Title: “Outward-looking phonologically-conditioned allomorphy versus first-last tone harmony in Cilungu”

Abstract

We present a case study of grammatical tone allomorphy in Cilungu (Bantu). Tense/Aspect/Mood designations (TAMs) are realized via co-exponence of prefixes, suffixes, and floating tones. In a small number of TAMs, there is allomorphy with the floating tones. For example, in the Recent Past one allomorph involves high tone targeting the final TBU of the stem (Ⓗ^{F}) at the right-edge, versus one targeting the second stem TBU (Ⓗ^{2}). For all TAMs, the alternation is conditioned by the tone of subject agreement markers (SMs) at the left edge of the word. If the SM is high-toned the Ⓗ^{F} variant occurs, but if it is toneless then Ⓗ^{2} occurs. We present two competing accounts of these data. Under a morphological account, we posit contextual realizational rules with multiple stored allomorphs, i.e. distinct (suppletive) exponents conditioned by SM tone. In contrast, under a phonological account there is morphologically-conditioned phonology causing the alternation, triggered only in the context of SMs and the small set of TAMs. A rule would capture a conspiracy in these alternations: if the SM is H at the left edge then there is a grammatical H at the right edge, but if the left-edge SM is toneless then grammatical tone does not fall on the right edge, a rule of 'first-last tone harmony'. We present several arguments in favor of the morphological analysis (suppletion) over a phonological one, and discuss a major theoretical implication: outward-looking phonologically-conditioned allomorphy is possible, standardly argued to be unattested and/or impossible. We hold that under either interpretation, Cilungu patterns present a novel and important contribution linguistic theory.

1 Introduction

The topic of allomorphy has seen a resurgence in linguistic inquiry, along many different dimensions and across frameworks. Most issues remain without consensus, such as what constitutes allomorphy vs. morphologically conditioned phonology (Kiparsky 1996, Paster 2014), and what are the restrictions on directionality and locality between the allomorphic trigger and target (Bobaljik 2000), among many other topics. Largely absent in these discussions is allomorphy found in suprasegmental exponence, such as grammatical tone. At least half the world’s languages are tonal (Yip 2002) with virtually all African tonal languages exhibiting something which can be classified as grammatical or morphological tone (Hyman *et al*. in press). Tone is also known to be different from other (morpho)phonological phenomena both quantitatively and qualitatively (Hyman 2011), as well as computationally (Jardine 2016). These factors conspire to make for a ripe area for developing empirically rich yet constrained morphologically theories, and ideal grounds for testing them.

This paper seeks to incorporate grammatical tone into these theoretical debates, presenting a case study of grammatical tone (GT) allomorphy in the Bantu language Cilungu. In Cilungu, tense/aspect/mood (TAM) designations are realized via a combination of segmental and tonal exponence, e.g. the Remote Perfect is realized as a complex /a-...-a Ⓗ$^{2\text{-}F}$/, consisting of a segmental prefix, segmental suffix (Bantu final vowel), and floating tone which docks to specific positions within the stem, in this case from the second to the final tone-bearing unit (TBU). We will focus on a class of TAM designations which show grammatical tone alternations which cannot be reduced to the general phonology. For example, the Recent Past is realized as /á-cí-...-il-e Ⓗ^{F} ~ Ⓗ^{2}/ with an alternation between two types of floating tones: one which docks to the final of the stem and the other to the second TBU of the stem. The alternation is conditioned by the tone of the subject agreement markers (SMs): if the SM is high-toned the Ⓗ^{F} variant occurs, but if it is toneless then Ⓗ^{2} occurs. An example is below, where the grammatical tone and the positions it associates to are boxed, and the trigger of the alternation (the subject marker) is bolded and underlined.

(1) Recent Past /á-cí-...-il-e/ grammatical tone alternation

a. / **<u>tú</u>**-á-cí- |$_{\text{STEM}}$ sópolol-il-e Ⓗ^{F} / \ **<u>tú</u>**-á-cí-sópolol-il-é \ [twáácísópólwìlé]
SM-TAM-TAM-untie-TAM-FV TAM ‘we recently untied’

b. / **<u>u</u>**-á-cí- |$_{\text{STEM}}$ sópolol-il-e Ⓗ^{2} / \ **<u>u</u>**-á-cí-sópólol-il-e \ [wàácísópólwíílè]
SM-TAM-TAM-untie-TAM-FV TAM ‘he/she recently untied’

There are several alternations like this, but they constitute a minority. Most TAM designations either have consistent grammatical tone or no grammatical tone.

We present two possible accounts of these data, one morphological the other phonological. Under the morphological account, we appeal to irregular morphology in the form of contextual realizational rules with suppletive allomorphs, e.g. different exponents for the tense feature [RECENT] are inserted depending on the tone value of the subject marker. In this account, phonology is maximally regular and general, without appeal to morphologically-conditioned statements. In contrast, under the phonological account morphology is maximally regular, having no stored allomorphs inserted based on the context. Instead, it is phonology which is irregular in that it has morphologically-conditioned phonology in the context of subject markers and a small set of TAM features. The alternation in (1) above as well as all other alternations shows a striking conspiracy: if the SM is high-toned at the left edge then there is a grammatical high tone at the right edge, and equally if the left-edge SM is toneless then grammatical tone does not fall on the right edge. Exploiting this conspiracy, we appeal to a rule 'first-last tone harmony' requiring identical tone values between the first and last TBUs.

This boils down to the following debate: should the GT alternations be captured as suppletive allomorphs or as morphologically-conditioned phonology? Critically, this rests on what the definition of suppletion is, and whether the Cilungu alternations instantiate it. One common criterion for suppletion is the phonological distance of the allomorph forms, under which the GT allomorphs would not qualify as suppletive (and if so, only weakly). However, we emphasize the subjectivity of the appropriate threshold of distance for this criterion, making it difficult to decide which cases constitute suppletion and which do not. We thus focus on two other criteria. One is that the alternation in Cilungu is unique to this context, which we conceptualize as a bounded trigger (the phonological identity of SMs) and a bounded target (the grammatical tone of certain TAMs). This is unlike canonical cases of morphologically-conditioned phonology in which the alternation is specific to single trigger (or set), but not bounded with respect to potential targets.

The other is the phonological naturalness of the alternation, which we conclude provides the best evidence for suppletion. As stated, the alternative phonological rule is first-last tone harmony, which is not a phonologically natural rule based on three arguments. First, there is virtually no typological precedence for such a rule, whether general or morphologically-conditioned. Second, a number of artificial language experiments designed to probe the learnability of first/last rules show that for the most part participants are unsuccessful at doing so. Third, there is a principled reason for its absence: such a rule would involve computational complexity which would be outside of the known range of phonological patterns (e.g. Heinz 2018). We highlighted recent work in Jardine (2020) who concludes that admissible tonal restrictions involve bans only on contiguous spans of tonemes and/or tone-valued TBUs, as these always constitute a finite set; first-last tone harmony would not. Taken all together, suppletion emerges as the superior analysis.

An important ramification of the morphological account involves the intersection of phonologically-conditioned allomorphy (PCA) and directionality. First, Cilungu grammatical tone suppletive allomorphy (the target) constitutes PCA because it must reference the tonal value (a phonological feature) of the subject marker (the trigger). Directionality refers to whether the trigger is more outward in the morphological structure compared to the target, or more inward. At their intersection, inward-looking PCA is extremely common cross-linguistically, e.g. English allomorphs *a/an* (the target) is conditioned by the initial segment (C or V) of a more inward morph (the trigger). This constitutes inward-looking PCA. A large literature has emerged arguing that *outward*-looking PCA is unattested and impossible (Bobaljik 2000, Paster 2006, 2009, 2015, Embick 2010, 2015, *inter alia*), what we call the 'unidirectional PCA hypothesis'. We argue that under our suppletion account, this pattern constitutes outward-looking PCA and adds to a growing list of proposed counterexamples (e.g. Deal & Wolf 2017). Our position falls out from the following conclusions: (i) with respect to hierarchical morpho-syntactic structure, the trigger (SMs) is higher and thus more outward compared to the target (T and Asp), and (ii) with respect to linear structure, the trigger is further away from the root and thus more outward compared to the target.

Ultimately, this Cilungu case study is important for morpho-phonological theory regardless of one's conclusions. Under our account, it constitutes the typologically rare outward-looking PCA, which requires us to reevaluate morphological theories such as those in Distributed Morphology whereby exponence proceeds strictly inside-out. Under the alternative phonological account involving, first-last tone harmony, it forces phonological theory to reevaluate the kinds of phonological operations which are possible, perhaps permitting a wider set under morphologically-conditioned phonological patterns (see e.g. discussion in Finley 2012). This case highlights the fact

that 'restrictiveness' is not a uniform measurement across a grammar, and arguments in favor of a theory due to restrictiveness must take into account concomitant changes in other modules.

This paper is structured as follows. Section 2 lays out the basic facts on the Cilungu language to understand the morphological patterns, and section 3 describes the details of the grammatical tone alternations. Section 4 presents two accounts of these facts, one morphological and the other phonological. Section 5 debates the two accounts and concludes the morphological account is superior. Section 6 discusses the implications. After our conclusion and references, we include three appendices which highlight further complicated data for any analysis of these patterns.

2 Preliminaries on Cilungu

Cilungu [ISO: mgr] is a Bantu language spoken in Zambia and Tanzania (Bantu zone M14). The data in this paper come from Bickmore (2007, 2014); each data point is accompanied by its relevant source. This section provides the necessary background to understand the patterns, such as basic facts about the verbal template, the tone system, tense/aspect/mood (TAM) designations, and tone specification of subject markers.

2.1 Verbal template

The focus of this paper are grammatical tone patterns exhibited in the verbal domain as part of tense/aspect/mood (TAM) inflection. To explain these patterns, we introduce its 'verbal template', familiar across Bantu languages:

(2) Verbal template of Cilungu

[$_{V}$ **SM** (NEG) **TAM** [$_{MS}$ (OM) [$_{STEM}$ **ROOT** (DERIV) **TAM FV**]]]

(V =verb , SM = subject marker , TAM = tense/aspect/mood , MS= macro-stem , OM = object marker , NEG = negative , DERIV = derivational suffixes, FV = final vowel)

The more or less obligatory parts of the template (in bold) are the initial position for subject markers (agreement with the phi-features of the subject), the expression of tense/aspect/mood in one of several TAM positions, the root, and the Bantu final vowel whose shape co-varies with specific inflectional contexts. Optional positions include one for a negative prefix, one for object markers, and one post-radical position for derivational morphology. Note two important boundaries within the verbal template. Between TAM and OM is the macro-stem boundary (MS), which plays an important role in demarcating H tone spreading domains (immediately below). Between the OM and the root is the stem boundary, which will be important in understanding grammatical tone assignment (the focus of this paper).

2.2 Basics of tone system

Cilungu is classified as a privative tone system (Hyman 2001), contrasting /H/ vs. Ø (toneless).[1] Low tone is inserted by default on toneless tone-bearing units (TBUs) after all phonological operations; no /L/ toneme exists. The position of /H/ tone is not predictable, and thus must be pre-associated to specific TBUs in the underlying representation of morphemes:

(3) Tone as a property of underlying representations

a.	/ kálukuluku /	'turkey'	[kálúkúlúkù]	[B07:358]
	/ mulámu /	'brother-in-law'	[mùlámù]	[B07:360]
	/ cipuzí /	'pumpkin'	[cìpùzí]	[B07:353]
b.	/ címbuí /	'hyena'	[cîmbwí]	[B07:363]
	/ cipámbasí /	'bull'	[cìpáámbáˈsí]	[B07:363]
c.	/ munjili /	'warthog'	[mùùnjìlì]	[B07:364]

Examples in (a.) illustrate tone on the first, second, or final TBU in the underlying representation. Examples in (b.) illustrate that more than one /H/ can occur within a morpheme (although it is rare), and (c.) shows an entirely toneless noun (with default low), illustrating that /H/ tone is not obligatory.

[1] The Cilungu data are presented in the language's conventional orthography, which differs from the IPA only in the following: <sh> = [ʃ], <c>/<ch> = [tʃ], <j> = [dʒ], and <y> = [j].

Surface forms exhibit a number of phonological processes. Most relevant to this paper is high tone spreading. There are three main types of high tone spreading, sensitive to whether its domain is final within the intonational phrase (ιP): Word-spreading, MStem-spreading, and Binary spreading. All of these are general across the language, and not morphologically conditioned. These are shown in the table below; the position of underlying high tone and the spread tone are provided in bold. Note that MS = macro-stem, τ = tone bearing unit (TBU), ω = phonological word, and ι = intonational phrase.

Word-spreading				
a.	Final in ιP (Unbounded spreading)	(**τ́** τ |MS τ τ τ)ω]ι	→	(**τ́ τ́** |MS **τ́ τ́** τ)ω]ι
b.	Non-final in ιP (Bounded spreading)	(**τ́** τ |MS τ τ τ)ω (τ τ τ)ω]ι	→	(**τ́ τ́** |MS τ τ τ)ω (τ τ τ)ω]ι
MStem-spreading				
c.	Final in ιP (Unbounded spreading)	(τ τ |MS **τ́** τ τ τ τ)ω]ι	→	(τ τ |MS **τ́ τ́ τ́ τ́** τ)ω]ι
d.	Non-final in ιP (Unbounded spreading)	(τ τ |MS **τ́** τ τ τ τ)ω (τ τ τ)ω]ι	→	(τ τ |MS **τ́ τ́ τ́ τ́ τ́**)ω (τ τ τ)ω]ι
Binary spreading				
e.	Bounded spreading:	(τ |MS τ τ **τ́**)ω (τ τ τ)ω]ι	→	(τ |MS τ τ **τ́**)ω (**τ́** τ τ)ω]ι

Table 1: Major tonological spreading rules (not morphologically conditioned)

The first type is Word-spreading. If a high tone originates before a macro-stem boundary |MS within a phonological word ω, it spreads unbounded up to the penultimate syllable, but only if the word is final within the ιP (a.). It shows bounded spreading up to the final syllable before the macro-stem boundary if the word is non-final in the ιP (b.).[2] Examples below illustrate Word-spreading, where the subject marker /tú-/ with inherent high tone spreads up to the penult when final but stops at the macro-stem boundary when non-final.

(4) Word-spreading: Unbounded when final in ιP
/ **tú**-ku- |MS mu-sukilil-a / → (**tú-kú**-|MS **mú-súkílíl**-à)ω]ι
we-TAM-OM-accompany-FV ‘we are accompanying him/her’ [B07:148]

(5) Word-spreading: Bounded when non-final in ιP
/ **tú**-ku- |MS mu-ful-a ningó / → (**tú-kú**-|MS mù-fùl-à)ω (nìingó)ω]ι
we-TAM-OM-wash-FV well ‘we are washing him/her well’ [B07:156]

The second pattern is MStem-spreading. If a high tone originates after a MStem boundary, it spreads unbounded up to the penultimate syllable if the word is final within the ιP (row c. in Table 1), but up to the ultimate syllable if the word is non-final (d.). Examples below illustrate the two types of unbounded MStem-spreading.

(6) MStem-spreading: Unbounded when final in ιP
/ tú-ku- | mu-**pá**apaatik-a / → (tú-kú-| mù-**páápáátík**-à)ω]ι
we-TAM-OM-flatten-FV ‘we are flattening him/her’ [B07:148]

(7) MStem-spreading: Unbounded when non-final in ιP
/ tú-ku- | **yá**-suel-il-a ningó / → (tú-kú-| **ꜜyá-swéél-él-á**)ω (nìingó)ω]ι
we-TAM-them-brew-APPL-FV well ‘we are brewing for them well’ [B07:158]

The final type is Binary spreading (row e. in Table 1), which is always bounded and automatic. A high tone will spread one syllable to the right, even crossing phonological word boundaries. The example below illustrates Binary spreading, showing that binary spreading is a ‘late’ rule, applying after palatalization shifts the high of /sí/ onto the

[2] We are simplifying the details here somewhat, as there is also an effect of phonological phrases φ in spreading here. See Bickmore (2007:Chapter 9) for details.

final vowel in [shá]. Bounded spreading occurs even if it were to incur an OCP violation, which is repaired by inserting a downstep, indicated throughout by a raised exclamation point.

(8) Binary spreading (bounded)
/ tú-ku- |$_{STEM}$ **sí**-a Choola / → (tú-kú-ꜜ**shá**)$_{ω}$ (**Chóó**là)$_{ω}$]$_{ι}$
we-TAM-leave-FV Chola 'we are leaving Chola' [B07:172]

Certain additional restrictions exist for these rules, often interacting with whether they result (or would result) in adjacent high tones. In total, though, these three productive spreading rules are orthogonal to the grammatical tone allomorphy which is the focus of this paper, and play no role in our analysis. We identify them because they alter the tone of the surface form, sometimes drastically. For each example, they thus need to be 'factored out' in order to reveal underlying tone and morphologically assigned tones (such as the relevant ones from tense and aspect).

2.3 The trigger of allomorphy: Subject markers and their underlying tone

As established in the verbal template in (2), subject markers (SMs) agree with the subject in class (and in number/person where applicable). They are invariably monosyllabic, and show familiar shapes to their cognate forms in other Bantu languages. Individual SMs either have inherent high tone (H) or are toneless (Ø). The toneless SMs are in bold below, and boxed for emphasis. Note that class 1 (3SG) has two allomorphs, both of which are toneless.

Classes	1SG	2SG	**3SG**	1PL	2PL	3PL										
1/2:	ń-	ú-	**a- ~ u-**	tú-	mú-	yá-										
Other	3	**4**	5	6	7	8	**9**	10	11	12	13	14	15	16	17	18
classes:	gú-	**i-**	lí-	yá-	cí-	ví-	**i-**	zí-	lú-	ká-	tú-	gú-	kú-	pá-	kú-	mú-

Table 2: Subject markers (SMs) appear on verbs, and agree in noun class with the subject

Most of the SMs are high-toned and also consonant-initial, while the exceptional toneless SMs are onsetless. However, notice that CL1 (2SG) is high-toned /ú-/ while CL1 (3SG) is toneless /u-/. This creates minimal pairs such as below (the unit Ⓗ$^{2\text{-}F}$ is a grammatical tone, which we explain shortly):

(9) Subject marker tonal minimal pair
a. / **ú**-a-mu-fuk-il-il-e / → \ **ú**-a-mu-fuk-íl-íl-é \ → [**wáá**múfùkíílé]
SM-TAM-OM-harvest-APPL-TAM-FV '**you (sg.)** harvested for him/her' [B07:8,280,282]
b. / **u**-a-mu-fuk-il-il-e / → \ **u**-a-mu-fuk-íl-íl-é \ → [**wàà**mùfùkíílé]
SM-TAM-OM-harvest-APPL-TAM-FV '**he/she** harvested for him/her' [B07:8]

It is these toneless SMs as a class which trigger grammatical tone allomorphy. Toneless SMs do not form a natural morphosyntactic class, being class 1 /a-/~/u-/, class 4 /i-/, and class 9 /i-/ versus all other classes. Rather, they form a class based on their tonal designation, a phonological property.

Although we call these 'toneless' SMs, there is some evidence that they in fact do sponsor a tone. However, our characterization as the trigger being phonological still holds. Consider the data in (10) involving the present progressive /ku-...-a Ø/ which has no inherent or grammatical tone, used with toneless verb roots /ziik/ 'bury' and /ful/ 'wash'. In a., the high tone from the SMs /tú-/ and /ú-/ undergo unbounded Word-spreading, up to the penult (Table 1). In comparison in b., although the SM /a-/ itself is realized without high tone, the same unbounded Word-spreading takes place. A straightforward analysis is that toneless SMs sponsor a floating high Ⓗ which docks immediately to the right.

