		*!						
g.	$\begin{pmatrix} L & H \\ & \\ \mu & \\ & \\ mb\grave{a}l & \\ \omega & \omega \end{pmatrix}$	$\begin{pmatrix} L & H \\ & \\ \mu & \\ & \\ \eta & \grave{a} \\ \omega & \omega \end{pmatrix}$	*!							

Examining this tableau, the high-ranked constraints MAX(T), * $\text{\textcircled{T}}$, and *R eliminate candidates (52c), (52f) and (52g), respectively. Further, candidates (52d) and (52e) violate the newly introduced constraints * $T_{(\omega)-\mu}$ and * $\mu_{(\omega)-V}$, respectively. Candidate (52d) shows a mora associating with a vowel over a left-edge word boundary, and, similarly, (52e) shows a tone associating with a mora over this boundary. The remaining candidates in (52a) and (52b) each violate * $\text{\textcircled{\phi}}$ by epenthesising a vowel to host the tone, and the more faithful (52a) wins.

Next, consider the variant in (54), which shows word recursion. Here, due to this recursion, we require sensitivity both to the left edges of prosodic words (above), as well as to the right edges. Therefore, we add the constraints in (53) to the grammar.

(53) Continued constraint set for word-level phonology (final additions)

- a. *CROSS-WORD-R(T- μ) (* $T_{(\omega)-\mu}$): Do not associate a word-internal tone (T) with a word-external mora (μ) across a right-edge word boundary ($_{(\omega)}$)
- b. *CROSS-WORD-R(μ -V) (* $\mu_{(\omega)-V}$): Do not associate a word-internal mora (μ) with a word-external vowel (V) across a right-edge word boundary ($_{(\omega)}$)

(54) Word-level phonology: $mb\acute{\lambda}l(H)=\eta\acute{a} \rightarrow [mb\acute{\lambda}l\acute{a}=\acute{a}]$

	$\left(\left(\begin{array}{c} L H \\ \\ \mu \\ \\ mb\acute{\lambda}l \end{array} \right)_{\omega} \right) \left(\begin{array}{c} L H \\ \vee \\ \mu \\ \\ \acute{a} \end{array} \right)_{\omega}$	*CC	* $T_{(\omega)-\mu}$	* $T_{(\omega)-\mu}$	* $\mu_{(\omega)-V}$	* $\text{\textcircled{\phi}}$	MAX(C)	DEP(μ)	* $\mu_{(\omega)-V}$
52a	$\left(\left(\begin{array}{c} L H \\ \\ \mu \\ \\ mb\acute{\lambda}l \end{array} \right)_{\omega} \right) \left(\begin{array}{c} L H \\ \vee \\ \mu \\ \\ \acute{a} \end{array} \right)_{\omega}$						*	*	*
b.	$\left(\left(\begin{array}{c} L H \\ \\ \mu \\ \\ mb\acute{\lambda}l \end{array} \right)_{\omega} \right) \left(\begin{array}{c} L H \\ \vee \\ \mu \\ \\ \acute{a} \end{array} \right)_{\omega}$					*!		*	
c.	$\left(\left(\begin{array}{c} L H \\ \\ \mu \\ \\ mb\acute{\lambda}l \end{array} \right)_{\omega} \right) \left(\begin{array}{c} L H \\ \vee \\ \mu \\ \\ \acute{a} \end{array} \right)_{\omega}$		*!				*		
d.	$\left(\left(\begin{array}{c} L H \\ \\ \mu \\ \\ mb\acute{\lambda}l \end{array} \right)_{\omega} \right) \left(\begin{array}{c} L H \\ \vee \\ \mu \\ \\ \acute{a} \end{array} \right)_{\omega}$		*!					*	*
e.	$\left(\left(\begin{array}{c} L H \\ \\ \mu \\ \\ mb\acute{\lambda}l \end{array} \right)_{\omega} \right) \left(\begin{array}{c} L H \\ \vee \\ \mu \\ \\ \acute{a} \end{array} \right)_{\omega}$		*!	*					

Here, because the morphemes are grouped into a single word, they are subject to *CC, which eliminates candidates (54d) and (54e). Next, candidate (54c) violates *T_{(ω)-μ} by associating a tone across the right edge of a word boundary. None of the candidates, however, violate similar constraints involving the left edge – *T_{(ω)-μ} or *μ_{(ω)-V} – due to the recursive word structure. Of the remaining two candidates, candidate (54b) violates * $\partial|_{\Phi}$; therefore, it is eliminated. The winning candidate, (54a), violates DEP(μ) by epenthesising a mora to host the floating tone, as well as low-ranked *μ_{(ω)-V} by associating this mora across a right-edge word boundary.