(10) Floating Ⓗ sponsored by toneless SMs
a. / **tú**-ku-mu-ziik-a Ø / [**tú-kú-mú-zíí**k-à] 'we are burying him/her' [B07:153]
/ **ú**-ku-mu-ful-a Ø / [**ú-kú-mú-fúl**-à] 'you (sg.) are washing him/her' [B07:328]
b. / a$^{Ⓗ}$-ku-mu-ziik-a Ø / [à-**kú-mú-zíík**-à] 'he/she is burying him/her' [B07:153]

Toneless SMs with many TAMs can be analyzed in this way, e.g. with the Contrastive Habitual /ma-áa-...-a Ø/ and Future Continuative /ka-áa-...-a Ø/. As above, the floating Ⓗ of the SM /a-/ docks onto the TAM prefix (although cannot undergo unbounded spreading due to other H tones blocking):

(11) Toneless SM sponsoring floating Ⓗ
- a. Contrastive Habitual /ma-áa-...-a Ø/
  / a**Ⓗ**-ma-áa-ful-il-a Ø Choola / [à-**má**-ˡá-fúl-ìl-à Chòòlà] 'these days he/she washes for Chola' [B07:199]
- b. Future Continuative /ka-áa-...-a Ø/
  / a**Ⓗ**-ka-áa-ziik-a Ø / [à-**ká**-ˡá-zíík-à] 'he/she will continue to bury' [B07:202]

However, with future TAMs containing the prefix /la-/, toneless SMs do not seem to sponsor a floating high. This is shown below with the Future Progressive /la-áa-...-a Ø/ and the Remote Future /la-...-a Ⓗ$^{2\text{-}F}$/.[3]

(12) Toneless SM *not* sponsoring floating Ⓗ
- a. Future Progressive /la-áa-...-a Ø/ - Variation in surface form
  / **a-la**-áa-ku-súul-a Ø /~ / **a**Ⓗ**-la**-áa-ku-súul-a Ø /
  [**à-là**-á-kú-ˡsúúl-a] ~ [**à-lá**-ˡá-kú-ˡsúúl-a]
  'he/she will be ignoring you (sg.)' [B07:206]
- b. Remote Future /la-...-a Ⓗ$^{2\text{-}F}$/
  / **a-la**-mu-ziik-il-a Ⓗ$^{2\text{-}F}$ / [**à-là**-mù-zìik-íl-á] 'he/she will bury for him/her' [B07:287]
  / **a-la**-mu-léet-il-a Ⓗ$^{2\text{-}F}$ / [**à-là**-mù-léét-él-á] 'he/she will bring for him/her' [B14:47]

In the Future Progressive, there is variation between whether toneless SMs sponsor a tone with two possible pronunciations, while in the Remote Future only a form where the SM sponsors no tone is found.[4]

Despite these complications, what remains is that it is always a unique *phonological* criterion which classifies these SMs together, whether this be complete tonelessness, their sponsoring a floating tone but not having pre-associated inherent tone, or having some variation between the two. In all cases, they remain a grammatically unnatural class. In what follows, we propose that the criterion which unites CL1 /a-/~/u-/, CL4 /i-/, and CL9 /i-/ is their being toneless on the SM itself, acting as a shorthand for this collection of phonological patterns.

2.4 The target of allomorphy: Tense/Aspect/Mood (TAM) system and grammatical tone

Bantu languages are famous for complicated systems of tense/aspect/mood (TAM) exponence, which Cilungu certainly exemplifies. Individual semantic categories of tense/aspect/mood are expressed by a unique combination of TAM morphs. These consist of prefixes, suffixes, the final vowel, and/or tone (recall the positions of segmental TAM markers in the verbal template in 2). We will refer to this unique combination of morphs as 'TAM designations':

(13) Component morphs of TAM designations:
- a. 0, 1, or 2 prefixes in pre-radical TAM position
- b. 0 or 1 suffix in post-radical TAM position
- c. Shape of the final vowel (-a/-e)
- d. A grammatical tone which associates within the stem

[3] The example below shows that these patterns cannot be attributed to deletion of tone associated with SMs. The high tone of the SM /tú-/ 'we' is retained before this future prefix /la-/.

(i.) / **tú**-la-lol-a Ⓗ$^{2\text{-}F}$ mulámu / [**tú**-lá-lòl-á múˡlámù] 'we will see the brother-in-law' [B07:424]

[4] Further complications with toneless SMs exist when they sponsor a high tone before an onsetless root (and only a root) in certain TAMs, such as the Perfect and Narrative Past (see Bickmore 2007:519).

For example, consider the TAM designation Bickmore calls the Yesterday Past Progressive /á-...-ang-a Ⓗ^{F}/. This is composed of a prefix morph /á-/ (with inherent high tone), a suffix /-ang/, the final vowel /-a/, and a grammatical high tone which docks to the final vowel of the stem, Ⓗ^{F}. This is illustrated immediately below. In this example (and throughout), we use the following conventions: / / slashes indicate underlying forms of morphs, \ \ backslashes indicate the concatenated forms after grammatical tone is associated (essentially an intermediate form), and [ ] brackets indicate surface forms after all phonological rules have applied (such as the general spreading rules in Table 1 above, and insertion of default low).[5]

(14)	/ tú-**á**-mu- $\|_{STEM}$	ziik-il-**ang-a**	Ⓗ^{F} /	\ tú-**á**-mu- $\|_{STEM}$ ziik-il-**ang-á** \	[twáámúzììkìlààngá]
	SM-**TAM**-OM-	root-DER-**TAM-FV**	**TAM**	'we were burying for him/her'	[B07:258]

Such grammatical tone is referred to as 'Melodic Tone' or 'Melodic Highs' in the Bantu literature (e.g. Odden & Bickmore 2014, and papers therein), which we analyze as floating tones not pre-associated to a TBU in the input. Following Yip (2002) and others, we circle floating tones Ⓗ to differentiate them from pre-associated high tone.

The inventory of possible grammatical tones in TAM designations is restricted to four patterns. A TAM designation may have either no grammatical tone (denoted with Ø), a grammatical high tone on the final TBU of the stem (Ⓗ^{F}), high on the second TBU of the stem (Ⓗ^{2}), or high which stretches from the second to the final TBUs of the stem (Ⓗ$^{2\text{-}F}$). These are illustrated below (note that τ = Tone-Bearing Unit, which in Cilungu is the mora μ).

a.	Ø	No grammatical tone	($_{V}$ τ τ $\|_{STEM}$ τ τ τ τ)
b.	Ⓗ^{F}	H on final TBU of stem	($_{V}$ τ τ $\|_{STEM}$ τ τ τ **τ́**)
c.	Ⓗ^{2}	H on 2nd TBU of stem	($_{V}$ τ τ $\|_{STEM}$ τ **τ́** τ τ)
d.	Ⓗ$^{2\text{-}F}$	H from 2nd to final TBU	($_{V}$ τ τ $\|_{STEM}$ τ **τ́ τ́ τ́**)

Table 3: Restricted inventory of grammatical tones exponing TAM

It is an idiosyncratic property of the TAM designation whether it is co-exponed with grammatical tone, and if so which one. Bickmore is explicit on this point, stating that "it does not seem possible to assign the [grammatical tone] any consistent meaning that it contributes the form" (Bickmore 2007:254). The Ⓗ^{2} type constitutes a rare and special grammatical tone, to be detailed.

These patterns are consistent in both toneless verb roots and high-toned roots. For example, forms in the Remote Perfect show a Ⓗ$^{2\text{-}F}$ pattern with both a toneless root (a. below), as well as with the high-toned root (b.).[6]

(15) Remote Perfect a-...-a Ⓗ$^{2\text{-}F}$

a. Toneless root
/ yá-**a**-$\|_{ST}$ sukilil-**a** Ⓗ$^{2\text{-}F}$ / \ yá-a-$\|_{ST}$ su**kílíl-á** \ [yáásù**kílílá**] 'they have already accompanied' [B14:48]

b. High-toned root
/ tú-**a**-$\|_{ST}$ sópolol-**a** Ⓗ$^{2\text{-}F}$ / \ tú-a-$\|_{ST}$ só**pólól-á** \ [twáàsó**pólólá**] 'we have already untied' [B07:290]

One important observation is that while phonologically-general tonal spreading rules are sensitive to the macro-stem boundary (Table 1 above), the domain to which grammatical tone is assigned is the stem rather than the macro-stem. For example, Far Past is exponed via the sequence /a-...-il-e Ⓗ$^{2\text{-}F}$/. That this grammatical tone targets the second TBU of the stem and not the macro-stem is illustrated below (see Bickmore 2007:ch. 4 for extensive discussion of imbrication, as seen in this example).

[5] Numerous other rules exist, such as gliding, pre-nasal lengthening, tone shifting due to eliminating rises on syllables, downstepping, among many others. We refer to reader to Bickmore (2007) for a thorough explication on each of these rules. They are orthogonal to the allomorphy patterns under investigation.

[6] As in many Bantu languages, in Cilungu verbs only contrast for tone on the initial TBU of the verb root.

(16) / tú-**a**- |$_{MS}$ mu- |$_{STEM}$ londolol-**il-e** Ⓗ$^{2\text{-}F}$ / \ tú-a-mu-|$_{STEM}$ lon**dólól-íl-é** \ [tw-áá-mú-lòòn**dólw-ííl-é**]
SM-**TAM**-OM-explain-**TAM-FV** **TAM** 'we explained to him/her' [B07:278]
(Cf. * \ tú-a-|$_{MS}$ mu-**lóndólól-íl-é** \ *[tw-áá-mù-**lóóndólw-ííl-é**])

2.5 Table of TAM designations

A list of TAM designations is summarizes in the following table, split into five groups based on their tonal behavior. The first group have no grammatical tone (Ø), the second group (consisting of only one TAM) has a final grammatical tone (Ⓗ^{F}), and the third group has grammatical tone from the second to the final TBU (Ⓗ$^{2\text{-}F}$). Grammatical tone patterns (or the lack thereof) in these groups are invariant. In contrast, the fourth group (in bold) show three patterns of phonologically-conditioned allomorphy affecting grammatical tone. It is these that are the focus of our study. Group five shows a different kind of grammatical tone allomorphy with mood designations Subjunctive and Imperative, allomorphy which is both grammatically- and phonologically-conditioned. Crucially, allomorphy here is not conditioned by the tonal designation of the SM, and is thus outside of the scope of this paper.[7]

[7] Certain TAMs change the tone of subject markers, e.g. in the Past Inceptive and Hortative the subject marker is always high (regardless of its underlying value; cf. Table 2). We indicate this with a superscript Ⓗ before the TAM prefix. In the Potential and Persistive Potential (both with /ngá-/), the subject marker is always toneless, which we indicate with a superscript Ø before the prefix. The Subjunctive is exceptionally complex, assigning a high tone to the subject marker while in several contexts neutralizing root tone to Ø; we represent this above as a floating sequence Ⓗ Ø. These prefix-like tonal morphs do not interact with the allomorphy of focus, and we will not treat them further. For an overview of similar patterns across the Bantu subjunctive and imperative, see Meeussen (2014 [1962]).

	Group	TAM designation		Prefix		Suffix	FV	Gram. Tone
1.	No grammatical tone	Past Inceptive	Ⓗ	aa-	...		-a	Ø
		Contrastive Habitual		ma-áa-	...		-a	Ø
		Persistive Potential	Ø	ngá-aa-	...		-a	Ø
		Future Continuative		ka-áa-	...		-a	Ø
		Future Progressive		la-áa-	...		-a	Ø
		Hortative	Ⓗ	áa-	...		-a	Ø
		Immediate Future		máa-	...		-a	Ø
		Present Progressive		ku-	...		-a	Ø
		Habitual		káa-	...		-a	Ø
		Persistive		cí-líi-	...		-a	Ø
2.	High tone on final	Potential	Ø	ngá-	...		-a	Ⓗ^{F}
3.	High tone on 2nd to final	Far Past		a-	...	-il	-e	Ⓗ$^{2-F}$
		Far Past 2		a-cí		-il	-e	Ⓗ$^{2-F}$
		Far Past Progressive		a-	...	-ang	-a	Ⓗ$^{2-F}$
		Remote Perfect		a-	...		-a	Ⓗ$^{2-F}$
		Narrative Past					-a	Ⓗ$^{2-F}$
		Remote Future		la-	...		-a	Ⓗ$^{2-F}$
4.	**Grammatical tone allomorphy** (conditioned by SM)	**Yesterday Past**		**á-**	**...**	**-il**	**-e**	**Ⓗ^{F} / Ø**
		Yesterday Past Progressive		**á-**	**...**	**-ang**	**-a**	**Ⓗ^{F} / Ø**
		Recent Perfect		**á-**	**...**		**-a**	**Ⓗ^{F} / Ø**
		Recent Perfect 2		**á-cí-**	**...**		**-a**	**Ⓗ^{F} / Ø**
		Recent Past Progressive		**á-cí-**	**...**	**-ang**	**-a**	**Ⓗ^{F} / Ø**
		Recent Past		**á-cí-**	**...**	**-il**	**-e**	**Ⓗ^{F} / Ⓗ^{2}**
		Perfect				**-il**	**-e**	**Ⓗ$^{2-F}$ / Ⓗ^{2}**
5.	Other grammatical tone allomorphy	Subjunctive	Ⓗ Ø				-e	Ⓗ$^{2-F}$ / Ⓗ^{F}
		Imperative					-a ~ -e (~ -ini)	Ⓗ$^{2-F}$ / Ⓗ^{F}

Table 4: TAM designations grouped by grammatical tone patterns

There also exist a series of compound TAMs, which involve what could be considered an [AUXILIARY VERB] construction. We will not treat compound TAMs in this paper. See Bickmore (2007:chapter 8).

3 The relevant allomorphy patterns: Core data

With this background established, we now present the basics of the relevant allomorphic grammatical tone patterns. From Table 4 above, the TAM designations (hereafter, 'TAMs') which show the relevant allomorphy all appear with either the prefix /á-/ which indicates a more recent temporal situation, or with the perfect suffix /-il/ without a prefix TAM co-exponent. It is *only* TAMs with these morphs which are affected. In this way we can say the target is 'morphologically bounded': these and only these TAMs exhibit the grammatical tone allomorphy, and all other comparable TAMs are unaffected even if the trigger is present.

3.1 Allomorphy pairing Ⓗ^{F}/Ø

We can begin examining allomorphy with the TAM Yesterday Past (YP) /á-...-il-e/. Examples with the toneless root /ziik/ 'bury' are in (17). In the context of a high-toned subject marker /tú-/ 'we', this TAM is co-exponed with a Ⓗ^{F} grammatical tone (a.). In contrast, in the context of a toneless subject marker /u-/ 'he/she' there is no TAM grammatical tone, i.e. Ø (b.). Here and in all examples illustrating GT allomorphy, the trigger of allomorphy is in bold and underlined (the SM), and the relevant TAM morph which is the target of allomorphy is in a dotted box. Recall that / /

indicates the underlying form, \ \ the intermediate form after grammatical tone associates, and [ ] the surface form after general tonal rules (e.g. spreading).

(17) Toneless root /ziik/ 'bury' in Yesterday Past (YP)

a. H-toned SM /tú-/ triggering Ⓗ^{F} allomorph

/ **tú**-á- |$_{STEM}$	ziik-il-e	Ⓗ^{F} /	\ **tú**-á-|$_{STEM}$ ziik-il-é \	[twáázíìsìlé]
SM-TAM	bury-TAM-FV	TAM	'we buried'	[B07:278]

b. Toneless SM /u-/ triggering Ø allomorph

/ **u**-á- |$_{STEM}$	ziik-il-e	Ø /	\ **u**-á-|$_{STEM}$ ziik-il-e \	[wàázíìsìlè]
SM-TAM	bury-TAM-FV	TAM	'he/she buried'	[B07:245]

We see that the form with SM /tú-/ surfaces as [**twáá**zíìsì**lé**] while that with SM /u-/ surfaces as [**wàà**zíìsì**lè**]. The key observation here is that if the verb form begins with a high tone, it must end with a (grammatical) high tone /Ⓗ^{F}/, a type of 'tone harmony'. Equally, if it begins with a toneless SM, it ends toneless as well with no grammatical tone (with surface low tone by default). We return to the concept of 'tone harmony' in Section 4.2 below.

These allomorphy facts are replicated across the full range of Yesterday Past contexts. The examples immediately below illustrate the same allomorphy patterns with the minimal pair /fuk-/ 'to harvest' vs. /fúk/ 'turn up hem':

(18) Toneless root /fuk/ 'harvest' with Yesterday Past (YP)

a. H-toned SM /ú-/ triggering Ⓗ^{F}

/ **ú**-á-mu- |$_{STEM}$ fuk-il-il-e		Ⓗ^{F} /	\ **ú**-á-mu-fuk-il-il-é \	[wáámúfùkìlé]
SM-TAM-OM-harvest-APPL-TAM-FV		TAM	'you (sg.) harvested for him/her (yesterday)'	[B07:8]

b. Toneless SM /u-/ triggering Ø

/ **u**-á-mu- |$_{STEM}$ fuk-il-il-e		Ø /	\ **u**-á-mu-fuk-il-il-e \	[wàámúfùkìlè]
SM-TAM-OM-harvest-APPL-TAM-FV		TAM	'he/she harvested for him/her (yesterday)'	[B07:8]

(19) High-toned root /fúk/ 'turn up hem' with Yesterday Past (YP)

a. H-toned SM /ú-/ triggering Ⓗ^{F}

/ **ú**-á-mu- |$_{STEM}$ fúk-il-il-e		Ⓗ^{F} /	\ **ú**-á-mu-fúk-il-il-é \	[wáámúˡfúkíìlé]
SM-TAM-OM-turn.up.hem-TAM-FV		TAM	'you (sg.) turned up hem for him/her (yesterday)'	[B07:8]

b. Toneless SM /u-/ triggering Ø

/ **u**-á-mu- |$_{STEM}$ fúk-il-il-e		Ø /	\ **u**-á-mu-fúk-il-il-e \	[wàámúfúkìlè]
SM-TAM-OM-turn.up.hem-TAM-FV		TAM	'he/she turned up hem for him/her (yesterday)'	[B07:8]

As above, the form with SM /ú-/ surfaces with high tone on the initial and final TBU (e.g. [**wáá**múˡfúkíì**lé**]), while the form with SM /u-/ surfaces with low on both (e.g. [**wàà**múfúkìì**lè**]).

Allomorphy equally applies in embedded clauses as it does in matrix clauses, seen in the relative clauses below. The H-toned SM /yá-/ triggers the Ⓗ^{F} form, while the toneless SM /u-/ does not.

(20) Relative form in Yesterday Past – high-toned root /lás/ 'hit'

a. H-toned SM /yá-/ triggering Ⓗ^{F} allomorph

/ á-**yá**-á-yá |$_{STEM}$ lás-il-e		Ⓗ^{F} /	\ á-**yá**-á-yá-lás-il-é \	[ááˡáyálásíˡlé]
REL-**SM**-TAM-OM-hit-TAM-FV		TAM	'those who hit them'	[B07:254]

b. Toneless SM /u-/ triggering Ø allomorph

/ ú-**u**-á-yá |$_{STEM}$ lás-il-e		Ø /	\ ú-**u**-á-yá-lás-il-e \	[úwáàyálásílè]
REL-**SM**-TAM-OM-hit-TAM-FV		TAM	'one who hit them'	[B07:257]

The relative prefix is a H-toned copy of the subject marker's vowel (the leftmost morpheme in these examples). These examples are important in demonstrating that it is specifically the tone of the SM which conditions grammatical tone

allomorphy, and not that of the initial morpheme of the word. This shows that the trigger of allomorphy is also morphologically bounded: only the tone of SMs matters, not that of any other morph.

Furthermore, all and only toneless SMs trigger the special allomorphy. The table below lists SMs of classes 3-15 with the toneless verb /ful/ 'wash' in the Yesterday Past. Like toneless class 1 /a-/~/u-/, toneless SMs /i-/ (class 4) and /i-/ (class 9) trigger the Ø form of the Yesterday Past (rows shaded gray), while all other classes are high-toned and trigger the Ⓗ^{F} form.

CL	Yesterday Past (YP): **x**-á-ful-il-e x 'it/they washed'		
3	/ **gú**-á-ful-il-e Ⓗ^{F} /	\ **gú**-á-ful-il-é \	[wááfúzìlé]
4	/ **i**-á-ful-il-e Ø /	\ **i**-á-ful-il-e \	[yààfúzílè]
5	/ **lí**-á-ful-il-e Ⓗ^{F} /	\ **lí**-á-ful-il-é \	[lyááfúzìlé]
6	/ **yá**-á-ful-il-e Ⓗ^{F} /	\ **yá**-á-ful-il-é \	[yááfúzìlé]
7	/ **cí**-á-ful-il-e Ⓗ^{F} /	\ **cí**-á-ful-il-é \	[cááfúzìlé]
8	/ **ví**-á-ful-il-e Ⓗ^{F} /	\ **ví**-á-ful-il-é \	[vyááfúzìlé]
9	/ **i**-á-ful-il-e Ø /	\ **i**-á-ful-il-e \	[yààfúzílè]
10	/ **zí**-á-ful-il-e Ⓗ^{F} /	\ **zí**-á-ful-il-é \	[zyááfúzìlé]
11	/ **lú**-á-ful-il-e Ⓗ^{F} /	\ **lú**-á-ful-il-é \	[lwááfúzìlé]
12	/ **ká**-á-ful-il-e Ⓗ^{F} /	\ **ká**-á-ful-il-é \	[kááfúzìlé]
13	/ **tú**-á-ful-il-e Ⓗ^{F} /	\ **tú**-á-ful-il-é \	[twááfúzìlé]
14	/ **gú**-á-ful-il-e Ⓗ^{F} /	\ **gú**-á-ful-il-é \	[wááfúzìlé]
15	/ **kú**-á-ful-il-e Ⓗ^{F} /	\ **kú**-á-ful-il-é \	[kwááfúzìlé]

Table 5: Parallel behavior of class 1 (3SG) and classes 4 and 9 [second author field notes]

As with class 1, allomorphy holds with class 4 and 9 SMs regardless of other aspects of the context. The next table below replicates these facts with classes 3-10 but using the root /ziik/ 'bury' marked by the toneless suffix /-u/ PASSIVE which appears between the TAM suffix and the final vowel.[8]

CL	Yesterday Past (YP): **x**-á-ziik-il-u-e x 'it was/they were buried'		
3	/ **gú**-á-ziik-il-u-e Ⓗ^{F} /	\ **gú**-á-ziik-il-u-é \	[wáázîsìlwé]
4	/ **i**-á-ziik-il-u-e Ø /	\ **i**-á-ziik-il-u-e \	[yààzîsìlwè]
5	/ **lí**-á-ziik-il-u-e Ⓗ^{F} /	\ **lí**-á-ziik-il-u-é \	[lyáázîsìlwé]
6	/ **yá**-á-ziik-il-u-e Ⓗ^{F} /	\ **yá**-á-ziik-il-u-é \	[yáázîsìlwé]
7	/ **cí**-á-ziik-il-u-e Ⓗ^{F} /	\ **cí**-á-ziik-il-u-é \	[cáázîsìlwé]
8	/ **ví**-á-ziik-il-u-e Ⓗ^{F} /	\ **ví**-á-ziik-il-u-é \	[vyáázîsìlwé]
9	/ **i**-á-ziik-il-u-e Ø /	\ **i**-á-ziik-il-u-e \	[yààzîsìlwè]
10	/ **zí**-á-ziik-il-u-e Ⓗ^{F} /	\ **zí**-á-ziik-il-u-é \	[zyáázîsìlwé]
…	...	...	...