Taking this all together, the optimal output is one where the floating tone triggers mora epenthesis but not vowel epenthesis; the epenthesised mora is able to parasitically associate with another vowel. This results in one of the few long vowels found in Wamey, an output [mbəláá]. We return to tone-driven μ-epenthesis in our discussion in §5.1.

4.4. /x/-alternating suffixes

The final forms to derive using our phonological grammar is the interaction of [ə]-alternating suffixes with the /x/-alternating suffixes introduced in §3.3. We illustrate their interaction using the data point in (55) (repeated from Table 14), showing the deletion of /x/.

- (55) / $\textcircled{\text{H}}$ -yǝd-k $\textcircled{\text{H}}$ -xîŋ/ → [njǝdǝ-k-î]
 INFL-give-3S.MIN-2S.O ‘he gave you’ (cf. long *[njǝdǝ-kí-î])

Notice in this example that the floating $\textcircled{\text{H}}$ does not condition mora insertion (the final vowel remains short). We can compare this to a minimal pair in (56) with the demonstrative enclitic /=ŋî/ ‘this’. This, too, bears a lexical HL tone and, like the definite enclitics, may optionally undergo /ŋ/-deletion when adjacent to a consonant. With this clitic, however, the final vowel surfaces as long [...líi] (cf. short [...kî] immediately above).

- (56) wǝ-mbəl $\textcircled{\text{H}}$ =ŋî → [wǝ-mbəlǝ=ŋî] ~ [wǝ-mbəlí=i]
 CLI2B-milk-DEM.CLI2B ‘this milk’ (cf. short *[wǝ-mbəl=i])

Our grammar captures this contrast as in (57), which shows the input–output mapping of the form in (55). No new constraints need to be added.²²

²²As before, for simplicity and reasons of space we neither include the inflectional prefix in this tableau (the floating $\textcircled{\text{H}}$ tone prefix) nor account for the deletion of the coda /n/ of the final suffix. In the tableau, we also show the verb in its unmutated form /yǝd/ rather than its actual surface form [njǝd].

(57) *Word-level phonology: yâd-k(H)-xîn → yâdâ-k-î*

	OCp(H)	AL(•,Φ)	*μ-)Σ-T	*T-)ω-μ	MAX(T)	*ə]Φ	MAX(C)	DEP(μ)
$\left(\begin{array}{c} \left(\begin{array}{c} L \\ \\ \mu \\ \\ y\hat{a}d' \end{array} \right)_{\Sigma} \begin{array}{c} H_1 \\ \\ k \\ \\ x \end{array} \begin{array}{c} H_2 \\ \\ \mu \\ \\ \hat{i} \\ \\ n \end{array} \end{array} \right)_{\omega}$								
a. $\left(\begin{array}{c} \left(\begin{array}{c} L \\ \\ \mu \\ \\ y\hat{a}d' \end{array} \right)_{\Sigma} \begin{array}{c} H_1 \\ \\ k \\ \\ \hat{i} \end{array} \end{array} \right)_{\omega} \begin{array}{c} L \\ \\ \mu \\ \\ \hat{i} \\ \\ n \end{array}$					*	*	*	*
b. $\left(\begin{array}{c} \left(\begin{array}{c} L \\ \\ \mu \\ \\ y\hat{a}d' \end{array} \right)_{\Sigma} \begin{array}{c} H_1 \\ \\ k \\ \\ \hat{i} \end{array} \end{array} \right)_{\omega} \begin{array}{c} L \\ \\ \mu \\ \\ \hat{i} \\ \\ n \end{array}$					*	*	*	**!
c. $\left(\begin{array}{c} \left(\begin{array}{c} L \\ \\ \mu \\ \\ y\hat{a}d' \end{array} \right)_{\Sigma} \begin{array}{c} H_1 \\ \\ k \\ \\ \hat{i} \end{array} \end{array} \right)_{\omega} \begin{array}{c} L \\ \\ \mu \\ \\ \hat{i} \\ \\ n \end{array}$			*!		*	*	*	*
d. $\left(\begin{array}{c} \left(\begin{array}{c} L \\ \\ \mu \\ \\ y\hat{a}d' \end{array} \right)_{\Sigma} \begin{array}{c} H_1 \\ \\ k \\ \\ \hat{i} \end{array} \end{array} \right)_{\omega} \begin{array}{c} L \\ \\ \mu \\ \\ \hat{i} \\ \\ n \end{array}$		*!			*		*	*
e. $\left(\begin{array}{c} \left(\begin{array}{c} L \\ \\ \mu \\ \\ y\hat{a}d' \end{array} \right)_{\Sigma} \begin{array}{c} H_1 \\ \\ k \\ \\ \hat{i} \end{array} \end{array} \right)_{\omega} \begin{array}{c} L \\ \\ \mu \\ \\ \hat{i} \\ \\ n \end{array}$		*!			*	*		**
f. $\left(\begin{array}{c} \left(\begin{array}{c} L \\ \\ \mu \\ \\ y\hat{a}d' \end{array} \right)_{\Sigma} \begin{array}{c} H_1 \\ \\ k \\ \\ \hat{i} \end{array} \end{array} \right)_{\omega} \begin{array}{c} L \\ \\ \mu \\ \\ \hat{i} \\ \\ n \end{array}$		*!			*	*		**
g. $\left(\begin{array}{c} \left(\begin{array}{c} L \\ \\ \mu \\ \\ y\hat{a}d' \end{array} \right)_{\Sigma} \begin{array}{c} H_1 \\ \\ k \\ \\ \hat{i} \end{array} \end{array} \right)_{\omega} \begin{array}{c} H_2 \\ \\ \mu \\ \\ x \\ \\ \hat{i} \end{array} \end{array}$	*!	*				*		**

First, candidate (57g) is eliminated because it fails to delete one of the two high tones, which violates OCP(H). Next, candidates (57d)–(57f) each violate AL(•,Φ) by epenthesising [ə] between the two consonants rather than at a prosodic constituent edge. The remaining candidates all equally violate MAX(T) and *ə]Φ. Candidate (57c) violates *μ-)Σ-T by associating the floating tone over a stem boundary, leaving candidates (57a) and (57b). The winner is (57a), which epenthesises less structure compared to (57b), which epenthesises an additional mora. Notice that because all of the morphemes are within a single non-recursive word, candidate (57a) does not violate *T-)ω-μ (prohibiting associating a tone over a word boundary). This accounts for the fact that the floating tone does not require a mora to host it here, whereas it does require a mora with an enclitic in a recursive word (cf. (54)).

5. Discussion

As defined in §1, tone-intonation parallelism is the premise that tones (and in particular floating tones) in tonal languages and intonational languages should not be ontologically distinct (i.e. they should have comparable representations and behaviour). We

explored this premise looking at tone-driven vowel epenthesis, which is attested in intonational systems but has been claimed to be impossible or unattested in tonal languages where tone is used for lexical, derivational and inflectional purposes. We presented Wamey as the best case to date for tone-driven epenthesis in a tonal language, filling an important empirical gap and supporting tone-intonation parallelism. In this section, we (§5.1) situate the Wamey data by discussing phenomena similar to tone-driven epenthesis, (§5.2) call attention to a small number of other cases where tone-driven epenthesis has been postulated (or, at the very least, considered), and (§5.3) speculate as to why tone-driven epenthesis is so rare.

5.1. *Similar phenomena*

Tone-driven vowel epenthesis is one of several phenomena which demonstrate linguistic systems cultivating segmental environments ‘better suited for realising meaningful f0 movements’ (Roettger & Grice 2019: 279). One such phenomenon has already been introduced – namely, tone-driven vowel retention – which was entertained (but rejected) as an alternative to epenthesis in Wamey in §3. Under this type, vowels which are otherwise expected to delete and/or reduce are retained if they bear tone. Roettger & Grice (2019) identify several such cases in intonational systems (e.g. Standard European Portuguese, Bulgarian, Greek, Ath-Sidhar Rifian Berber, Moroccan Colloquial Arabic, Bonaara Oromo and Tunica), and highlight parallel patterns in lexical accent/tone systems (e.g. Cheyenne, Acoma, Konso, Shanghainese and Japanese). To these we can add tone-driven vowel retention in tonal languages Baraïn (Lovesstrand 2012), Sumi Naga (Teo 2009) and Arapaho (Cowell & Moss 2008; Gleim 2019). For example, in Arapaho, an epenthetic vowel surfaces to break up certain consonant clusters only if it additionally hosts a high tone (e.g. the floating high in (58)).