Table 6: No effect on GT allomorphy from verb/clause structure (e.g. passive) [B07:246]

In total, grammatical tone allomorphy with the Yesterday Past is consistent across (i) different toneless subject markers, (ii) different root types, and (iii) other morphological contexts such with object markers and passive /-u/.

Entirely parallel patterns are seen with other Ⓗ^{F}/Ø TAMs from Table 4, namely the Yesterday Past Progressive, the Recent Perfect and Recent Perfect 2, and the Recent Past Progressive. All of these also contain the TAM morph /á-/, denoting more recent situations. Example sets for each TAM are shown below.

[8] Bickmore (2007:119) cites the position of passive /-u/ as one argument in favor of splitting the TAM morphs into /-il/ and /-e/, rather than just /-ile/.

(21) Ⓗ^{F}/Ø allomorphy with Yesterday Past Progressive /á-...-ang-a/

a.	/ **tú**-á-mu-ziik-il-ang-a Ⓗ^{F} /	\ **tú**-á-mu-ziik-il-ang-á \	[twáámúzììkìlààngá]	
	SM-TAM-OM-bury-APPL-TAM-FV TAM	'we were burying for him/her'		[B07:258]
	/ **u**-á-mu-luk-il-ang-a Ø /	\ **u**-á-mu-luk-il-ang-a \	[wàámúlúkìlààngà]	
	SM-TAM-OM-weave-APPL-TAM-FV TAM	'he/she was weaving for him/her'		[B07:259]
b.	/ **tú**-á-mu-léet-il-ang-a Ⓗ^{F} /	\ **tú**-á-mu-léet-il-ang-á \	[twáámúˈléétélààngá]	
	SM-TAM-OM-bury-APPL-TAM-FV TAM	'we were bringing for him/her		[B07:259]
	/ **u**-á-mu-léet-ang-a Ø /	\ **u**-á-mu-léet-ang-a \	[wàámúléètààngà]	
	SM-TAM-OM-bring-TAM-FV TAM	'he/she was bringing him/her'		[B07:260]

(22) Ⓗ^{F}/Ø allomorphy with Recent Perfect /á-...-a/

a.	/ **yá**-á-sukilil-a Ⓗ^{F} /	\ **yá**-á-sukilil-á \	[yáásúkìlìlá]	'they have just accompanied' [B14:45]
	/ **u**-á-sukilil-a Ø /	\ **u**-á-sukilil-a \	[wààsúkílìlà]	'he/she has just accompanied' [B07:269]
b.	/ **yá**-á-sópolol-a Ⓗ^{F} /	\ **yá**-á-sópolol-á \	[yáásópólòlá]	'they have just untied' [B14:45]
	/ **u**-á-sópolol-a Ø /	\ **u**-á-sópolol-a \	[wààsópólòlà]	'he/she has just untied' [B07:269]

(23) Ⓗ^{F}/Ø allomorphy with Recent Past Progressive /á-cí-...-ang-a/

a.	/ **yá**-á-cí-ful-ang-a Ⓗ^{F} /	\ **yá**-á-cí-ful-ang-á \	[yáácífúlààngá]	'they recently washing' [B14:45]
b.	/ **u**-á-cí-mu-ful-ang-a Ø /	\ **u**-á-cí-mu-ful-ang-a \	[wààcímúfùlààngà]	
	'he/she was recently washing him/her' [B14:45]			

Before moving to the next allomorphy pairing, we must mention that there is unexpected blocking of a general spreading rule with the Ø allomorph, blocking previously identified in Bickmore (2007). In Table 1 above, we described Word-spreading, whereby a high tone which originates outside of the macro-stem spreads (unbounded) to the penult TBU if the word it is contained within is final in the ɪP, i.e. (**ŧ́** τ |$_{MS}$ τ τ τ)$_{ω}$]$_{ɪ}$ → (**ŧ́ ŧ́** |$_{MS}$ **ŧ́ ŧ́** τ)$_{ω}$]$_{ɪ}$.

As expected from this rule, with TAM designations which do not sponsor any grammatical tone (group 1 from Table 4), high tone from outside of the macro-stem undergoes unbounded spreading. This is shown below with the Persistive Potential /^{Ø}ngá-aa-...-a/ which does not sponsor a grammatical tone. Spreading from /ngá-/ is in bold in the surface form, which is unbounded in a., but bounded in b. because it is not ɪP-final.

(24) Persistive Potential /^{Ø}ngá-aa-...-a/ [B14:42]

a.	/ ya-ngá-aa-|$_{MS}$ sukilil-a /	[(yàà**ngáásúkílíl**à)$_{ω}$]$_{ɪ}$
	'they can keep on accompanying'	
b.	/ ya-ngá-aa-|$_{MS}$ sukilil-a Choola /	[(yàà**ngáású**kìlìlà)$_{ω}$ (Chòòlà)$_{ω}$]$_{ɪ}$
	'they can keep on accompanying Chola'	

Unbounded spreading only takes place if there is no later high tone within the phonological word.

Naively, with the Ⓗ^{F}/Ø allomorphy pairing we would expect unbounded spreading from a high tone outside the macro-stem with the Ø allomorph. However, this is not found. Instead the high tone undergoes bounded binary spreading to only one TBU to the right. This is shown below with allomorphs of the Recent Perfect /á-...-a Ø/ and Recent Past Progressive /á-cí-...-ang-a Ø/.

(25) Lack of unbounded spreading with Ø grammatical tone allomorphs

a. Recent Perfect /á-...-a Ø/
/ u-á-|$_{MS}$ sukilil-a Ø / \ u-á-sukilil-a \ 'he/she has just accompanied' [B07:269]
Bounded spreading: [wàà**súkí**lìlà]
(cf. Unattested unbounded spreading *[wàà**súkílí**là])

b. Recent Past Progressive /á-cí-...-ang-a Ø/
/ u-á-cí-|$_{MS}$ mu-ful-ang-a Ø / \ u-á-cí-mu-ful-ang-a \ 'he/she was recently washing him/her' [B14:45]
Bounded spreading: [wàà**címú**fùlààngà]
(cf. Unattested unbounded spreading *[wàà**címúfúlá**ángà])

These data suggest either that (1) the allomorphy here is not between Ⓗ^{F} and Ø, but rather between Ⓗ^{F} and another floating tone which *never* docks, e.g. Ⓗ^{0} where the superscript 0 indicates that it cannot dock to a TBU, or (2) Ø should be replaced with a L tone, which would complicate the fact that Cilungu is otherwise a straightforward H vs. Ø Bantu language. We do not provide an account of these data in this paper. What is important is that regardless of the interpretation, there is complementary allomorphy between Ⓗ^{F} versus some other GT allomorph.[9]

3.2 Allomorphy pairings Ⓗ^{F}/Ⓗ^{2} *and* Ⓗ$^{2\text{-}F}$/Ⓗ^{2}

Let us now examine the other two relevant allomorphic TAMs from Table 4: the Recent Past (segmentally: /á-cí-...-il-e/) and Perfect (/-il-e/). In these cases, the trigger of allomorphy is the same – namely the tone value of the subject marker – but the allomorphic patterns are different. The Recent Past shows a Ⓗ^{F}/Ⓗ^{2} allomorphy pairing, while the Perfect shows a Ⓗ$^{2\text{-}F}$/Ⓗ^{2} pairing.

Examples with the Recent Past are below, with high-toned a root and a toneless root.

(26) Toneless roots and Recent Past /á-cí-...-il-e/ allomorphy

a. / **tú**-á-cí-mu |$_{STEM}$ ziik-il-e Ⓗ^{F} / \ **tú**-á-cí-mu-ziik-il-é \ [twáácímúzìsìlé]
SM-TAM-TAM-OM-bury-TAM-FV TAM 'we recently buried for him/her' [B07:262]

b. / **u**-á-cí-mu |$_{STEM}$ sukilil-il-e Ⓗ^{2} / \ **u**-á-cí-mu-sukíl-il-e \ [wàácímúsùkílíílè]
SM-TAM-TAM-OM-accompany-TAM-FV TAM 'he/she recently untied' [B07:262]

(27) High-toned root and Recent Past /á-cí-...-il-e/ allomorphy

a. / **tú**-á-cí- |$_{STEM}$ sópolol-il-e Ⓗ^{F} / \ **tú**-á-cí-sópolol-il-é \ [twáácísópólwìílé]
SM-TAM-TAM-untie-TAM-FV TAM 'we recently untied' [B14:49]

b. / **u**-á-cí- |$_{STEM}$ sópolol-il-e Ⓗ^{2} / \ **u**-á-cí-só**pó**lol-il-e \ [wàácísópólwíílè]
SM-TAM-TAM-untie-TAM-FV TAM 'he/she recently untied' [B14:49]

If the SM is toneless, grammatical tone is assigned to the second TBU of the stem Ⓗ^{2}. We know that it is not toneless Ø because in the surface form [wàácímúsù**kílíí**lè] there is high tone on the toneless root, and we know it is not Ⓗ^{F} because the final TBU is low [wàácímúsùkílíí**lè**].

Analogous data are provided below with the Perfect /-il-e/ with Ⓗ$^{2\text{-}F}$/Ⓗ^{2} allomorphy, one of the few TAM designations with no prefix morph:

[9] Cilungu is not the only Bantu language where bounded spreading takes place in certain contexts where unbounded spreading is expected given other facts of the tonal system, e.g. in other closely related M Zone languages such as Aushi and Copperbelt Bemba. Interestingly, in those languages there is no evidence of grammatical tone allomorphy triggered by toneless SMs. In both, the TAMs corresponding to those here are exponed segmentally as /á-cí-/ but without grammatical tone. And in both of those languages, the H on /cí-/ exceptionally undergoes bounded rather than the expected unbounded spreading (second author's field notes).

(28) Allomorphy with Perfect /...-il-e/

a. H-toned SM triggering Ⓗ$^{2\text{-}F}$ allomorph

/ **tú**- |$_{STEM}$ ful-il-e Ⓗ$^{2\text{-}F}$ /	\ **tú**-ful-íl-é \	[túfúzˡílé]	‘we have washed’ [B07:293]
/ **tú**-mu |$_{STEM}$ ziik-il-e Ⓗ$^{2\text{-}F}$ /	\ **tú**-mu-ziík-íl-é \	[túmúzìsílé]	‘we have buried him/her’ [B14:50]
/ **tú**-yá |$_{STEM}$ léet-il-e Ⓗ$^{2\text{-}F}$ /	\ **tú**-yá-léét-íl-é \	[túyáléésílé]	‘we have brought them’ [B07:294]

b. Toneless SM triggering Ⓗ^{2} allomorph

/ **a**- |$_{STEM}$ ful-il-e Ⓗ^{2} /	\ **a**-ful-íl-e \	[àfùzílè]	‘he/she has washed’ [B07:294]
/ **a**- |$_{STEM}$ sukilil-il-e Ⓗ^{2} /	\ **a**-sukíl-il-il-e \	[àsùkílíílè]	‘he/she has accompanied’ [B14:50]
/ **a**- |$_{STEM}$ páapaatik-il-e Ⓗ^{2} /	\ **a**-pá-á-paatik-il-e \	[àpáápáátííkè]	‘he/she has flattened’ [B14:50]
/ **a**-yá |$_{STEM}$ lás-il-e Ⓗ^{2} /	\ **a**-yá-lás-íl-e \	[àyálásílè]	‘he/she has hit them’ [B07:294]

The Perfect is exponed with Ⓗ$^{2\text{-}F}$ if the SM is high-toned (a.), but exponed with Ⓗ^{2} if the SM is toneless (b.). In the verbal domain, Ⓗ^{2} is restricted to allomorphs of these two TAM designations, Recent Past and Perfect. A similar grammatical tone is also found in certain nominal constructions, not in an allomorphic context (Bickmore 2007:329).

3.3 Non-local conditioning

An important observation is that all three of these types of SM-conditioned tone allomorphy pairings apply regardless of the phonological or morphological locality of the trigger and target. The trigger is always the value of the SM which appears at (or near) the left edge, and the target is always grammatical tone which appears towards the right edge. Any intervening morphemes and/or intervening tonemes are transparent and do not disrupt this allomorphy relationship. An example set illustrating tonological non-locality is below, taking examples from all three allomorphic pairings (20, 27, 28). High tone on the intervening TAMs, object markers, or roots neither blocks nor triggers the allomorphy relation.

(29) Non-local trigger and target – Ⓗ^{F}/Ø pairing

a. H **H** H H H Ⓗ^{F}

á-**yá**-á-yá-lás-il-é	[ááˡáyálásíˡlé]	‘those who hit them’ [B07:254]

b. H **Ø** H H H Ø

ú-**u**-á-yá-lás-il-e	[úwáàyálásílè]	‘one who hit them’ [B07:257]

(30) Non-local trigger and target – Ⓗ^{F}/Ⓗ^{2} pairing

a. **H** H H H Ⓗ^{F}

tú-á-cí-sópolol-il-é	[twáácísópólwìlé]	‘we recently untied’ [B14:49]

b. **Ø** H H H Ⓗ^{2}

u-á-cí-sópólol-il-e	[wàácísópólwíílè]	‘he/she recently untied’ [B14:49]

(31) Non-local trigger and target – Ⓗ$^{2\text{-}F}$/Ⓗ^{2} pairing

a. **H** H H Ⓗ$^{2\text{-}F}$
| | | / | \
tú-yá-léét-íl-é [túyáléésílé] ‘we have brought them’ [B07:294]

b. **Ø** H H Ⓗ^{2}
| | |
a-yá-lás-íl-e [àyálásílè] ‘he/she has hit them’ [B07:294]

3.4 Other TAMs are unaffected by tone of SM

As stated, several other TAMs with grammatical tone exist, and none of them show allomorphy triggered by the tone of the subject marker. This is why we said the target was bounded. We illustrate this below with the Remote Perfect /a-...-a Ⓗ$^{2\text{-}F}$/, the Far Past /a-...-il-e Ⓗ$^{2\text{-}F}$/, and the Narrative Past /...-a Ⓗ$^{2\text{-}F}$/.

(32) No allomorphy with Remote Perfect /a-...-a Ⓗ$^{2\text{-}F}$/

a. / tú-a-ziik-a Ⓗ$^{2\text{-}F}$ / \ tú-a-zíík-á \ [twáázìíká] ‘we have already buried’ [B07:289]
/ tú-a-sópolol-a Ⓗ$^{2\text{-}F}$ / \ tú-a-sópólól-á \ [twáàsópólólá] ‘we have already untied’ [B07:290]

b. / u-a-ziik-a Ⓗ$^{2\text{-}F}$ / \ u-a-zíík-á \ [wàázìíká] ‘he/she has already buried’ [B07:289]
/ u-a-yá-lás-il-a Ⓗ$^{2\text{-}F}$ / \ u-a-yá-lás-íl-á \ [wààyálásílá] ‘he/she has already hit for them’ [B07:290]

(33) No allomorphy with Far Past /a-...-il-e Ⓗ$^{2\text{-}F}$/

a. / ú-a-mu-fuk-il-il-e Ⓗ$^{2\text{-}F}$/ \ ú-a-mu-fuk-íl-íl-é \ [wáámúfùkíílé]
‘you (sg.) harvested for him/her’ [B07:8,280,282]

b. / u-a-mu-fuk-il-il-e Ⓗ$^{2\text{-}F}$ / \ u-a-mu-fuk-íl-íl-é \ [wààmùfùkíílé]
‘he/she harvested for him/her’ [B07:8]

(34) No allomorphy with Narrative Past /...-a Ⓗ$^{2\text{-}F}$ /

a. / tú-yá-ziik-il-a Ⓗ$^{2\text{-}F}$ / \ tú-yá-zíík-íl-á \ [túyázíìkílá] ‘and then we buried for them’ [B07:299]

b. / a-yá-sukilil-a Ⓗ$^{2\text{-}F}$ / \ a-yá-sukílíl-á \ [àyású^{l}kílílá] ‘and then he/she accompanied them’ [B07:301]

Finally, as alluded to in Table 2 the Potential /^{Ø}ngá-...-a Ⓗ^{F}/ has a special tonal property of making all SMs toneless, while the Past Inceptive /$^{Ⓗ}$aa-...-a Ø/ makes all SMs high tone. Despite the neutralization of SM tone, neither show any tonal allomorphy.

(35) No allomorphy with Potential /^{Ø}ngá-...-a Ⓗ^{F}/

a. / tú-^{Ø}ngá-pón-a Ⓗ^{F} / \ **tu**-ngá-pón-á \ [tùùngápóná] ‘we can fall’ [B07:513]

b. / a-^{Ø}ngá-pón-a Ⓗ^{F} / \ **a**-ngá-pón-á \ [ààngápóná] ‘he/she can fall’ [B07:513]

c.

(36) No allomorphy with Past Inceptive /$^{Ⓗ}$aa-...-a Ø/

a. / tú-$^{Ⓗ}$aa-ful-a Ø / \ **tú**-aa-ful-a \ [twááfúlà] ‘and then we started to wash’ [B07:195]

b. / a-$^{Ⓗ}$aa-ful-a Ø / \ **á**-aa-ful-a \ [ááfúlà] ‘and then he/she started to wash’ [B07:196]

3.5 Local summary

To summarize at this junction, we can summarize the allomorphic TAM patterns in the table below. Allomorphy in grammatical tone is conditioned by whether the subject marker is high-toned or toneless. Allomorphy only affects tone; without exception, the segmental morphs in the same TAM designation do not change.

TAM designation	Segments				Grammatical tone if SM=H		if SM=Ø
Yesterday Past	á-		-il	-e	Ⓗ^{F}	/	Ø
Yesterday Past Progressive	á-		-ang	-a	Ⓗ^{F}	/	Ø
Recent Perfect	á-			-a	Ⓗ^{F}	/	Ø
Recent Perfect 2	á-	cí-		-a	Ⓗ^{F}	/	Ø
Recent Past Progressive	á-	cí-	-ang	-a	Ⓗ^{F}	/	Ø
Recent Past	á-	cí-	-il	-e	Ⓗ^{F}	/	Ⓗ^{2}
Perfect			-il	-e	Ⓗ$^{2\text{-}F}$	/	Ⓗ^{2}

Table 7: Interim summary GT allomorphy in the TAM system

Based on these allomorphy patterns we established a number of core properties, which will inform the debate we have of whether to attribute these patterns to morphology or phonology. These are summarized below:

(37) Core properties of the allomorphic patterns:
- a. **Bounded trigger**: it is the phonological identity of SMs and only SMs which trigger allomorphy
- b. **Bounded target**: the grammatical tone of certain TAMs and only these TAMs are the target of allomorphy
- c. **Clause-structure insensitivity**: allomorphy applies regardless of morphosyntactic context (e.g. matrix vs. embedded clauses, with and without object markers, presence or absence of derivation such as passive, *etc*.)
- d. **Non-locality**: allomorphy is insensitive to intervening tones; these do not trigger nor block allomorphy

Taken all together, a conspiracy can be seen across all three allomorphy pairings: a high tone on the SM allows a high tone on the final TBU (the grammatical tone), but if the SM does *not* bear a high tone, then the final TBU also does not bear a high tone. We can refer to this as a 'first-last tone conspiracy'.

(38) **First-last tone conspiracy**: in these TAMs, the first and last TBUs of the verbal phonological word have the same tonal value (either both are H or both are toneless)

Before moving to the next section, we must qualify one of the properties above, namely that of clause-structure insensitivity. While it is true that most contexts do not affect allomorphy, one context systematically *does* affect it: negation. For example, the Recent Past exhibits Ⓗ^{F}/Ⓗ^{2} according to whether the SM is H or Ø in the affirmative. However, in the negative this same allomorphy switches to being conditioned by whether the root is H or Ø. The facts regarding negation are complicated, and in order to streamline this paper, we provide the details of allomorphy altered by negation in Appendix 1. Additional unexpected data are provided in Appendix 2 for full transparency, particularly with very short roots.

4 Morphology or Phonology?

We can now begin to address the central question of this paper: should these patterns be treated as morphology or phonology? And what are the implications upon choosing one over the other? As stated in the introduction, we argue that this is morphology, i.e. that the patterns emerge based on a claim we make about the morphological component of Cilungu grammar. In this section, we wish to neutrally present the case for both morphology and phonology, to the best of our abilities. In the next section we will turn to our arguments in favor of morphology.

4.1 Interpretation as morphology: Grammatical tone suppletive allomorphy

Let us first establish the basics of the morphological solution. As our starting point, we assume a realizational model of morphology, whereby morphs are exponents made up of phonological substance which 'realize' the already present morphosyntactic features, rather than introducing these features themselves (Stump 2001, Trommer 2012). We can model this with simple realizational rules of the type familiar to item-based (morph(eme)-based) realizational models such as Distributed Morphology (Halle & Marantz 1993, Embick 2015).

For example, take the Narrative Past /...-a Ⓗ$^{2\text{-}F}$/ (see Table 4). This consists of the shape /-a/ of the Bantu final vowel, and a grammatical tone Ⓗ$^{2\text{-}F}$ which associates from the second to final TBUs of the stem. No TAM prefixes or suffixes occur in this TAM.

(39) Narrative Past

a. / n-sukilil-a Ⓗ$^{2\text{-}F}$ / [ìn-sù**kílíl-á**] 'and then I accompanied'

b. / n-sópolol-a Ⓗ$^{2\text{-}F}$ / [ìn-só**pólól-á**] 'and then I untied'[10]

We can write a realizational rule for this TAM as below:

(40) Realizational rule: [T:NARRATIVE.PAST] ↔ Ⓗ$^{2\text{-}F}$

This should be interpreted along the following lines: if there is a tense morphosyntactic feature which expresses the TAM meaning [T:NARRATIVE.PAST], this is realized as the phonological object Ⓗ$^{2\text{-}F}$. Following standard morphological practice, we call these latter realizations 'exponents' and the entire process 'exponence'. Notice as well that we do include the final vowel as part of the exponence of tense. The exact morphosyntactic category associated with Bantu final vowels is notoriously difficult, and we choose not to enter this debate here. We follow Pietraszko (2018:283) in positing that the final vowel is an exponent of the verbal head *v*.[11]

With this in mind, let us examine several of the TAMs which involve grammatical tone:

[10] While normally high-toned, in the Narrative Past the SM here /n-/ [1SG] is low-toned.

[11] Pietraszko's (2018:283) proposal is for Ndebele, with the following exponence rules:

(i.) Ndebele exponence of *v*

[*v*] ↔ -ile / [T:RPAST] __

[*v*] ↔ -a

Pietraszko assumes two complementary suppletive allomorphs: /-ile/ occurs in the context of remote past [T:RPAST], and /-a/ occurs elsewhere. Following this model, we posit the following exponents for [*v*] in Cilungu:

(ii.) Cilungu exponence of *v*

[*v*] ↔ -ini / [IMPERATIVE] & [PLURAL] [B07:308]

[*v*] ↔ -e / /-il/__

/ [SUBJUNCTIVE] & [AFFIRMATIVE]

/ [IMPERATIVE] & [OM]/[ANDATIVE] [B07:309]

[*v*] ↔ -a

The allomorph /-ini/ appears only in plural imperatives. The three contexts which trigger /-e/ do not form a natural class, therefore we write three disjunctive statements for this exponence rule. Note that Bickmore (2007) analyzes /-il-e/ in Cilungu as separate morphs (e.g. they can be interrupted by the passive morph /-u/; see Table 6).

An alternative to final vowels being exponents of [*v*] is in Julien (2002) analyzing Chichewa, who assumes they are exponents of a Mood head. Importantly, under this alternative the relevant morphosyntactic feature [MOOD] is analogous to the little [*v*] in being located deep in the extended projection, closer to the root than tense/aspect heads.

Consistent high tone on 2nd to final TBU	Remote Perfect	a- ...		-a	Ⓗ$^{2\text{-}F}$
	Far Past Progressive	a- ...	-ang	-a	Ⓗ$^{2\text{-}F}$
	Far Past	a- ...	-il	-e	Ⓗ$^{2\text{-}F}$
	Far Past 2	a-cí-...	-il	-e	Ⓗ$^{2\text{-}F}$
Grammatical tone suppletive allomorphy	Perfect		-il	-e	Ⓗ$^{2\text{-}F}$ / Ⓗ^{2}
	Recent Perfect	á- ...		-a	Ⓗ^{F} / Ø
	Recent Perfect 2	á-cí-...		-a	Ⓗ^{F} / Ø
	Yesterday Past Progressive	á- ...	-ang	-a	Ⓗ^{F} / Ø
	Recent Past Progressive	á-cí-...	-ang	-a	Ⓗ^{F} / Ø
	Yesterday Past	á- ...	-il	-e	Ⓗ^{F} / Ø
	Recent Past	á-cí-...	-il	-e	Ⓗ^{F} / Ⓗ^{2}

Table 8: Sample of TAMs with grammatical tone co-exponence

As can be observed, certain TAM affixes always appear with a specific grammatical tone. For example, the toneless prefix /a-/ always co-varies with the grammatical tone Ⓗ$^{2\text{-}F}$. All of these examples express a [REMOTE] temporal situation, e.g. the Remote Perfect /a- -a Ⓗ$^{2\text{-}F}$/ below:

(41) Remote Perfect

a. / tú-a-sukilil-a Ⓗ$^{2\text{-}F}$ / [twáásù**kílílá**] 'we have already accompanied' [B07:289]

b. / tú-a-sópolol-a Ⓗ$^{2\text{-}F}$ / [twáàsó**pólólá**] 'we have already untied' [B07:290]

We can capture this covariation between meaning and the two forms directly by positing that they are 'co-exponents' of a morphosyntactic feature [T:REMOTE], written within a single rule.

(42) [T:REMOTE] ↔ a- Ⓗ$^{2\text{-}F}$

Segmental exponence is linearized at the left, while the grammatical tone targets TBUs at the right sensitive to the stem domain. In this way the co-exponents are circumfixal.

Under this morphological approach, we can now define the exponence involved in the allomorphic TAMs. All but one of these TAMs involve the prefix /á-/, which denote a more recent temporal situation (the counterpart to remote /a-/). The prefix /á-/ co-varies with Ⓗ^{F}~Ø grammatical tone (the locus of the allomorphy), and we therefore interpret them as co-exponents of [T:RECENT]. Under a morphological interpretation, we attribute the allomorphy not to surface variation conditioned by phonology (or the phonology/phonetics interface), but rather to there being two stored allomorphs. In other words, this constitutes grammatical tone suppletion.

The suppletive exponence rules are below:

(43) [T:RECENT] ↔ á- Ⓗ^{F} / H—τ—[SM] ___
↔ á- Ø

In the first part, [RECENT] is exponed with a grammatical tone Ⓗ^{F} if it appears in the context of a subject marker ([SM]) whose TBU (τ) is associated to a high tone (H). This suppletive allomorph is sensitive to both morphological information in its context (the features which define the [SM], most straightforwardly subject agreement phi-features) and phonological information (presence/absence of associated H). The second part is the elsewhere case, where [RECENT] is exponed with Ø grammatical tone. Recall from the end of Section 3.2, that this may be some other type of unassociated Ⓗ^{0} based on its blocking of general spreading rules. In either case, it differs from Ⓗ^{F}.

At this juncture, let us present evidence that these are in fact prefixes exponing tense. Based on their distribution, the prefixes /á- Ⓗ$^{2\text{-}F}$/ [RECENT] and /a- Ⓗ^{F}~Ø/ [REMOTE] are in a paradigmatic relationship with a consistent meaning difference. The table below organizes the data with /á-/ vs. /a-/ based around the presence or absence of other affixes. Observe that the /a-/ form is used to indicate Remote Perfect without a suffix, and Far Past with /-il/ and Far Past

Progressive with /-ang/. Compare the equivalent forms with /á-/ and /á-cí-/, which denote the equivalent meanings but are more recent.

Prefix \ Suffix	-Ø	/-il/	/-ang/
/a-/	Remote Perfect	Far Past	Far Past Progressive
/á-/	Recent Perfect	Yesterday Past	Yesterday Past Progressive
/á-cí-/	Recent Perfect 2	Recent Past	Recent Past Progressive

Table 9: Remote vs. recent temporal parallels across TAM designations

Their paradigmatic relationship can also be seen in certain compound TAMs, such as the Obligative. The Present Obligative is formed with the construction [SM-lí na INFINITIVE] based around the auxiliary verb /lí/ and the infinitive.

(44) Present Obligative

a. / tú-lí na ú-ku-lim-a / \ tú-lí na ú-ku-lim-a \ [túlí nú!kúlímà] 'we (will) have to farm' [B07:397]

b. / tú-lí na ú-ku-léet-a / \ tú-lí na ú-ku-léet-a \ [túlí nú!kúlé!étà] 'we (will) have to bring' [B07:397]

The auxiliary /lí/ can be inflected with these tense prefixes, with /á-/ to indicate Yesterday Past Obligative and /a-/ for Far Past Obligative. The position of these tense prefixes is in bold in the examples below.

(45) Paradigmatic contrast of /á-/ vs. /a-/

a. Yesterday Past Obligative
/ tú-**á**-lí Ⓗ$^{2\text{-}F}$ na ú-ku-lim-a / \ tú-**á**-lí na ú-ku-lim-a \ [tw**áá**lí nú!kúlímà]
'we had to farm', 'we were to farm' [B07:398]

b. Far Past Obligative
/ tú-**a**-lí Ⓗ^{F} na ú-ku-lim-a / \ tú-**a**-lí na ú-ku-lim-a \ [tw**áà**lí nú!kúlímà]
'we had to farm', 'we were to farm' [B07:399]

Moving on, we next analyze TAM suffixes, /-il/ and /-ang/. Beginning with /-ang/, in all instances in Table 4 /-ang/ expresses a kind of imperfective aspect, what Bickmore classifies as 'Progressive'. Its imperfective meaning is used in several other contexts as well, e.g. with imperatives to indicate continuative meaning:

(46) Imperfective /-ang/ used in imperatives transparently [B07:306]

a. / sukilil-a Ⓗ$^{2\text{-}F}$ / \ sukílíl-á \ [sùkílílá] 'accompany!'

b. / sukilil-ang-a Ⓗ$^{2\text{-}F}$ / \ sukílíl-áng-á \ [sùkílíláángá] 'keep accompanying!'

We therefore analyze /-ang/ as directly exponing this aspectual category, with the following realizational rule:

(47) [ASP:IMPERFECTIVE] ↔ -ang

Unlike the temporal prefixes, /-ang/ does not consistently co-vary with a specific grammatical tone, and we therefore do not include tone in its realizational rule.

This aspectual suffix is in a paradigmatic relationship with the aspectual suffix /-il/, the only other morph which is found in this position. While no TAM designation exists where /-ang/ appears without a tense prefix, /-il/ may occur without one. On its own, /-il/ expresses perfect aspect (also called 'anterior' aspect, e.g. throughout Nurse 2008).[12]

[12] This morph /-il/ (often referred to as /-ile/ with its final vowel) is widespread across Bantu, with Nurse (2008:24) noting that "at least 66 per cent of Bantu languages have an anterior ('perfect') in suffixal -ile", and in those languages with a morph /-ile/, it "refers predominantly to anterior (aspect) or to various degrees of past (tense) perfective" (Nurse & Philippson 2006:181).

(48) /-il/ expresses perfect aspect

a.	/ tú-Ø-mu-ziik-**il**-e	Ⓗ$^{2\text{-}F}$ /	\ tú-mu-zíík-íl-é \	[túmúzììsílé]
	SM-T-OM-bury-PERF-FV	PERF	'we have buried him/her'	[B07:293]
b.	/ a-Ø-mu-ziik-**il**-e	Ⓗ^{2} /	\ a-mu-zíík-il-e \	[àmùzììsílè]
	SM-T-OM-bury-PERF-FV	PERF	'he/she has buried him/her'	[B07:294]

As established, /-il/ shows GT suppletive allomorphy in this context: with high-toned SMs it is co-exponed with Ⓗ$^{2\text{-}F}$ but with toneless SMs it is Ⓗ^{2}. Realizational rules are below, to be amended in (53) (and 88 within Appendix 1):

(49) [ASP:PERFECT] ↔ -il Ⓗ$^{2\text{-}F}$ / H—τ—[SM] ___ (*to be amended in* 53)
↔ -il Ⓗ^{2}

Just as with /á-/, the morphological solution involves multiple listed allomorphs with suppletive grammatical tone co-exponents.

As the reader has likely noticed, one significant issue in interpreting the TAM system of Cilungu is the semantic compositionality of morphs within a single TAM designation. We have proposed thus far that prefixes such as /á-/ and /a-/ express tense, while suffixes /-ang/ and /-il/ express aspect. In several cases the meaning of their combination is not transparently composed from their individual meanings:

Perfect	...	-il	Ⓗ$^{2\text{-}F}$ / Ⓗ^{2}	Perfect		...-il	Ⓗ$^{2\text{-}F}$ / Ⓗ^{2}
Remote Perfect	a-...		Ⓗ$^{2\text{-}F}$	Recent Perfect	á-	...	Ⓗ^{F} / Ø
Far Past	a-...	-il	Ⓗ$^{2\text{-}F}$	Yesterday Past	á-	...-il	Ⓗ^{F} / Ø

Table 10: Issues of compositionality in tense and aspect

On its own, /-il/ indicates Perfect, while /a-/ Remote Perfect, but together indicate the Far Past. Likewise, /á-/ indicates Recent Perfect, but with /-il/ is Yesterday Past.

A full semantic account of these grammatical idiosyncrasies is outside of the scope of this paper. The solution must involve a combination of default temporal and aspectual states, and the Perfect marker /-il/ having some kind of temporal meaning in some contexts. Across Bantu, issues of tense and aspect compositionality are notoriously difficult with cognates of /-il/. Nurse (2008) notes the "difficulty of distinguishing anterior (aspect) [Perfect] and near past (perfective), in which the perfective is also an aspect, but typically unmarked in Bantu", remarking that "in some cases it is clear, in others not" (p. 94).[13] Specifically regarding the sequence /a-...-ile/ across Bantu compared to /-ile/, Nurse states the following:

> "The -Ø-…-*ile* pattern occurs predominantly as a present anterior, where the reference point is the present or some other time established. Where it and -*a*-…-*ile* co-occur, -*a*-…-*ile* always indicates a time further removed, suggesting that -*a*- is added to encode the past component. -*A*-…-*ile* has often has been recategorized from anterior to middle or far past perfective." (Nurse 2008:157)

From the perspective of Bantu, it is not surprising that Cilungu exhibits these complications in compositionality.

There are several responses one could pursue for to account for these complexities. One is to say that /-il/ occupies a structurally low grammatical category, but it is some hybrid category between tense and aspect. Another is that tense and aspect are simply fused and are co-exponents of a single TAM designation. For example, the Far Past and Yesterday Past TAMs would have realization rules as below.

[13] In many cases, the same language can be analyzed in two different ways, e.g. in Kongo (H16), Carter (1973) analyzes three pasts and no anterior, while Welmers (1973: 350) interprets Carter's near past as anterior" (p.155).

(50) Alternative realizational rules that circumvent issues of compositionality (GT not indicated)

a. [‘Perfect’] ↔ -il …
b. [‘Far Past’] ↔ a- -il …
c. [‘Yesterday Past’] ↔ á- -il …

Such rules circumvent compositionality, as e.g. the Far Past is not derived from two separate exponence rules, one for /a-/ and one for /-il/. This sacrifices the transparent semantics in many cases of these individual morphs, as detailed already (i.e. regular form-meaning correspondence). Regardless, the core properties of allomorphy remain same: the trigger is the tone of the subject marker, and the target is TAM grammatical tone.

With this is mind, we must still address one remaining issue: the tone patterns when /á-/ and /-il/ co-occur. This occurs in the Yesterday Past TAM. Tense /á-/ [RECENT] has allomorphic pairing Ⓗ^{F}/Ø while aspect /-il/ [PERFECT] has Ⓗ$^{2\text{-}F}$/Ⓗ^{2}. When the two co-occur, the grammatical tone of /á-/ is the winner, as shown in the example below (repeated from 17). If the GT of perfect were to win, we would have expected the surface forms to be *[twáázììsílé] and *[wààzììsílè], respectively.

(51) Toneless root /ziik/ 'bury' in Yesterday Past (YP)

a.	/ **tú**-á-ziik-il-e	Ⓗ^{F} /	\ **tú**-á-ziik-il-é \	[twáázíìsìlé]
	SM-RECENT-bury-PERFECT-FV	RECENT	‘we buried’	[B07:242]
b.	/ **u**-á-ziik-il-e	Ø /	\ **u**-á-ziik-il-e \	[wààzíìsìlè]
	SM-RECENT-bury-PERFECT-FV	RECENT	‘he/she buried’	[B07:245]

We can say that tense /á-/ is 'dominant' over aspect /-il/, following standard interpretation of stress/pitch accent/tone in competition in the prosodic literature (Kiparsky & Halle 1977, Kiparsky 1984, Inkelas 1998, *inter alia*).[14]

Finally, the thorniest issue in the morphological analysis involves the seemingly peripheral TAM prefix /cí-/, which appears in several TAM designations (Table 4). Bickmore (2007:287) states /cí-/ is used to emphasize “the recent nature of the action in question”, often translated as ‘just’. This morph does not co-vary with any specific grammatical tone. We posit the following realization rule:

(52) [‘just’] ↔ cí-

This morph /cí-/ has a peculiar tonal effect in the Recent Past /á-cí-...-il-e/, and only in the Recent Past. Because this occurs with the prefix /á-/ we expect Ⓗ^{F}/Ø allomorphy, an expectation which holds for all cases of /á-/ *except* in this TAM. Instead, with /cí-/ we find Ⓗ^{F}/Ⓗ^{2} allomorphy, an allomorphic pairing not found elsewhere in any other context with /á-/ or /cí-/. This is summarized in the table below.

	TAM designation		if SM=H	if SM=Ø
a.	Recent Perfect	á-...-a	Ⓗ^{F}	Ø
b.	Yesterday Past	á-...-il-e	Ⓗ^{F}	Ø
c.	Recent Past	á-cí-...-il-e	Ⓗ^{F}	Ⓗ^{2}
d.	Perfect	...-il-e	Ⓗ$^{2\text{-}F}$	Ⓗ^{2}

Table 11: Recent Past as a unique GT allomorph pairing

[14] In Section 6, we conclude that tense morphs such as /á-/ are 'outer' and further removed from the root compared to aspect morphs such as /-il/. This complies with cross-linguistic patterns of dominance (Rolle 2018). For /á-/, note that if Ø is interpreted as truly toneless, this constitutes a 'subtractive-dominant pattern' (Rolle 2018:47), but is a more straightforward dominant pattern if interpreted as a Ⓗ^{0} GT which is unassociable to any TBU. Also note that regardless of tense or aspect winning, lexical tone of the verb root remains unaffected.

We see that the Recent Past has features of the other two pairings, showed by the thick outlined boxes. What is in need of explanation is the Ⓗ² of the Recent Past (when SM=Ø), as we expect it to lose to the tone designation of /á-/.

Under the morphological interpretation, we capture this by positing another allomorph of [PERFECT] in the context of /cí-/ 'just', shown below. The special allomorph is notated as $\boxed{Ⓗ^{2}}$ which is meant to indicate that it is a special grammatical tone which has exceptional faithfulness to its grammatical tone, and cannot be overwritten by dominant tone (the double boxed outline).

(53) [ASP:PERFECT] ↔ -il $\boxed{Ⓗ^{2}}$ / ['just'] ___
↔ -il $Ⓗ^{2\text{-}F}$ / H—τ—[SM] ___
↔ -il $Ⓗ^{2}$

To see how this works, consider the simple table below which shows the grammatical tone of /á-/ and /-il/ in the context of /cí-/, depending on whether the SM is high or toneless.