(58) *Arapaho tone-driven vowel retention*

- a. /tʃew-^Hsee/ → [tʃeb-í-see] ‘to walk along’
 b. /tʃew-kóóhu/ → [tʃeb-kóóhu] ‘run along’

Gleim (2019) provides a lengthy presentation of the Arapaho facts as tone-driven vowel retention rather than tone-driven epenthesis, crucially showing that consonant mutation (e.g. w → b above) provides evidence for A → B → A Duke-of-York derivations (i.e. C-C → C-i-C → C-C).

In contrast to the rarity of tone-driven insertion of a vowel, there are several languages where a mora is inserted to realise tone, which then associates with some already present segmental root node. We have already seen this in Wamey in one environment; namely, across an internal word boundary with definite enclitics (§§3.2 and 4.3). Two other examples come from the tonal languages Kuria (Marlo *et al.* 2015: 256ff.) and Gokana (Hyman 1985: 24, 2011a: 74), among other examples in African languages.

Table 16. *Ghomala'* tone contrasts (Eichholzer 2010: 31).

H	/láp/	[láp]	↑	‘be bland’	(‘être fade’)
L ⁰	/báp ⁰ /	[báp ⁰]	↓	‘animal’	(‘bête, animal’)
L	/lâp/	[lâp]	↓	‘mock’	(‘se moquer’)
HL	/lâp/	[lâp]	↘	‘elegance’	(‘élégance, fierté’)
LH	/lăp/	[lăp ~ lâpə]	↑ ~ ↓ ↑	‘pool of water’	(‘mare d’eau’)

5.2. Other cases of tone-driven vowel epenthesis in tonal languages

Outside of Wamey, we are aware of only a handful of tonal languages for which tone-driven vowel epenthesis has been posited, or at least entertained. These are Kejom (aka Babanki; Akumbu *et al.* 2020), Kifuliiru (van Otterloo 2011: 71–73), Hdi (Frajzyngier & Shay 2002) and Ghomala’ (aka Bandjoun/Banjun; Nissim 1981; Eichholzer 2010). Of these, the first two are morphologically quite restricted rather than phonologically general, and the case of Hdi has already been dismissed as a case of epenthesis (Gleim 2019: 4).

By far the most convincing case of these is Ghomala’. There are five main tone patterns on monosyllabic roots, as shown in Table 16. The pattern denoted by L⁰ is a low pitch which does not fall to the bottom of a speaker’s pitch range (i.e. level low), while L is a low pitch which does fall to the bottom (i.e. falling low).

In general, if a root ends in an obstruent (possible codas: /p k ʔ/), then that obstruent faithfully surfaces in final position. However, with LH roots and only LH roots, this may variably be realised either as a rising tone, or L on the first syllable and H on an epenthetic [ə]. This is very similar to Wamey in that (i) it involves the general unmarked vowel [ə], (ii) it is a solution that avoids a rising tone on a closed syllable (a common restriction; see Zhang 2013), and (iii) CVCV roots are otherwise not allowed. It is clear that in both languages the epenthetic [ə] cannot be attributed solely to a syllabically driven restriction on codas. In fact, Nissim (1981: 63, fn. 12) is explicit, stating that words with rising tone ending in obstruents are realised with an epenthetic final vowel. Active alternations also exist, which show that if the rising tone is eliminated (e.g. by regular tone rules), no epenthetic vowel can surface. We refer the reader to Nissim (1981) for details.

5.3. Rarity

If the patterns of Wamey (and Ghomala’) constitute genuine cases of tone-driven epenthesis in tonal languages, then such systems cannot be banned by some universal component of phonological architecture. At the same time, it is indisputable that tone-driven epenthesis is very rare. If we cannot point to a universal restriction on such systems, we are forced to find additional avenues to explain its particular rarity. We conclude this section by speculating why this rarity exists, focusing on two features of floating tone in tonal languages which make it different from its use in intonational systems: co-exponence with segmental material, and positional (un)restrictedness.