Context of /cí-/ &	SM=H	SM=Ø
á-	$Ⓗ^{F}$	Ø
-il	$Ⓗ^{2\text{-}F}$	$\boxed{Ⓗ^{2}}$
Winner	$Ⓗ^{F}$	$\boxed{Ⓗ^{2}}$
	[due to dominance of /á-/]	[due to special faithfulness to $\boxed{Ⓗ^{2}}$]

Table 12: Recent Past as a unique GT allomorph pairing

The suppletive allomorphs of /á-/ are unaffected by /cí-/, which does not condition any special form (exponence rules in 43). In contrast is /-il/. If it is in the context of both /cí-/ and SM=H, the exponence rules are in conflict. We will assume that the [SM] specific allomorph wins (refer to the Appendix 1 for a principled reason why this is the case). This means that the allomorph $Ⓗ^{2\text{-}F}$ is chosen. In contrast, if the SM is Ø then only the /cí-/ context is met and the special allomorph $\boxed{Ⓗ^{2}}$ is chosen.

After these allomorphs are chosen, they compete as described above. In the context of SM=H, the grammatical tone associated with /á-/ wins due to it being dominant. Therefore the winning GT is $Ⓗ^{F}$. In contrast, in the context of SM=Ø by default we expect the GT of /á-/ to also win, i.e. for Ø to win over $\boxed{Ⓗ^{2}}$. However, because of the special faithfulness to the GT $\boxed{Ⓗ^{2}}$ of /-il/ (in the context of /cí-/ 'just' and only this context), the winner is $\boxed{Ⓗ^{2}}$. This therefore accounts for the special $Ⓗ^{F}/Ⓗ^{2}$ allomorph pairing with the Recent Past TAM designation /á-cí-...-il-e/.

This concludes the sketch of the morphological interpretation of GT allomorphy in Cilungu. We further address numerous aspects of this analysis when we directly compare the morphological versus phonological interpretations in Section 5, but this serves to establish its basic logic. Note that in Appendix 1 we adjust the realizational rules slightly to accommodate complexities in negative contexts. The core of the proposal remains.

4.2 Interpretation as phonology: First-last tone harmony

Let us now compare our morphological interpretation to a phonological one. This attributes the allomorphy to a phonological rule/constraint which derives the surface differences. In other words, only one of the allomorphs is stored and thus there is no grammatical tone suppletion.

We can begin with a commonality with the morphological approach: we assume realizational rules which map morphosyntactic features to exponents (strings of phonological substance). The important difference is that there is no allomorphy at this stage; exponents are uniformly inserted in all phonological/morphological contexts. Rules are in (54). Compare this to exponence rules in the previous section above, where these exhibited grammatical tone allomorphs (Ø and $Ⓗ^{2\text{-}F}$ respectively).

(54) Realization rules (without allomorphy)
a. [T:RECENT] ↔ á- $Ⓗ^{F}$
b. [ASP:PERFECT] ↔ -il $Ⓗ^{2\text{-}F}$

This entails that for both high-toned SMs and toneless SMs, Ⓗ^{F} is inserted. This is shown below with the Recent Perfect TAM designation, in a minimal pair with high-toned /yá-/ 'they' (a.) and toneless /u-/ 'he/she' (b.).

(55) Uniform exponence with [T:RECENT] ↔ /á- Ⓗ^{F}/

a. / yá-**á**-sópolol-a Ⓗ^{F} / → yá-á-sópolol-**á** → **yá**-á-sópolol-**á** → [**yá**ásópólòl**á**]
'they have just untied' [B14:45]

b. / u-**á**-sópolol-a Ⓗ^{F} / → u-á-sópolol-**á** → **u**-á-sópolol-**a** → [**wà**àsópólòl**à**]
'he/she has just untied' [B07:269]

The Ⓗ^{F} attaches uniformly to both, shown in the first intermediate representation. Emphasized in red is the fact that this Ⓗ^{F} deletes/delinks only in the context of toneless SMs. This results in the fact that the initial tone and final in these and other examples are identical (both high or low).

We refer to this as phonological rule 'first-last tone harmony', defined below:

(56) **First-last tone harmony**: For some domain *D*, the first/leftmost TBU τ_{FIRST} (τ_{F}) has the same tone value as the last/rightmost TBU τ_{LAST} (τ_{L})

Tone rules of this nature have been lingering in the Bantu literature at least since Meeussen (1967), under the name 'tonal harmony' or the 'Law of Initials and Finals'. As summarized in Hyman (2012:109), such rules state that "certain verb forms end H if the subject prefix is /H/, but L if the subject prefix is /L/". To exemplify, Hyman states that "this rather unusual tonal agreement [is] often found in [non-subject relative clauses]", e.g. in relative clauses in the Konda variety of Mongo [lol] (Nsuka Nkutsi 1982:189). Below, the relative clause is in square brackets, and the subject agreement marker on the verb agrees with the relativized noun (denoted by subscripts), and not the embedded subject *mí* 'I' in post-verbal position. Parallel patterns are reconstructed for Proto-Bantu (Meeussen 1967:113-114).

(57) 'Law of Initials and Finals' – Konda dialect of Mongo (Nsuka Nkutsi 1982:189)

a. bont' [**o**-lang-**a** mí]
person$_i$ [**AGR$_i$**-like-**FV** I]
'the person that I like'

b. banto [**bá**-lang-**á** mí]
people$_i$ [**AGR$_i$**-like-**FV** I]
'the people that I like'

In Konda, if the agreement marker has no lexical tone then the final vowel will also have no tone (a.), but if it has a lexical high like *bá-* (b.) then the final vowel also bears high.

Hyman cites Meeussen (1971) in linking data like that above to the loss of a grammatical marker between the final vowel of the verb and post-verbal argument which may have left a floating high tone[15], supporting its diachronic plausibility by citing several languages where a pronoun is repeated after the verb in the Negative, i.e. structures like [SM$_i$-V PRON$_i$] (Hyman 2012:115-116).[16]

[15] It is worth repeating Meeussen's (1971:10) original quote: "instead of tonal harmony at a distance, there is a *repetition of the initial morpheme at the end of the word*, but in such a way that it is reduced to mere [high] tone — except if this repetition is propped up by a pronominal (**-e**) or anaphoric (**-o**) support, as in Swahili".

[16] Is this characterization as morpheme-repetition a possible synchronic analysis of Cilungu? We conclude that it is not. For one, the subject marker at the left edge would not be identical to its counterpart at the right edge, which undermines the idea that this is "repetition". Such changes could not be attributed to general phonology of the language, especially given that several SMs begin with consonants which never lenite intervocalically (e.g. /tú-/ 1PL). We would therefore be forced to posit another agreement morpheme series which only appear post-verbally and consist only of two possible members: Ⓗ^{F} and Ø.

Second, such "repetition" would only take place in the contexts of /á-/ [RECENT] and /-il/ [PERFECT], unlike in bona fide agreement where all TAM morphs co-occur with an agreement subject marker. Presumably, [RECENT] and [PERFECT] would trigger its own agreement (in addition to general agreement on all verbs). For example, one series of agreement would be at the left edge and exponed as subject markers (e.g. ú-, u, etc.), while a special agreement series (AGR$_{\text{REC}}$) would appear at the right edge.

A similar rule in fact was originally pursued for the Cilungu facts in Bickmore (2007:250,271), though by a name 'Final Vowel Delinking' (FV Delinking). This rule stated that tone on the final mora of the (phonological) word delinks and rendering the H toneme floating, illustrated below:

(58) Final Vowel Delinking (in context of toneless SMs and TAM /á-/) [B07:250,271]

Such a rule must be qualified to applying "only when the TAM prefix /á-/ is present, as well as a toneless SM" (p. 250), /á-/ being the [RECENT] TAM morph. Under these accounts, there is no appeal to suppletive grammatical tone.

Because such a phonological rule cannot be attributed to the general tonology of Cilungu, it must be understood as 'morphologically-conditioned phonology' (Inkelas 2014 for an overview). A classic example to illustrate this type of process comes from Turkish (Inkelas 2014:30). Vowel hiatus at stem-suffix boundaries is not permitted, a shorthand for which we can use a constraint '*VV'. With the majority of cases *VV is repaired by glide epenthesis, e.g. with /-Iver/ FACILITATIVE (a. below), where [j] is inserted between the vowels. However, with the progressive suffix /-Ijor/ PROGRESSIVE (b.), the vowel of the root is deleted and no epenthesis takes place.

(59) Turkish suffix-specific responses to *VV (with root /anla-/ 'understand')

a. / anla-Iver /'understand-FACILITATIVE' → [anla-**j**ɯver]
b. / anla-Ijor / 'understand-PROGRESSIVE' → [anl-ɯjor]

The phonological operation to repair *VV – epenthesis in (a.) but deletion in (b.) – is morphologically-conditioned according to the suffix attached to the root.

Let us apply this to Cilungu. We can accomplish this by formalizing first-last tone harmony (56), which states that for some domain *D*, the first/leftmost TBU has the same tone value as the last/rightmost TBU. In the representations below, correspondence between TBUs is indicate via an index *i*. Those where the TBUs have the same tonal value are well-formed (a.-b.), whereas those with different values are not (c.-d.).

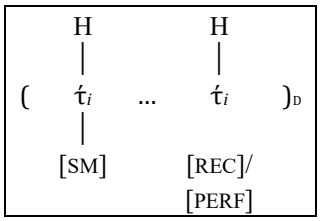
(i.) AGR[REC…AGR$_{REC}$] → ú[á…Ⓗ^{F}]
(ii.) AGR[REC…AGR$_{REC}$] → u[á…Ø]

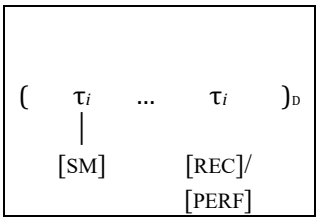
We maintain that it is simpler to view exponents of AGR$_{REC}$ Ⓗ^{F} and Ø as part of the exponence of [RECENT] itself.

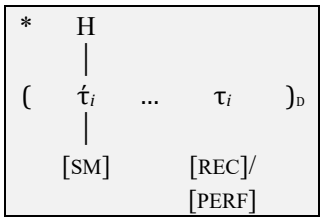
Third, the contexts in which this 'Law of Initials and Finals' applies in various Bantu languages – e.g. in relative clauses or under negation – are not the contexts where it is found in Cilungu. Any proposal in which tone harmony is the "synchronic residue" or a former more robust system must contend with the fact that the syntactic contexts where it applies are not unified.

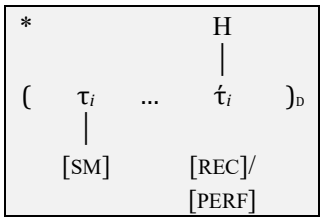
Finally, viewing the right-edge grammatical tones as part of the exponence of [RECENT] fits better with the patterns under negation (Appendix 1).

(60)

a. 

b. 

c. 

d. 

Crucially, the constraint in (c.-d.) only applies in a context with both a [SM] at the left edge, and grammatical tone exponing by [T:RECENT] ([REC] above) or [ASP:PERFECT] ([PERF]). We capture the morphologically-conditioned nature of this rule by placing these features within the representations above.

There are numerous ways to capture morphologically-conditioned phonology of the type here, for example through lexical morphology and phonology (Kiparsky 1982, Monahan 1986), stratal OT (Bermúdez-Otero 2008), cophonologies (Anttila 1997, 2002), indexed constraints (Pater 2000, 2007), *inter alia*. We will not go through the predictions of each of these for the Cilungu data, in light of the fact that we ultimately do not support an interpretation of GT allomorphy as phonology. What is necessary in any account is that the phonological constraint apply only in this morphological environment.

Notice that we must place both information about [SM] and [RECENT]/[PERFECT] within the constraint. Having the [SM] alone – the trigger of suppletive allomorphy under the morphological interpretation – will not suffice to restrict this constraint to the appropriate environments. As we have established, first-last tone harmony *only* takes place in the context of [RECENT]/[PERFECT] TAM morphology – the target in the morphological interpretation.

Is it possible to have the opposite, namely a constraint with [RECENT]/[PERFECT] but without [SM]? The language does not provide a definitive answer to this because all instance of [RECENT]/[PERFECT] must occur with an overt subject marker. One piece of evidence that we *do* require [SM]'s within the conditioning environment of the constraint comes from embedded clauses, already introduced in (20). In these cases, toneless subject markers still condition final tonelessness on the verb, but the SMs do not appear at the left edge. Instead, they are preceded by a left-edge relative marker, which is a high-toned copy vowel of the following subject marker.

(61) Relative clauses

a.	/ Ý-**cí**-á-ziik-il-u-e	Ⓗ^{F} / →	í-**cí**-á-ziik-il-u-**é**	→	[ícáàzììsìlwé] [B07:254]
	REL-**SM.7**-REC-bury-PERF-PASS-FV	**REC**			‘that (C7) which was buried’
b.	/ Ý-**i**-á-ziik-il-u-e	Ⓗ^{F} / →	í-**i**-á-ziik-il-u-**e**	→	[íyáàzíìsìlwè] [B07:256]
	REL-**SM.4**-REC-bury-PERF-PASS-FV	**REC**			‘they (C4) which were buried’

Due to the presence of the relative marker, in the surface forms both clauses with high-toned SMs and toneless SMs begin with a high tone. This shows that it is specifically not the leftmost TBU of the word which governs first-last tone harmony, but rather the subject marker specifically.

In (60) above, we captured this by including the [SM] feature within the constraint itself, and linking it to the first TBU of a domain *D*, which we assume this to be the left edge of the [SM] to the right edge of the word. If we were to eliminate [SM] and make no reference to it (62), it is not clear what the left-edge of the domain would be. It is not the edge of the phonological word as seen in relative clauses. The presence of [SM] allows us to demarcate this edge.

(62) Alternative without [SM] (*rejected*)

a. H H
(... τ́$_i$ ... τ́$_i$)$_D$
[REC]/
[PERF]

b. * H
(... τ$_i$ ... τ́$_i$)$_D$
[REC]/
[PERF]

etc.

Furthermore, let us continue to formalize this phonological account, using a prominent model used to capture long-distance phonological agreement between phonological units: Agreement by Correspondence (Rose & Walker 2004).[17] Under this model, individual phonological units are in correspondence with each other if they are sufficiently similar. The basic ABC configuration is in the example immediately below, illustrating two consonants in a correspondence relation (C_x) which consequently enter an agreement relationship along some additional dimension ([αF]). Data from Kikongo exemplifies this configuration (Rose & Walker 2004:510). Here, underlying /n/ and /l/ are sufficiently similar in both being alveolar and sonorant, and therefore must be in correspondence (subscripted *x*). Parasitic on this, units in correspondence must additionally agree in nasality, resulting in deviation from the input form. Other segments are not similar enough to be in correspondence, and therefore do not show nasal agreement.

(63) Correspondence: C_x V C_x V e.g. /nik-ulu/ [n$_x$ik -un$_x$u]
Agreement: [αF] [αF] [αNAS] [αNAS]

For Kikongo, Rose & Walker propose a grammar with highly ranked correspondence constraint CORR-N↔L and agreement constraint ID-C$_L$C$_R$(NAS), ranked above a faithfulness constraint for nasality.

While tone has remained a hold-out against Agreement by Correspondence (whereby assimilation is via syntagmatic agreement rather than autosegmental spreading), Shih & Inkelas (2018) propose capturing tone spreading, tone plateauing, tone absorption, tone polarity, contour tone copying, among other tonal phenomena using the same ABC formalisms. For example, for the unbounded tone spreading rule in Cilungu, they posit that (adjacent) vowels must be in correspondence with each other, notated as 'CORR-VV'. Parasitic on this correspondence, all vowels which are in correspondence must also agree for their tone value – in Cilungu H or toneless – using a constraint 'IDENT-VV[Tone]'. This ensureshs that an input like /kú-fulumy-<a>/ 'to boil over' (where final <a> is extraprosodic) is mapped to an output [kú$_1$-fú$_{1,2}$lú$_2$my-<à>], where vowels exist in correspondence chains and therefore must all agree for tone value.

Let us now apply Shih & Inkelas' proposal to first-last tone harmony. The constraints in a.-b. below are parallel to the ones above, while those in c.-d. involve faithfulness to underlying tone structure.

(64) Constraints for Cilungu first/last harmony
a. CORR-τ$_F$τ$_L$: the first (τ$_F$) and last (τ$_L$) TBUs within the domain *D* are in correspondence
b. IDENT-τ$_F$τ$_L$(T): TBUs in correspondence have the same tone value (both H or both toneless)
c. DEP-IO(H): all H tonemes in the output have correspondents in the input (i.e. don't insert H)
d. MAX-IO(H): all H tonemes in the input have correspondents in the output (i.e. don't delete H)

Under this analysis, we must assume that edge TBUs by virtue of being at a domain edge are sufficiently similar to one another, to the exclusion of intermediate TBUs. Domain edges are cross-linguistically prominent positions, and it therefore is reasonable that they could be in correspondence parasitic on this standing similarity.[18]

[17] A bibliography of ABC has been compiled by Stephanie Shih & Sharon Inkelas: http://linguistics.berkeley.edu/~inkelas/ABCBibliography.html

[18] Lai (2015), Heinz (2018), and Jardine (2020) all highlight that edge positions are articulatorily and perceptually prominent, with many phonological generalizations referencing these positions. They highlight these facts to illustrate

We illustrate these constraints with the following examples showing the Ⓗ^{F}/Ø alternation in the TAM designation Recent Perfect /á-...-a/. The first has a high-toned subject marker and a toneless root, while the second has a toneless subject marker but with a high-toned root.

(65) First-last tone harmony in TAM Recent Perfect /á-...-a/

a. / yá-á-sukilil-a Ⓗ^{F} / → yá-á-sukilil-á → **yá**-á-sukilil-**á** → [yáásúkìlìlá]
'they have just accompanied' [B14:45]

b. / u-á-sópolol-a Ⓗ^{F} / → u-á-sópolol-á → **u**-á-sópolol-**a** → [wààsópólòlà]
'he/she has just untied' [B07:269]

We can use these constraints to derive the mapping between the two intermediate forms above, i.e. not the underlying representation at the far left, but also not the surface form mapped to phonetics at far right.[19] This mapping is shown in the tableaux in Table 13, illustrated with a sample of candidates. The input contains both phonological structure and the morphological conditioners are also included there (but for space reasons, they are only implied in the output candidates).

The tableau on the left corresponds to (65a.) above, rendered in τ notation. High-ranked CORR-$\tau_F\tau_L$ eliminates candidates d.-h. because the first and last TBUs are not in correspondence (they are not co-indexed). While candidate c. shows correspondence, it violates IDENT-$\tau_F\tau_L$(T) because its TBUs do not agree in their tonal value (the second H is deleted, indicated in light gray). Candidate b. shows both correspondence and agreement, but superfluously: intermediate TBUs also correspond/agree resulting in violations of DEP-IO(H) militating against epenthetic tone (added structure in outputs in blue). Candidate a. is optimal. In this case, no changes take place to the input other than establishing first/last correspondence.

Compare this to the second tableau to the right (corresponding to 65b.). Candidates g.-h. do not show first/last correspondence and are eliminated. Next, f. shows correspondence but not agreement, and so is also eliminated. All remaining candidates show correspondence/agreement. Candidates d.-e. accomplish agreement by adding H tonemes to the outputs, in violation of higher ranked DEP-IO(H). Finally, candidates a.-c. all violate MAX-IO(H) by deleting H's in the input. Candidate a. does so only for the final TBU, whereas b.-c. also egregiously eliminate the root's H tone. This derives the fact that first/last harmony is a non-local process which leaves intermediate tone structure unaffected.

that from phonetics along we might expect first-last harmony. These authors attribute its absence to computational complexity (discussion in Section 5.4).

[19] We do not wish to debate here which modification to OT is best for allowing intermediate forms.

	H H (τ́…τ…τ́)D [SM] [REC]	CORR-τFτL	IDENT-τFτL(T)	DEP-IO(H)	MAX-IO(H)
☞ a.	H H (τ́1…τ…τ́1)D				
b.	H H H (τ́1,3…τ́1,2…τ́2,3)D			*!	
c.	H H (τ́1…τ…τ1)D		*!		*
d.	H H (τ́…τ…τ)D	*!			*
e.	H H H (τ́1…τ́1…τ́)D	*!		*	
f.	H H H (τ́…τ́1…τ́1)D	*!		*	
g.	H H H (τ́1…τ́1,2…τ́2)D	*!		*	
h.	H H (τ́1…τ1,2…τ́2)D	*!	**		

	H H (τ…τ́…τ́)D [SM] [REC]	CORR-τFτL	IDENT-τFτL(T)	DEP-IO(H)	MAX-IO(H)
☞ a.	H H (τ1…τ́…τ1)D				*
b.	H H (τ1…τ…τ1)D				**!
c.	H H (τ1,3…τ1,2…τ2,3)D				**!
d.	H H H (τ́1…τ́…τ́1)D			*!	
e.	H H H (τ́1,3…τ́1,2…τ́2,3)D			*!	
f.	H H (τ1…τ́…τ́1)D		*!		
g.	H H (τ…τ́…τ́)D	*!			
h.	H H (τ…τ́1…τ́1)D	*!			

Table 13: Tableaux for $(\acute{\tau}\ldots\tau\ldots\acute{\tau})_D$ and $(\tau\ldots\acute{\tau}\ldots\acute{\tau})_D$ inputs (gray is deleted structure, blue is inserted)

Finally, these same constraints can also account for the alternations in [PERFECT] contexts, in which the alternation is between Ⓗ$^{2\text{-}F}$ and Ⓗ^{2}. Under the morphological account, this would uniformly be exponed as Ⓗ$^{2\text{-}F}$ in all SM types. When first-last tone harmony, it delinks the H from the final TBU. The result is that it only remains on the second TBU.[20]

(66) First-last tone harmony in [PERFECT]

a. / tú-mu-ziik-il-e Ⓗ$^{2\text{-}F}$ /→ tú-mu-zi**ík-íl-é**→ **tú**-mu-zi**ík-íl-é**→ [túmúzìsílé]
'we have buried him/her' [B14:50]

b. / a-mu-ziik-il-e Ⓗ$^{2\text{-}F}$ / → a-mu-zi**ík-íl-é** → **a**-mu-zi**ík-il-e** → [àmùzìsílè]
'he/she has buried him/her' [B07:294]

4.3 Local summary

To summarize, we have compared two ways to account for the grammatical tone allomorphy seen in Cilungu, one morphological, the other phonological. This is summarized in the table below. Under the first account, we appeal to

[20] Two things remain outside of our scope here. First, under this analysis we would still have to account for why the H also delinks from the penultimate TBU (though in most contexts its effect would not be discernable due to general spreading rules). Second, we will not propose a solution under the phonological account for the special Ⓗ^{F}/Ⓗ^{2} alternation in the context of the Recent Past TAM designation /á-cí-...-il-e/.

irregular morphology in the form of contextual realizational rules with multiple stored allomorphs, e.g. different exponents for the tense feature [RECENT] are inserted depending on its environment (e.g. the presence of absence of a high-toned subject marker). In this account, phonology is maximally regular and general, without appeal to morphologically-conditioned statements.

In contrast is the second account, where morphology is maximally regular by having no stored allomorphs inserted based on the context. Instead, it is phonology which is irregular in that it has morphologically-conditioned phonology in the context of subject markers [SM] and [RECENT]/[PERFECT]. We called the rule deriving the surface alternations first-last tone harmony, and formalized it via Agreement by Correspondence with constraints CORR-$\tau_F\tau_L$ requiring correspondence between the first (τ_F) and last (τ_L) TBUs, and IDENT-$\tau_F\tau_L$(T) requiring TBUs in correspondence to have the same tone value. This results in the deletion/delinking of final H tones in these contexts, e.g. mapping an input $(\tau\ldots\acute{\tau}\ldots\acute{\tau})_D$ to an output $(\tau_1\ldots\acute{\tau}\ldots\tau_1)_D$ but leaving intermediate tone structure unaltered.

	Account 1: Interpretation as morphology	**Account 2**: Interpretation as phonology
MORPH.	**Irregular** – Stored allomorphy (suppletion) [RECENT] ↔ á- Ⓗ^{F} / H—τ—[SM] ___ ↔ á- Ø [PERFECT] ↔ -il Ⓗ^{2} / ['just'] ___ ↔ -il Ⓗ$^{2\text{-}F}$ / H—τ—[SM] ___ ↔ -il Ⓗ^{2}	**Regular** – No stored allomorphs [RECENT] ↔ á- Ⓗ^{F} [PERFECT] ↔ -il Ⓗ$^{2\text{-}F}$
PHON.	**Regular** – Phonological rules/constraints are general (i.e. not morphologically-conditioned)	**Irregular** – Morphologically-conditioned phonology, i.e. 'first-last tone harmony' in context of [SM] & [REC]/[PERF]

Table 14: Summary of two accounts

5 Debate: In support of the morphological account

In this section, we will debate the phonological versus morphological account, ultimately supporting the morphological account. This account entails that the Cilungu allomorphy constitutes suppletion, whereby one allomorph cannot be derived from the other, and thus both need to be stored in the lexicon.[21] If the Cilungu patterns are bona fide suppletion, their inclusion has significant implications for morphological theory, which we shall detail in the section following this one. In this section, we establish our criteria for defining suppletion. Although this is notoriously difficult to define theory-neutrally and categorically, we make a serious effort to do so here. We take it as a given that an analysis as suppletion entails storing both allomorphs with distinct underlying representations (Embick 2010:43, Paster 2016, Bermúdez-Otero 2018).

5.1 Defining suppletion

Our starting point is a non-technical characterization of suppletion taken from the Surrey Suppletion Database (Brown *et al*. 2003) as "a morphological phenomenon where different inflectional forms of the same sign are maximally regular in their semantics, yet maximally irregular in form" (equally Mel'čuk 1994, Veselinova 2006, Corbett 2007). Consider a canonical case with English *go*: it has a suppletive past tense form *went*, with which it bears no phonological similarity and is thus "maximally irregular in form". At the same time, *go*/*went* are identical in their semantics as evidence by their interchangeability in idioms, e.g. ***go*** *bananas* vs. ***went*** *bananas* 'act crazy'.

Of this characterization, let us further probe irregularity of form. There are in fact two primary ways this aspect of suppletion has been treated in the literature. Some works emphasize that suppletive forms are phonologically unrelated, distant, or dissimilar (e.g. Carstairs 1990:17, Bobaljik 2012:1, Borer 2013, Vafaeian 2013:114, Bauer 2016:341, Smith et al. 2019:1030), which can be done by directly comparing the phonological strings or other such structure. Other places in the literature emphasize the lack of generalizability of the alternation and/or the

[21] This list is of course called 'vocabulary' in Distributed Morphology, distinct from the repository of morphosyntactic features/feature bundles, and repository for idiosyncratic meaning (the 'encyclopedia'). We use the term 'lexicon' for convenience, it being familiar terminology.

underivability of one morph from the other (e.g. Carstairs 1990:18, Mel'čuk 1994:390, Veselinova 2006:*xv*,47ff., Embick 2010:43, Inkelas 2014:153-154 fn5, Paster 2016:96). These two are distinct criteria (Veselinova 2016:15ff., drawing on Bloomfield 1933), and the most convincing cases of suppletion would show both properties.

Additional criteria come from Kiparsky (1996) and Paster (2006, 2016). We highlight one of them: suppletion should reference morphological locality while morphologically-conditioned phonology should reference phonological locality. For example, Kiparsky argues that German umlaut is a phonological process since it applies only to a vowel local to the triggering suffix:

(67) German umlaut: Obeys phonological locality (Kiparsky 1996:12)

a. *attentat* / 'atən,taːt / 'assassination (attempt)' → *attentät-er* / 'atən,tɛːtɐ / 'assassin' cf. ***ä**ttentat-er*

b. *Europa* / ɔʏ'roːpa / 'Europe' → *Europä-isch* / ɔʏro'pɛːɪʃ / 'European' cf. **Eur**ö**pa-isch*

Morphological suppletion should have no such restriction.

We can group locality under what Paster emphasizes as an important (and underappreciated) criterion: phonological, phonetic, and typological plausibility of a potential rule. If a pattern constitutes suppletion, it should "[not be] obvious how any plausible phonological process could relate the two allomorphs to a single underlying form" (Paster 2006:1). She illustrates this using a familiar example from Dyaabugay [dyy], whereby the genitive suffix is exponed as *-n* after vowels but *-ŋun* after consonants (Patz 1991:269). No rule deleting/inserting the [ŋu] sequence exists which would be phonetically natural, phonologically motivated, or typologically attested. Suppletion is thus the superior analysis.

Taking this all together, we will assess the Cilungu alternations using the following:

(68) Basis for assessing suppletion for Cilungu

a. **Phonological distance of forms**: two forms F_1 and F_2 are suppletive if they exhibit phonological distance past a threshold T, measured with respect to phonological structure

b. **Uniqueness of alternation**: two forms F_1 and F_2 are suppletive if the alternation is not found in comparable morpho-phonological contexts

c. **Phonological naturalness of alternation**: two forms F_1 and F_2 are suppletive if the alternation cannot be derived via a phonologically natural rule, with respect to phonological locality and typological precedence

5.2 Phonological distance of forms

Let us first address the phonological distance between the two allomorphs for [RECENT] and [PERFECT]. These are repeated below (we leave aside the special -il Ⓗ² allomorph of [PERFECT] in the context of /cí-/ 'just').

(69) a. [RECENT] ↔ á- Ⓗ^{F} / H—τ—[SM] ___
↔ á- Ø

b. [PERFECT] ↔ -il Ⓗ$^{2\text{-}F}$ / H—τ—[SM] ___
↔ -il Ⓗ²

In order to examine phonological distance, we require a more complete phonological representation of these allomorphs. This is straightforward for the segmental co-exponents, it is not trivial how to represent the floating grammatical tones, compounded by the fact that they systematically associate to distinct positions within the stem, i.e. Ⓗ$^{2\text{-}F}$ vs. Ⓗ² vs. Ⓗ^{F}.

To this end, we adopt abstract 'phantom structure' representations (Rolle & Lionnet 2020). This is shown in the figures below. In these representations, there are two types of structure. The first is 'substantive structure', i.e. the actual phonological substance of the underlying representation(s), consisting of strings of segments and suprasegments (in white and outlined in black in the representations). For the exponence rule "[RECENT] ↔ á- Ⓗ^{F}", the phonological substance is the high-toned prefix /á-/ and the floating tone Ⓗ. The second is 'phantom structure', in gray with dashed outlined. The substantive structure is pre-specified in its lexical entry with the 'desire' to be linearized with and associated to phantom structure. The phantom structure is not provided by the lexical item itself, but rather is a kind of 'blueprint' of what the output structure should look like if substantive structure is provided by other exponents. For "[RECENT] ↔ á- Ⓗ^{F}", the phantom structure constitutes 'instructions' that the floating high should associate to the final

TBU of the stem if it is incidentally present via other exponence rules. This association is enforced via high-ranked faithfulness constraints to the phantom structure representation.

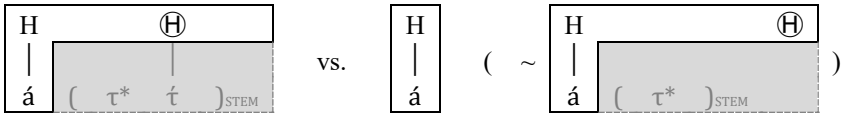


Figure 1: Allomorphs of [RECENT] with phantom structure (in grey)

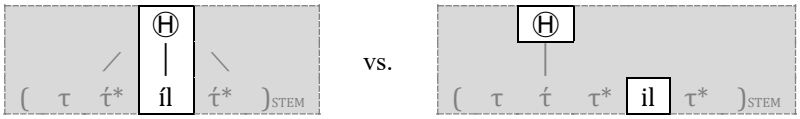


Figure 2: Allomorphs of [PERFECT] with phantom structure (in grey)

We will not discuss the many issues which phantom structure engenders, but use it as a tool for comparing representations.

We can immediately see from these figures that the allomorphs are more similar than they are distinct. With [RECENT], this differs only in the presence or absence of the floating tone Ⓗ. In fact, the alternative representation in parentheses – justified based on evidence from the lack of tone spread (Section 3.1) – is even more similar. There, the difference is that the floating tone cannot dock. A parallel situation is found with [PERFECT] exponence. The actual phonological substance is identical in the two allomorphs: a floating tone Ⓗ and a suffixal sequence /il/. The difference is in the association of the floating tone, i.e. the phantom structure. In the former, the floating tone associates to the second to final TBUs of the stem in the phantom structure, while in the latter it associates only to the second. Thus, with respect to phonological distance, the two forms F_1 and F_2 do not appear to be suppletive (and if so, only weakly).

However, we do not see this as a fatal flaw. Our definition here states that the allomorphic forms compared to each other exhibit phonological distance past a threshold T. This is a difficult criterion to use for suppletion for a number of reasons, keeping the Cilungu representations in mind. First, the distance will depend on the representation. In our representations, we posit both substantive structure and phantom structure. If only substantive structure is considered, then this is unlikely to be considered suppletion: the forms are essentially identical. If however phantom structure is considered as well, then this falls more in favor of suppletion. Further, if one were to posit sequences of floating Ⓗ and Ⓛ tones to account for non-local association – e.g. /il Ⓗ^{2}/ rather as /Ⓛ Ⓗ Ⓛ il Ⓛ/ or something equivalent – this would impact the degree of distance between morphs, again tipping the scales towards suppletion.

Second, it is not at all clear what this threshold T should be, or how it could be applied consistently within a single language, let alone cross-linguistically. This has spawned the strong vs. weak suppletion distinction (Dressler 1985), and a general approach to suppletion whereby allomorphs are gradiently suppletive with respect to one another. We fully recognize this history viewing suppletion as a cline with non-categorical canonical approaches to defining it (Corbett 2007). However, in order to test predictions of morphological theories which suppletion bears on, we need a way to include and exclude potential cases.

5.3 Uniqueness of alternation

To this end, we will focus on criteria which allow a clearer distinction of suppletion from non-suppletion. The first is uniqueness of alternation, whereby two forms are considered suppletive if the alternation is not found in comparable morpho-phonological contexts. This is indeed the case for Cilungu, supporting the suppletion analysis.

Recall that two core properties of the allomorphy patterns was that it involved a bounded trigger and a bounded target. It is the phonological identity of SMs and only SMs which trigger allomorphy, and it is the grammatical tone of certain TAMs and only these TAMs which are the target of allomorphy. We saw explicitly that other comparable morphs do not trigger the allomorphy – e.g. high-toned relative clause markers in word-initial position (20) – and that other comparable TAMs do not undergo it – e.g. the Potential TAM designation /^{Ø} ngá-...-a Ⓗ^{F}/, the Far Past /a-...-il-e Ⓗ$^{2\text{-}F}$/, among others (Section 3.4).

The boundedness of this operation in Cilungu crucially makes it distinct from morphologically-conditioned phonology, numerous cases of which are documented in Inkelas (2014). Consider the case of the Mayan language Mam (England 1983, Willard 2004). Mam contrasts short vs. long vowels. Some suffixes do not alter the length of

the stem to which they attach (classified as 'recessive' by Willard), e.g. the instrumental suffix /-b'il/ in (a.) below. In contrast, another set of suffixes systematically shorten preceding long vowels ('dominant' in Willard), e.g. /-na/ an adjectival participle (b.).

	Input		Output
a.	/ luk-b'il /	→	[luk-b'il]
	pull.up-INSTRUMENTAL		'instrument for pulling up'
	/ ooq-b'il /	→	[ooq-b'il]
	cry-INSTRUMENTAL		'something which causes crying'
b.	/ tooq-na /	→	[**toq**-na]
	break-PARTICIPLE		'broken'
	/ yuup-na /	→	[**yup**-na]
	put.out.fire-PARTICIPLE		'put out'
	/ nooj-na /	→	[**noj**-na]
	fill-PARTICIPLE		'full'

Table 15: Example of morphologically-conditioned phonology in Mam

The number of suffixes which trigger vowel shortening is limited, and hence we can consider the trigger (or trigger set) as bounded, as we do in the Cilungu case. Crucially, the target is not bounded. England divides affixes into productive/non-productive and classifies /-na/ as productive (p. 126), and Willard explicitly notes that "this is an extremely productive suffix" (p. 10). While morphological productivity should not be treated as synonymous with the unboundedness of the morpho-phonological operation, they appear to be co-extensive in this case.[22]

Vowel shortening constitutes morphologically-conditioned phonology because its application in this context cannot be attributed to any regular phonological rule of Mam. However, within the context of the trigger /-na/, it is a regular process as we expect from any phonological operation. Such regularity is not a quirk of Mam. Rather, the bulk of cases in Inkelas (2014) as in many other works illustrate that the target by default is not bounded.[23] If the Cilungu grammatical tone alternations were morphologically-conditioned phonology, we would expect it to apply in a much larger set of contexts than the bounded set of those TAMs involving [RECENT] /á-/ and [PERFECT] /-il/. That this is not the case supports suppletion.[24]

5.4 Phonological naturalness of alternation

The best evidence for the suppletion view comes from the final criterion, often not addressed in the literature: the phonological naturalness of the alternation. Logically speaking, if an alternation does not constitute suppletion – i.e. stored allomorphs with distinct underlying representations – then it must be derived via some phonological rule, whether morphologically conditioned or not. With respect to Cilungu, we are debating between suppletive allomorphs versus the morphologically-conditioned phonological rule first-last tone harmony. As Paster (2016) aptly points out, this requires us to assess "the plausibility of the proposed rule" which serves as the alternative to suppletion, embedded within "a commitment to some formal model for which it is clear what constitutes an allowable operation, trigger,

[22] For example, something may be morphologically productive but no longer trigger the application of a morpho-phonological process, e.g. adding *-ian* to roots in English is quite productive but concomitant application of phonological changes is not (compare *Christ-ian* to *Faust-ian*).

[23] We do not wish to claim that all cases of purported morphologically-conditioned phonology fits neatly into the bounded/unbounded target distinction. Inkelas (2014:19, citing DuBois 1985) in fact cites another Mayan language Sacapultec in which "some nouns undergo final-syllable vowel lengthening in combination with possessive prefixes" (e.g. ts'eˀ 'dog' → ni-ts'i:ˀ 'my dog'), while others do not (e.g. weʔ 'head hair' → ni-weʔ 'my head hair'). A very large literature has evolved in the past decades around this issue, which we will not recap here. We maintain that regardless, the Cilungu patterns instantiate a bounded target.

[24] Relatedly, we agree with the mounting criticism of 'readjustment rules' (Bermúdez-Otero 2012:79ff., Merchant 2015:282, Haugen & Siddiqi 2016:349ff., Paster 2016:110ff., *etc.*), which constitute a DM variation on morphologically-conditioned phonology with a bounded target (set) and bounded trigger. A common example is the change *sing* → *sang*, where the trigger is bounded ([PAST]) and so is the target (a handful of irregular roots).

target, and so forth, so that the plausibility of a rule can be assessed" (p. 113). To that end, we assess the phonological naturalness of first-last tone harmony along three dimensions: typological precedence, learnability in a laboratory setting, and computational complexity.

First, we expect a phonological rule which is morphologically-conditioned to also be attested in some grammar where it is general and not morphologically-conditioned. In our experience of tone systems we know of no established tonological rule of this type in any language. Nothing resembles this in any of the surveys of tone (Pike 1948, Fromkin 1978, Yip 2002, Hyman 2011, Wee 2019), or in common historical changes affecting tones (Hyman & Schuh 1974, Hyman 2007). Within the Bantu tone literature, a recent volume of approximately 20 languages, the only patterns mentioned which resemble first/last harmony are in Kikamba [kam] (Odden & Bickmore 2014:11). In a minority of contexts but systematically, the final vowel of the verb has the same tone value as the subject marker, either high or low. TAM designations include the Hodiernal Perfective and Stative (Assertive (nonfinal) and Relative, but not Object-Focus), the Immediate Past, *inter alia* (Roberts-Kohno 2000, 2014, Jones & Freyer 2019). An example is below as represented in Jones & Freyer (2019:186). The SM is in bold (tó-/o-) which the final vowel 'harmonizes' with. Notice like in Cilungu that the tone of a preceding suffix at the left edge does not disrupt the harmony, nor any intervening tones.