First, in tone languages, when floating tones realise a specific lexical, derivational or inflectional category, they are typically accompanied by segmental co-exponents. This was the case in Wamey, where the relevant floating tones we examined appear with other segmental material (e.g. roots such as /-mbəl(H)/ ‘milk’ and affixes such as /-æx(H)/ ADJI or /-k(H)/ 3S.MIN). Such segmental co-exponents provide additional cues (indeed, the primary cues) for the intended meaning target. If the floating tone were simply to delete in these cases without triggering epenthesis, little information would be lost. For example, of the 177 Wamey stems of the (surface) shape [c̀̀c̀̀] only 35 form minimal pairs with a [c̀̀c̀̀] stem with which they would merge if their floating high were deleted (e.g. /i-ỳ̀r/ [i-ỳ̀r] ‘droll’ vs. /i-ỳ̀r(H)/ [i-ỳ̀r̀̀] ‘a tuft of unshaven hair’). Of these 35, many would still remain distinct, due to different noun class prefixes (e.g. /æ-mbəl/ [æ-mbəl] ‘Guinea worm’ vs. /wæ-mbəl(H)/ [wæ-mbəl̀̀] ‘milk’) or part-of-speech differences (e.g. /wæ-pèl/ [wæ-pèl] ‘sword peas’ vs. /i-pèl(H)/ [i-pèl̀̀] ‘to keep food scraps’).

In contrast, floating tones in intonational systems typically do not occur with segmental co-exponents. The consequence is that the functional load of floating tone in tonal vs. intonational systems in expressing linguistic meaning is quite different. Losing the floating tone in intonational systems would be far more ‘costly’, and to avoid this cost, epenthesis may be employed. Relatedly, due to the tendency for floating tone to co-occur with segmental material in tonal systems but not in intonational systems, tone-driven epenthetic material in a tonal system would be more likely to be reinterpreted as part of the underlying representation. In other words, a surface form [ə̀̀] would be more likely to be reinterpreted as /ə̀̀/ in a tone language than in an intonational language.

Second, while less common than in intonational systems, it is certainly the case that floating tone may appear as the sole exponent of some meaning targets in tone languages. For example, both Ghomala’ and Gokana (previously mentioned) have an associative construction [N₁ (T) N₂] used for possession and compounds, where the sole marking of association is a floating tone (T) which does not co-occur with any segmental morphology. Even in such cases, however, there is a key difference. In intonational systems, floating tones are often positionally quite restricted (e.g. to stressed syllables or to prosodic domain edges, especially the right edge of large prosodic constituents such as the intonational phrase). This restricts the ‘window’ within which the floating tone can search to find a host. In contrast, floating tone association in tonal languages tends to be more flexible and need not specifically target a stressed syllable or domain edge.

For example, the other Mbam-Nkam languages of Cameroon all have [N₁ (T) N₂] associative constructions cognate with those in Ghomala’. Hyman & Tadjadjeu (1976) show that in these languages whether the floating tone in such constructions will be ‘grounded’ to the right or to the left will depend on a complex set of factors. These include attaching in the direction which (i) has the greatest tonal effect, (ii) creates the more natural tonal contour, and (iii) complies with syllable or other boundaries. This shows that there are more potential targets of the floating tone in tonal languages than there are in intonational systems, and as such epenthesis is less likely to be required to host the floating tone than it would be in an intonational context.

6. Conclusion

We have argued that theories of tone/epenthesis interaction must be amended to include tone-driven epenthesis. While it was previously claimed that tone-driven epenthesis is unattested/impossible (Blumenfeld 2006; Gleim 2019), we have argued that the Wamey language provides the best case to date which falsifies this position. We demonstrated that in Wamey an epenthetic [ə] is inserted to host a high tone in two contexts. The first was to host a tone which would otherwise be left floating due to a restriction on rising tones in closed syllables (i.e. /c̀vc̀(Ḥ)/ maps to [c̀vc̀ə́] due to a ban *[c̀vc̀]). The second was to host a tone which was introduced by word-level morphology but restricted from associating across a stem boundary (i.e. /(c̀vc̀v̀)ḥ/ maps to [(c̀vc̀v̀)ə́]). These patterns cannot be attributed to syllable phonotactics, which freely allow all consonants in the coda position. We presented the evidence for tone-driven epenthesis focusing on the distribution of final [ə] in lexical stem structure and [ə]-alternating suffixes which pattern as underlyingly consonant-final. We showed that a simple OT analysis derives [ə]-epenthesis, utilising common markedness constraints (e.g. *FLOAT, *RISE, OCP(H), DEP(μ), etc.) together with constraints against associating tone across certain prosodic boundaries. In total, Wamey provides evidence for parallelism between tonal and intonational languages, given that intonation-driven epenthesis is well established in the literature. This parallelism is predicted under a model where both types of prosodic systems make use of the same phonological substance and autosegmental architecture and have the same functional pressures to cultivate segmental environments best suited for realising pitch targets.

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