(70) Kikamba hodiernal perfective [as represented in Jones & Freyer 2019:186]

a. né-**tó**-[kon-ááng-i-**é**]$_{\text{STEM}}$ 'we hit (today)'

b. nó-**o**-[kon-ááng-í-**è**]$_{\text{STEM}}$ 'he hit (today)'

While we do not take a position on Kikamba, we remark that there is a parallel debate whether to treat this as morphology or phonology. Roberts-Kohno (2014) proposes a morphological account, with a grammatical tone melody /Ⓗ^{2} Ⓛ$^{\text{PEN}}$ Ⓗ$^{\text{F}}$/ for (a.) with H-toned SM (represented using the conventions of this paper), but /Ⓗ^{2} Ⓛ$^{\text{F}}$/ for (b.). This essentially involves two distinct inputs and as such constitutes suppletion. In response, Jones & Freyer (2019) provide a phonological account, involving a rule 'final lowering' which is morphologically-conditioned, applying in forms "with 3rd singular personal subject agreement" (p. 186), also requiring the specific TAM environments list above. Like in Cilungu, 3rd singular systematically differs from other subject markers in tone. Under this phonological account, Jones & Freyer posit uniform tonal exponence for these TAMs in all contexts, /Ⓗ^{2} Ⓗ$^{\text{F}}$/ (p. 188). That this is probably the best case of possible first-last tone harmony speaks to it being a typological anomaly.[25]

Second, a number of experiments have been conducted using artificial language designs to probe the learnability of first/last harmony rules, for the most part showing participants are unsuccessful. The most detailed studies are found in Lai (2012, 2015), albeit not studying tone. This involved testing 'Sibilant Harmony' (an attested pattern) in which all sibilants in a word must be identical ([s…s…s], [ʃ…ʃ…ʃ], *[s…s…ʃ]), versus 'First-Last Assimilation' where the first and last sibilants must be identical, but intervening sibilants can be of any type ([s…ʃ…s], [ʃ…s…ʃ], *[ʃ…s…s]). The results matched the predictions given its unattestedness: "Intensive First-Last participants definitely failed to internalize the First-Last Assimilation grammar that was intended in this study", showing that "First-Last Assimilation is harder to learn than Sibilant Harmony" (Lai 2015:445). A recent experiment following up Lai's study is in Avcu & Hestvik (2020), which largely replicated Lai's findings though not entirely. Although they observed "a residual sensitivity to the [First-Last Assimilation] rule in the [First-Last] and [Intensive First-Last] groups, which contradicts Lai's previous conclusion" (p. 15), in fact they interpret this as an artifact of the laboratory learning situation rather than reflecting linguistic-specific learnability.

Further, Finley (2012) conducted a similar experiment which trained participants on 'first-last consonant harmony', but under two conditions quite different from the others (as summarized succinctly in Finley 2017). One pattern was either 'morphemic' which "mark[ed] a distinction between singular and plural" (e.g., **k**ida**t** (sg.) vs. **g**ida**d** (pl.), **t**opa**k** vs. **d**opa**g**, *etc*.), or was a general 'phonological' rule "not marking any morphological category" (Finley 2017:9). Participants failed to learn any phonological rule, but were able to learn the morphemic pattern. While this opens the door to the possibility that the Cilungu patterns are similarly 'morphemic' and thus learnable, we stress a

[25] In what follows, all of the literature which we cite regarding learnability in a laboratory setting and computational complexity also accept a strong or weak form this typological finding. For example, Heinz (2018:144): "there are no known phonotactic patterns where the last sound in a word depends in some fashion on its first sound".

difference: in Finley's experiment the harmony was co-extensive with a single morphological dimension (singular/plural), while in Cilungu the harmony is between two distinct morphs with distinct morphological dimensions (subject agreement vs. tense/aspect). The tone harmony in Cilungu does not co-vary with any particular meaning.

Thus far, first-last tone harmony is both not clearly attested and not easily learnable. Let us tie this to the third dimension assessing phonological naturalness: computational complexity. As the experimental works above explicitly point out, there is a principled reason why such a pattern is phonologically unnatural, namely that its computational properties exceed that of natural phonological patterns. This is assessed against what is known as the Chomsky Hierarchy (Chomsky 1956, *inter alia*), which demarcates linguistic patterns into nested regions of complexity (Heinz & Idsardi 2013:113). Typologically-known phonological patterns belong within what is called the 'regular class' in this hierarchy (Kaplan & Kay 1994), a restriction has been called the 'regular hypothesis' in Heinz (2018). Examples include common phonotactic restrictions, e.g. allowing neologisms *plast* but not **ptak* (Heinz 2018, citing Halle 1978).

However, even within the large regular class, not all sub-regular patterns are attested. As characterized by Lai (2015:426), first-last harmony (whether segmental or tonal) falls outside of possible sub-regular patterning (it is "non–Strictly Local, non–Strictly Piecewise, and non–Tier-Based Strictly Local pattern")[26], a position which has emerged as a consensus amongst practitioners (Heinz & Rogers 2010, Heinz & Idsardi 2013, Lai 2015, Graf 2017, 2018, Heinz 2018). To quote Heinz & Idsardi (2013:119), "even if humans were exposed to words conforming to this pattern, they would fail to detect it, as it lies outside the hypothesis spaces of humans' phonological 'pattern detectors' ".

Let us show how such first-last tone harmony would be different, drawing from Jardine (2020). In Karanga Shona (Odden 1984, Odden 2014), non-assertive verb stems are limited to a two-way H-toned vs. L-toned contrast whose surface pattern is predictable based on the number of TBUs, repeated below:

(71)	Karanga Shona	1σ	2σ	3σ	4σ	5σ	6σ	7σ
a.	H-toned roots	H	HL	HLH	HHLH	HHHLH	HHHLLH	HHHLLLH
b.	L-toned roots	-	LH	LHL	LHHL	LHHLL	LHHLLL	LHHLLLL

Notice that the 3-7σ stems superficially show a first-last pattern, as both positions are tonally identical. As Jardine shows, the Karanga Shona patterns can be analyzed in strictly local terms using contiguous forbidden substrings, e.g. forbidden melody set {#HL#, HLHL, LHLH}. These state for example that that if a string begins with the toneme H it cannot be immediately followed by L at the end of the word. By using these melody constraints (in conjunction with another set of constraints involving TBUs), the surface patterns emerge as the only permissible types, without involving any long-distance first/last harmony.

In short, admissible tonal restrictions involve bans on contiguous spans of tonemes and/or tone-valued TBUs, which always constitute a finite set. This can be contrasted this with hypothetical first-last harmony constraints, which would be of the shape *H…L and *L…H. Because this is not a contiguous string, it constitutes a non-local constraint, which we highlighted above with respect to the Cilungu patterns. Jardine emphasizes that this is problematic in that it cannot be expressed via a finite set of forbidden substring constraints, as the "melodies of these can strings can be arbitrarily long…: mldy(HLHL) = HLHL, mldy(HLHLHL) = HLHLHL, mldy(HLHLHLHL) = HLHLHLHL, ad infinitum". By directly capturing a phonologically non-local interaction with a non-local constraint drastically increases the power of the phonological module, consequently lessening its restrictiveness.

5.5 Local summary

In this section, we debated the two proposed accounts, one phonological the other morphological, ultimately supporting the latter. This account entails that the Cilungu allomorphy constitutes suppletion, whereby one allomorph cannot be derived from the other and both need to be stored in the lexicon. We discussed three criteria for assessing suppletion in Cilungu: the phonological distance of the allomorph forms, the uniqueness of the alternation in the language, and the phonological naturalness of the alternation.

[26] Technically speaking, it constitutes a 'Locally Testable' pattern within the sub-regular space (Heinz 2018:146).

From the first criterion, the Cilungu allomorphs do not appear to be phonologically distant. However, we emphasized the subjectivity of this criterion, thus making it impossible to decide which cases constitute suppletion and which do not. We thus focus on the latter two criteria. We showed that the alternation was unique to this context, conceptualizing this as involving a bounded trigger (the phonological identity of SMs) and a bounded target (the grammatical tone of certain TAMs). This is unlike canonical cases of morphologically-conditioned phonology in which the alternation is specific to single trigger (or set), but not bounded with respect to potential targets.

Moreover, we concluded that the best evidence for suppletion is that the alternative phonological rule of first-last tone harmony is not a phonologically natural rule. We based this on three arguments. First, there is virtually no typological precedence for such a rule, whether general or morphologically-conditioned. Second, we referenced a number of artificial language experiments designed to probe the learnability of first/last rules, showing that for the most part participants were unsuccessful at doing so. Third, there is a principled reason for its absence: such a rule would involve computational complexity which would be outside of the known range of phonological patterns (e.g. Heinz 2018). We highlighted recent work in Jardine (2020) who concludes that admissible tonal restrictions involve bans only on contiguous spans of tonemes and/or tone-valued TBUs, as these always constitute a finite set; first-last tone harmony would not. Taken all together, suppletion emerges as the superior analysis.

6 Implication: Outward-looking phonologically-conditioned allomorphy is possible

If we accept that the Cilungu grammatical tone alternation constitutes suppletion as we have concluded, what are the implications of this for morphological theory? We will examine this from one issue in developing a restrictive model of suppletion, namely that of directionality between the trigger and target or allomorphy.

6.1 Directionality in phonologically-conditioned allomorphy (PCA)

One important issue which Cilungu touches upon is the interaction of phonologically-conditioned (suppletive) allomorphy (hereafter, PCA) and directionality. Allomorphy constitutes PCA if part of the conditioning environment includes phonological substance. Cilungu grammatical tone allomorphy (the target) constitutes PCA because it must reference the tonal value of the subject marker (the trigger). Directionality is an issue across models of morphology (Carstairs-McCarthy 1987), and it has in particular played a pronounced role in Distributed Morphology (Bobaljik 2000, 2012, Embick 2010, 2015). Directionality involves the relative position of the trigger of allomorphy and its target oriented with respect to the morphological head. Consider the word *programmers* and the prepositional construction *at a party* in English. The head of these is *program* and *party*, respectively.

(72) Directionality relations

a. *programmers*
[[pɹogɹæm] əɹ] z
[[NOUN] AGENTIVE] PLURAL

b. *at a party*
æt [ə [pɑɹti]]
PREPOSITION [ARTICLE [NOUN]]

Relative to the head, we can say that agentive /əɹ/ is inward compared to more outward plural /z/. Equally, the preposition /æt/ is outward compared to the more inward article /ə/. The head by definition is most inward.

The intersection of PCA and directionality with allomorphy can be illustrated with a familiar example. English has two allomorphs for the indefinite article, *a* used before consonants and *an* before vowels. This illustrates the most common type of directionality relation, namely 'inward-looking PCA' (also known as 'inwards-sensitive'/'inwards-sensitivity' – Carstairs-McCarthy 1987). Consider the example below.

(73) Inward-looking PCA:

Target	**Trigger**		Target	**Trigger**
a	**p**arty	vs.	an	**e**vent

In this example, the trigger (bold, underlined) is a phonological property of the inner element. In contrast, the target (boxed) is outward compared to the indefinite article. This is inward-looking in that what conditions allomorphy is an inward property.

Much more contentious is its counterpart: '**outward-looking PCA'** ('outwards-sensitivity'). A hypothetical toy example based on English is sketched below, involving a prepositional construction akin to English *at a party* above. The hypothetical allomorphs are *a* and *na*, conditioned by the preceding segment.

(74) Hypothetical outward-looking PCA:

Trigger	Target			**Trigger**	Target			
a**t**	a	party	vs.	t**o**	na	party		

Here, the trigger is a phonological property of the outer element (the preposition) and the target is an inner element (the article). Prepositions which end in consonants (*at, with, in, during*) would condition one allomorph (hypothetical *a*), while those which end in a vowel (*to, by, below, via*) would condition another (hypothetical *na*). In this case, the target is outward-looking in that it is a phonological property of an outer element which conditions the allomorphy.[27]

Is outward-looking PCA possible in language? There are several places in the morphology literature where this has been either directly or indirectly debated, which we can divide into two camps. The first is one which maintains that outward-looking PCA is not empirically attested and almost always frames its absence as a natural consequence of the architecture of grammar (rather than an accidental gap, or due to some other factors). Paster (2009) presents a typological survey of 137 instances of PCA, and finds that "135 indisputably have 'inside-out' conditioning" (see also Paster 2006, 2015). Work within Distributed Morphology (DM) predominantly adopts the position that outward-looking PCA is impossible, e.g. Bobaljik (2000), Embick (2010, 2015), Arregi et al. (2013), among others. Within DM, this proposed empirical gap is insightfully linked to the procedure of exponence itself: terminal nodes in the syntax are spelled out cyclically from the most deeply embedded node, moving outward. Inner vocabulary items (essentially exponents) are exponed earlier, and as such would have no access to the phonological features of outer vocabulary items.[28] We call this position 'unidirectional PCA'.

A second camp is composed of work proposing examples of outward-looking PCA. No work within this camp seeks to refute the clear markedness of outward-looking PCA, only that it is rare rather than impossible. Works that can be included this camp include Hannahs & Tallerman (2006), Anderson (2008), Wolf (2008, 2013, 2015), Svenonius (2012), and Deal & Wolf (2017).[29] Given the empirical bent of this camp, the theoretical architecture which allows outward-looking PCA is less articulated, though several proposals have been made which loosen but do not eliminate PCA restrictions altogether, e.g. PCA is strictly phase-bound and phases are strictly exponed inside-out (Deal & Wolf 2017). We refer to this latter camp as supporting some version of 'bidirectional PCA', with no restrictions on triggers and targets.

6.2 Determining directionality in the Cilungu case

In our morphological analysis, Cilungu grammatical tone alternations constitute (suppletive) allomorphy, whereby the trigger is the subject marker and the target are a subclass of TAM morphs (/á-/ and /-il/). In order to assess directionality, we must establish our assumptions on the underlying morphosyntactic structure. To begin, let us repeat the verbal template in Cilungu (and most of Bantu):

[27] This hypothetical toy example resembles Welsh definite article allomorphy (see Hannahs & Tallerman 2006).

[28] For example, Bobaljik (2000:14) concludes that outward sensitivity in allomorphy should be possible, "but only conditioned by those features that are relevant to the syntactic computation", entailing that anything "not a part of the syntactic computation" – such as phonological features inserted via an exponence operation (in DM, vocabulary insertion) or morpho-phonological diacritics, such as conjugation class – "can only serve as the context for allomorphy of a more peripheral affix".

[29] A number of cases have been mentioned in the literature without directly connecting them to outward-looking PCA, such as Fula (Carstairs-McCarthy 1987:185-186, citing Arnott 1970:219,224-225) and Ndyuka (Bye 2007:77, citing Huttar 1996). In Ndyuka the transitive marker varies between *-mi* and ∅ depending on the tone and vowel of the verb to which it attaches to its left, as well as whether the following object is monosyllabic or not to its right.

(75) Verbal template of Cilungu

[$_{V}$ **SM** (NEG) **TAM** [$_{MS}$ (OM) [$_{STEM}$ **ROOT** (DERIV) **TAM FV**]]]

(V =verb , SM = subject marker , TAM = tense/aspect/mood , MS= macro-stem , OM = object marker , NEG = negative , DERIV = derivational suffixes, FV = final vowel)

Our task is to determine the relevant position of SM and TAM positions. As reflected in the bracketing in this template, the consensus within Bantu literature which posits hierarchical structure is that prefixes are treated as further away from the verbal root than suffixes (e.g. Downing 1999, Nurse 2008, and literature cited therein). Across Bantu, the constituency of the inflected stem is evidenced by it being "the domain of nasal harmony, reduplication, and vowel coalescence" (Nurse 2008:14), among other phenomena. As we have seen in Cilungu, evidence for the stem comes from grammatical tone.

These hierarchical relations and their linear reflexes are formalized in the generative syntactic work on Bantu by positing a verb root and a series of higher functional heads which express verbal grammatical categories, e.g. tense, aspect, mood, polarity, etc. Suffixes reflect head movement of the root to an intermediate head, while all higher heads are spelled out as prefixes. For example, in her summary of the Bantu literature Pietraszko (2018:305) notes that “it is typically assumed that the verb in Bantu languages does not move all the way to [Tense] T, but that it stops in a lower position—the head hosting the final suffix”, citing Julien (2002:196), Buell (2005), Harford (2008), and Cheng & Downing (2012). An earlier analogous Bantu-wide statement is in Van der Wal (2008:333), who notes that verb movement “terminates in a functional projection lower than T”, and that higher inflectional prefixes “represent functional heads spelled out in their base positions”, additionally citing Myers (1990) and Carstens (2005) in support.

An example of such a structure is from Makhuwa-Enahara below (Van der Wal 2009). Polarity (NEG), agreement (1PL), and tense (PRES) are spelled out as prefixes because the root does not head-move past the intermediate aspect head.

(76) Makhuwa [Van der Wal 2009:168]

kha-ni-ń-lówa ehópa

NEG-1PL-PRES-fish.DJ 9.fish

‘we don’t catch fish’

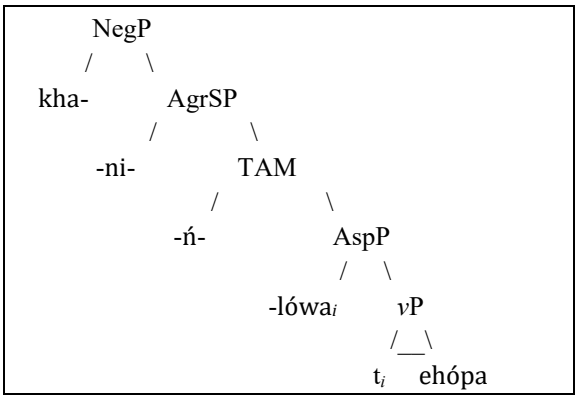


Figure 3: Bantu verbal syntax [Makhuwa – van der Wal 2009]

Schematically, the mapping from syntactic structure to morphological constituency can be captured as follows:

(77) [$_{XP}$ X° [$_{YP}$ Z°$_i$+Y° [$_{ZP}$ ~~Z°~~$_i$]]] → PREFIX$_X$-[ROOT$_Z$-SUFFIX$_Y$]

In this way, notions of 'inward' and 'outward' in the post-syntactic and linearized morphological structure derived from notions of 'upward' and 'downward' in a syntactic hierarchy (ideas related to the Mirror Principle and other familiar proposals in the generative literature – Baker 1985).

With respect to Cilungu, we can assume the basics of this syntactic structure, with two modifications: reverse the positions of AgrSP and NegP, and assume TAM is a tense position, TP. As in this Makhuwa tree, the verb moves to

Asp but does not move past it, which entails that AgrP and TP are higher than AspP. Such hierarchical structure is well-supported from the conclusions in several linguistic schools. For example, subject agreement being outside of T is well-supported in the typological literature (Bybee 1985:35) as well as the generative literature (Chomsky 1989:68ff.; Belletti 1990; Speas 1991:183ff; Harford 2008), and cross-linguistically tense predominantly scopes over aspect (Cinque 2014). Additional grammatical categories can be introduced in the functional field of the verb where evidence warrants (e.g. speech act mood, polarity, or other aspectual categories), though these do not interact with the relevant patterns in this paper.

Let us now return to the relevant exponence rules:

(78)

a. [T:RECENT] ↔ á- Ⓗ^{F} / H—τ—[SM] ___

b. [ASP:PERFECT] ↔ -il Ⓗ$^{2\text{-}F}$ / H—τ—[SM] ___

The subject markers are the triggers and are exponents of Agreement (outer), while the recent and perfect morphs are the targets and are exponents of Tense and Aspect (inner). In total, agreement is structurally higher in the syntactic tree and as such its exponents are linearly more peripheral. Because the trigger is outward compared to the target, and a phonological property of the trigger is part of the conditioning environment, this thus constitutes outward-looking phonologically-conditioned (suppletive) allomorphy.[30]

One point of clarity is required, namely the realization of tense and of aspect here involve two separate co-exponents. How should directionality be assessed in such cases: together or individually? In the Cilungu case, the two co-exponents share the same relative directionality. The segmental components of T/Asp are straightforwardly inward compared to SMs. We also take the tonal components to be inward given that they target an inner constituent, namely the stem. It may be the case that other allomorphy systems show mixed directionality between co-exponents.

6.3 Simultaneous exponence

If Cilungu constitutes outward-looking PCA, then we can add this to the growing list of counter-examples to the unidirectional PCA hypothesis. If the insertion of allomorphs can be conditioned both by the phonological structure of inner and outer morphs (even if rarely), what implications does this have for morphological theory?

As stated, the DM literature assumes that "rules of Vocabulary Insertion apply at each terminal node in the tree, proceeding cyclically from the most deeply embedded node upwards/outwards" (Gouskova & Bobaljik 2019). An alternative is that exponence still takes place one rule at a time, but that the order may not necessarily reflect linear order (Myler 2017, Kalin 2020) or hierarchical structure (Deal & Wolf 2017). An alternative to all these is that all exponence takes place simultaneously, within the relevant domain, whether this is phonologically-defined (e.g. an utterance) or syntactically-defined (e.g. a phase). We take the Cilungu data as supporting 'simultaneous exponence'.

This is a significant departure from the commonly assumed inside-out cyclicity of exponence, but one which we see as necessary. It has already been proposed in the literature that insertion is not restricted to one terminal at a time

[30] There are obviously many other syntactic issues here, which we do not discuss. One is the syntactic category correspondening to the final vowel, which we assumed was a verbal head *v* in section 4.1, following (Pietraszko 2018). Another is how the linear order of suffixes in the Bantu verb derived? The syntactic order of heads is Asp > *v* > Root, and the linear order of corresponding exponents is [...ROOT-ASP-V]. Can this be derived strictly via cyclic head movement (or cyclic lowering)? Or is some other mechanism additionally necessary, such as morphotactics which rearrange morphs according to language-specific principles, e.g. the CARP template (Causative-Applicative-Reciprocal-Passive morph order – Hyman 2003).

One other important morphosyntactic issue is whether subject agreement constitutes a separate projection in verbal syntax, i.e. whether it heads an AgrP. Under Pietraszko (2018), a phi-feature bundle [φ] (exponed as subject markers) falls under the highest head of the projection, e.g. Tense (T). A fission rule splits off the φ-node from its head H (i.e. [H, φ]→[[φ] [H]]), after which φ appears as an adjunct to the head T. This structure is also achieved via the insertion of 'ornamental' morphology, quite common within DM analyses (Embick & Noyer 2007, Kramer 2010, Norris 2014, Embick 2015:65, Harizanov 2018, *inter alia*). Under this approach, it becomes non-trivial how to assess inward and outward relations, given that the two heads of the complex head do not originate at syntactic locations which are clearly asymmetrical (unlike with AgrSP, which dominates TP).

contra standard DM assumptions, but may target larger constituents, e.g. Nanosyntactic approaches (Starke 2009, Caha 2009, Svenonius 2016, *inter alia*). Under Nanosyntactic 'spanning', if the exponence procedure is able to expone multiple syntactic heads at once – even heads which are not structurally local, e.g. post-linearization spanning for bracketing paradoxes like *re-written* (Haugen & Siddiqi 2016) – then it follows that a prerequisite is access to multiple heads simultaneously. If access is granted, then it is a short move to allow these multiple heads to either be exponed as one unit (many-to-one exponence), or be exponed as multiple units (many-to-many exponence). The latter is simultaneous exponence.

Finally, as sketched by Deal & Wolf (2017), simultaneous exponence makes distinct predictions from the one-at-a-time serial exponence normally adopted. Framing simultaneous exponence under Stratal OT, they state that "if the Stratal OT analysis is correct, we expect to find cases where allomorphic selection for two adjacent morphemes is resolved in a way that involves mutual phonological dependence" (p. 57). Thus, simultaneous exponence uniquely predicts that exponents can mutually trigger PCA on one another. Serial exponence predicts this to be impossible. In Appendix 3, we present data which may be interpreted as reciprocal PCA, but a weaker version: the phonological properties of SMs can condition allomorphs and T, and the phonological properties of T can condition an allomorph of a SM in at least one instance.

7 Conclusion

This paper has proposed a case of outward-looking phonologically-conditioned (suppletive) allomorphy, whereby the trigger of allomorphy is a phonological property of some *outer* morph within the relevant domain. In Cilungu, with tense /á-/ RECENT and aspect /-il/ PERFECT, their co-exponed grammatical tone (the target) show several allomorphic patterns conditioned by the tone of the subject agreement markers which appear before tense and aspect at the left edge of the verbal word (the trigger). We demonstrated that this alternation cannot be reduced to a natural phonological operation (hypothetical first-last tone harmony), and concluded that it suppletion. This constitutes outward-looking PCA in that a phonological property of outwardly-located subject markers trigger allomorphy on three inwardly-located TAM designations.

These data are important for several reasons. First, they falsify the claim made explicit in several morphological models that PCA is only sensitive to inward phonological properties, e.g. Paster (2006, 2009, 2015) and throughout Distributed Morphology (Bobaljik 2000, Embick 2010, 2015, Arregi et al. 2013, *inter alia*), and support a bidirectional PCA hypothesis. Second, these uncontroversially show surface non-local effects between tonal exponents, regardless of analysis. The tone of the SM at the left-edge conditions tonal effects at the right edge, even when there is intervening tonal structure. Third, even if we are ultimately wrong (and a phonological analysis is advacoted instead), this still has major ramifications for what kinds of phonological operations are allowed in human language.

We conclude with a few remarks to the morphological community who may read and build on this work. One is that if we accept outward-looking PCA as empirically attested, how can we restrict our theories to not overgenerate unattested (but diachronically plausible) allomorphy cases? This then relates to a very pressing question: why is outward-looking PCA so rare? If attempts fail to localize its rarity/non-existence to factors of Universal Grammar, then what are the usage-based, diachronic, or cognitive pressures which counteract its development? Finally, a major hope of this research is to encourage closer examination of grammatical tone systems, which proliferate across linguistically-rich areas such as sub-Saharan Africa. Many of these languages demonstrate complex, nuanced, and consistent patterns, collected by careful fieldwork and textual analysis. We have no doubt that many of these are well-described enough at the present moment to be valuable for testing morphological hypotheses.

8 References

Anderson, Stephen. 2008. Phonologically conditioned allomorphy in the morphology of Surmiran (Rumantsch). Word Structure 1(2): 109–134.

Anttila, Arto. 1997. Deriving variation from grammar. In *Variation, Change and Phonological Theory*, Frans Hinskens, Roeland Van Hout, and W. Leo Wetzels (eds.), 35–68. Amsterdam: John Benjamins.

Anttila, Arto. 2002. Morphologically conditioned phonological alternations. *Natural Language & Linguistic Theory* 20, 1–42.

Arnott, David W. 1970. *The nominal and verbal system of Fula*. Clarendon Press.

Arregi, Karlos, Neil Myler, & Bert Vaux. 2013. Number marking in Western Armenian: a non-argument for outwardly-sensitive phonologically conditioned allomorphy. In 87th Linguistic Society of America Annual Meeting, Boston.
Avcu, Enes & Arild Hestvik 2020. Unlearnable phonotactics. Glossa: a journal of general linguistics 5(1): 56. 1–22.
Baker, Mark. 1985. The mirror principle and morphosyntactic explanation. *Linguistic inquiry* 16(3): 373-415.
Bauer, Laurie. 2016. Classical morphemics: Assumptions, extensions, and alternatives. *The Cambridge handbook of morphology.* 331-355.
Belletti, Adriana. 1990. *Generalized Verb Movement: Aspects of Verb Syntax*. Rosenberg & Sellier.
Bermúdez-Otero, Ricardo. 2008. *Stratal Optimality Theory*. Oxford: Oxford University Press.
Bermúdez-Otero, Ricardo. 2012. The architecture of grammar and the division of labour in exponence. In Jochen Trommer (ed.), *The morphology and phonology of exponence* (Oxford Studies in Theoretical Linguistics 41), 8-83. Oxford: Oxford University Press.
Bermúdez-Otero, Ricardo. 2018. In defense of underlying representations: Latin rhotacism, French liaison, Romanian palatalization. *Probus* 30(2):171-214.
Bickmore, Lee. 2007. *Cilungu Phonology*. Stanford: CSLI Publications.
Bickmore, Lee. 2014. Cilungu Tone Melodies: A Descriptive and Comparative Study. *Africana Linguistica* 20, 39-62.
Bloomfield, Leonard. 1933. *Language*. London: Ruskin House, George Allen & Unwin. (Reprinted in 1962).
Bobaljik, Jonathan David. 2000. The ins and outs of contextual allomorphy. In *University of Maryland working papers in linguistics* 10:35-71.
Bobaljik, Jonathan David. 2012. *Universals in comparative morphology: Suppletion, superlatives, and the structure of words*. Vol. 50. Cambridge, MA.: MIT Press.
Borer, Hagit. 2013. Structuring sense: Volume iii: Taking form. Vol. 3. Oxford: Oxford University Press.
Brown, Dunstan, Marina Chumakina, Greville G. Corbett & Andrew Hippisley. 2003. Surrey Suppletion Database. University of Surrey. http://dx.doi.org/10.15126/SMG.12/1
Buell, L.C. 2005. Issues in Zulu Verbal Morphosyntax. Los Angeles: University of California dissertation.
Bybee, Joan L. 1985. Morphology: A study of the relation between meaning and form Vol. 9. John Benjamins Publishing.
Bye, Patrik. 2007. Allomorphy—selection, not optimization. In *Freedom of Analysis* 63–91.
Caha, Pavel. 2009. The Nanosyntax of Case. Ph.D. dissertation, University of Tromsø.
Carstairs-McCarthy, Andrew. 1987. Allomorphy in inflection. London: Croom Helm.
Carstairs, Andrew. 1990. Phonologically conditioned suppletion. In Dressler (ed.), *Contemporary morphology*. 17-23.
Carstens, Vicki. 2005. Agree and EPP in Bantu. Natural Language & Linguistic Theory 23: 219–279.
Carter, H. 1973. Syntax and Tone in Kongo. London: SOAS.
Cheng, Lisa, & Laura J. Downing. 2012. Against FocusP: Arguments from Zulu. In *Contrasts and positions in Information Structure*, eds. Ivona Kuˇcerová and Ad Neeleman, 247–266. Cambridge: Cambridge University Press.
Chomsky, Noam. 1956. Three models for the description of language. *IRE Transactions on Information Theory* 2: 113–124.
Chomsky, Noam. 1989. Notes on Economy of Derivation. *MIT Working Papers in Linguistics* 10: 53–82.
Cinque, Guglielmo. 2014. Again on Tense, Aspect, Mood Morpheme Order and the 'Mirror Principle'. In *Functional Structure from Top to Toe: The Cartography of Syntactic Structures* 9: 232–265.
Corbett, Greville G. 2007. Canonical Typology, Suppletion, and Possible Words. Language, 83(1):8-42.
Deal, Amy Rose, & Matthew Wolf. 2017. Outward-sensitive phonologically-conditioned allomorphy in Nez Perce. The *Morphosyntax-Phonology Connection: Locality and Directionality at the Interface.* 29–60.
Downing, Laura J. 1999. Prosodic stem =/= prosodic word in Bantu. In Hall and Kleinhenz (eds.), *Studies on the phonological word*. 73–98.
Dressler, W. 1985. Suppletion in Word-Formation. In *Historical Morphology*, J. Fisiak (ed.), 97–112. The Hague: Mouton.
DuBois, John W. 1985. Incipient semanticization of possessive ablaut in Mayan. *International Journal of American Linguistics* 51:396-398.
Embick, David. 2010. *Localism versus Globalism in Morphology and Phonology*. MIT Press.
Embick, David. 2015. *The Morpheme*. Walter de Gruyter.

Embick, David, & Rolf Noyer. 2007. Distributed morphology and the syntax/morphology interface. The Oxford Handbook of Linguistic Interfaces 289324.
England, Nora. 1983. A Grammar of Mam, a Mayan Language. Austin: University of Texas Press.
Finley, Sara. 2012. Learning unattested languages. Proceedings of the Annual Meeting of the Cognitive Science Society. 34.
Finley, Sara. 2017. Locality and harmony: Perspectives from artificial grammar learning." Language and Linguistics Compass 11.1.
Fromkin, Victoria A. 1978. Tone: A linguistic survey. New York: Academic Press.
Gouskova, Maria, & Jonathan David Bobaljik. 2019. Allomorphy and vocabulary insertion. Manuscript under review. New York University and Harvard University. https://www.gouskova.com/wp-content/uploads/2019/06/gouskova_bobaljik_2019.pdf
Graf, Thomas. 2017. The power of locality domains in phonology. *Phonology* 34:385–405.
Graf, Thomas. 2018. Locality domains and phonological c-command over strings. Proceedings of NELS.
Halle, Morris. 1978. Knowledge unlearned and untaught: What speakers know about the sounds of their language. In Linguistic Theory and Psychological Reality. The MIT Press.
Halle, Morris, & Alec Marantz. 1993. Distributed Morphology and the Pieces of Inflection. In *The View from Building 20*. MIT Press.
Hannahs, Stephen J., & Maggie Tallerman. 2006. At the interface: Selection of the Welsh definite article. Linguistics 44(4). 781–816.
Harford, Carolyn. 2008. The Bantu-Romance connection in verb movement and verbal inflectional morphology. In *The Bantu-Romance connection: A comparative investigation of verbal agreement, DPs, and information structure*, eds. Cécile De Cat and Katherine Demuth, 111–128. Amsterdam: Benjamins.
Harizanov, Boris. 2018. Word formation at the syntax-morphology interface: Denominal adjectives in Bulgarian. Linguistic Inquiry 49(2). 283–333.
Haugen, Jason D. 2016. Readjustment: rejected? In Daniel Siddiqi & Heidi Harley (eds.), Morphological metatheory (Linguistics Today 229), 303 – 342. Amsterdam: John Benjamins.
Haugen, Jason D., & Daniel Siddiqi. 2016. Towards a restricted realization theory. Morphological Metatheory 229. 343–386.
Heinz, Jeffrey. 2018. The computational nature of phonological generalizations. In Phonological Typology: Phonetics and Phonology. 126-195.
Heinz, Jeffrey & William Idsardi. 2013. What complexity differences reveal about domains in language. *Topics in Cognitive Science* 5(1). 111–131. DOI: https://doi.org/10.1111/ tops.12000
Heinz, Jeffrey, & J. Rogers. 2010. Estimating strictly piecewise distributions. In Proceedings of the 48th annual meeting of the association for computational linguistics. 886–896. Uppsala, Sweden: Association for Computational Linguistics.
Huttar, George L. 1996. Epenthetic -mi in Ndyuka: A transitive marker? *SIL Electronic Working Papers* 1996-003.
Hyman, Larry M. 2001. Privative tone in Bantu. In Shigeki Kaji (ed.), *Cross-linguistic studies of tonal phenomena*, 237-257. Tokyo: Institute for the Study of Languages and Cultures.
Hyman, Larry M. 2003. Suffix ordering in Bantu: A morphocentric approach. *Yearbook of Morphology 2002*. 245-281.
Hyman, Larry M. 2007. Universals of tone rules: 30 years later. In Typological Studies in Word and Sentence Prosody. Berlin, Boston: De Gruyter Mouton.
Hyman, Larry M. 2011. Tone: Is it different? In *The Blackwell handbook of phonological theory*, eds. John A. Goldsmith, Jason Riggle, and Alan C. L. Yu, 197–238. Hoboken: Wiley-Blackwell.
Hyman, Larry M. 2012. Post-Verbal subject in the Nzadi relative clause. Journal of African Languages and Linguistics 33(1). 97–117.
Hyman, Larry M., Hannah Sande, Florian Lionnet, Nicholas Rolle, & Emily Clem. in press. Prosodic systems: Niger-Congo and adjacent areas. In Carlos Gussenhoven & Aoju Chen (Eds.), *The Oxford Handbook of Language Prosody*. Oxford: OUP.
Hyman, Larry M. & Russell G. Schuh. 1974. Universals of Tone Rules: Evidence from West Africa. Linguistic Inquiry, 5(1):81-115.
Inkelas, Sharon. 1998. The theoretical status of morphologically conditioned phonology: a case study of dominance effects. In Geert Booij & Jaap Van Marle (eds.), Yearbook of Morphology 1997, 121–155. Springer Netherlands.
Inkelas, Sharon. 2014. The interplay of morphology and phonology Vol. 8. Oxford University Press.
Jardine, Adam. 2016. Computationally, tone is different. *Phonology* 33(2): 247–283.

Jardine, Adam. 2020. Melody learning and long-distance phonotactics in tone. *Natural Language & Linguistic Theory*.
Jones, Patrick, & Jake Freyer. 2019. Reconsidering tone and melodies in Kikamba. In Emily Clem, Peter Jenks & Hannah Sande (eds.), *Theory and description in African Linguistics: Selected papers from the 47th Annual Conference on African Linguistics*, 177–198. Berlin: Language Science Press. DOI:10.5281/zenodo.3367138
Julien, Marit. 2002. Syntactic heads and word formation. Oxford: Oxford University Press.
Kalin, Laura. 2020. Morphology before phonology: A case study of Turoyo (Neo-Aramaic). *Morphology,* 30: 135–184.
Kaplan, Ronald, & Martin Kay. 1994. Regular models of phonological rule systems. *Computational Linguistics* 20:331–378.
Kiparsky, Paul. 1982. Lexical morphology and phonology. In I. -S. Yang (ed.), Linguistics in the morning calm. Seoul: Hanshin, 3-91.
Kiparsky, Paul. 1984. A compositional approach to Vedic word accent. Amrtadhara: RN Dandekar Felicitation Volume 201–210.
Kiparsky, Paul. 1996. Allomorphy or morphophonology? In R. Singh (ed.), Trubetzkoy's Orphan: Proceedings of the Montreal Roundtable 'Morphophonology: Contemporary Responses'. Amsterdam: Benjamins, 13–31.
Kiparsky, Paul, & Morris Halle. 1977. Towards a reconstruction of the Indo-European accent. Studies in Stress and Accent 209. 238.
Kramer, Ruth. 2010. The Amharic definite marker and the syntax–morphology interface. Syntax 13(3). 196–240.
Lai, Regine. 2012. Domain Specificity in Learning Phonology. Doctoral dissertation. University of Delaware.
Lai, Regine. 2015. Learnable vs. Unlearnable Harmony Patterns. Linguistic Inquiry, 46(3):425-451.
Meeussen, Achille Emile. 1967. Bantu grammatical reconstructions. *Africana Linguistica AL* 3:79-121.
Meeussen, Achille Emile. 1971. Relative clauses in Bantu. Supplement 2, Studies in African Linguistics, 3–10.
Meeussen, Achille Emile. 2014 [1962]. Tones of the subjunctive and the imperative in Bantu. *Africana Linguistica* 20:15-38. [Translation from original Dutch by Maud Devos]
Mel'čuk, Igor A. 1994. Suppletion: toward a logical analysis of the concept. Studies in Language. 18(2): 339-410.
Menn, Lise, & Brian MacWhinney. 1984. The repeated morph constraint: Toward an explanation. *Language* 60(3):519-541.
Merchant, Jason. 2015. How Much Context Is Enough? Two Cases of Span-Conditioned Stem Allomorphy. Linguistic Inquiry 46(2): 273-303.
Mohanan, K. P. 1986. Lexical phonology. Dordrecht: Kluwer.
Myers, Scott. 1990. Tone and the Structure of Words in Shona. Garland: New York.
Myler, Neil. 2017. Exceptions to the Mirror Principle and morphophonological 'action at a distance'. In The structure of words at the interfaces, ed. Heather Newell, Maire Noonan, Glyne Piggot, and Lisa Travis, 100–125. Oxford University Press.
Norris, Mark. 2014. A theory of nominal concord. UC Santa Cruz dissertation.
Nsuka Nkutsi, F. 1982. *Les structures fondamentales du relatif dans les langues bantoues*. Tervuren: Musée Royal de l'Afrique Centrale.
Nurse, Derek. 2008. Tense and aspect in Bantu. Oxford University Press.
Nurse, Derek, & Philippson, G. 2006. Common tense-aspect markers in Bantu. JALL 27: 153–194.
Odden, David. 1984. Stem tone assignment in Shona. In Autosegmental studies in Bantu tone, eds. G. N. Clements and John A. Goldsmith, 255–280. Dordrecht: Foris Publications.
Odden, David. 2014. "Melodic tones in Karanga Shona." *Africana Linguistica* 20.1 (2014): 331-348.
Odden, David, & Lee Bickmore. 2014. Melodic Tone in Bantu: Overview. *Africana Linguistica* 20: 3–14.
Paster, Mary. 2006. Phonological conditions on affixation. PhD dissertation, University of California, Berkeley.
Paster, Mary. 2009. Explaining phonological conditions on affixation: Evidence from suppletive allomorphy and affix ordering. *Word structure* 2(1):18-37.
Paster, Mary. 2014. Allomorphy. In Rochelle Lieber & Pavel Štekauer (eds.), *The Oxford handbook of derivational morphology*, 219–234. Oxford: Oxford University Press.
Paster, Mary. 2015. Phonologically conditioned suppletive allomorphy: cross-linguistic results and theoretical consequences. In Bonet, E., Lloret, M.-R., and Mascaró, J., editors, *Understanding Allomorphy: Perspectives from Optimality Theory*. 218–253. Equinox, London.
Paster, Mary. 2016. Alternations: Stems and allomorphy. In Andrew Hippisley and Gregory T. Stump, eds. The Cambridge Handbook of Morphology. Cambridge: Cambridge University Press. 93-116.
Pater, Joe. 2000. Nonuniformity in English secondary stress: The role of ranked and lexically specific constraints. *Phonology* 17:237–274.

Pater, Joe. 2007. The Locus of Exceptionality: Morpheme-Specific Phonology as Constraint Indexation. In University of Massachusetts Occacional Papers 32: Papers in Optimality Theory III. Leah Bateman, Michael O'Keefe, Ehren Reilly and Adam Werle (eds.). 259-296.
Patz, Elizabeth. 1991. Djabugay. Pp. 245-347 in Robert M.W. Dixon and Barry J. Blake, eds. The Handbook of Australian Languages 4. Melbourne: Oxford University Press.
Pietraszko, Asia. 2018. Auxiliary vs INFL in Bantu. Natural Language & Linguistic Theory 36(1). 265–308.
Pike, Kenneth L. 1948. *Tone Languages*. Ann Arbor.
Roberts-Kohno, Ruth. 2000. Kikamba phonology and morphology. Ohio State University. Doctoral dissertation.
Roberts-Kohno, Ruth. 2014. Melodic tones in Kikamba. Africana Linguistica 20. 368–384.
Rolle, Nicholas. 2018. Grammatical tone: Typology and theory. UC Berkeley dissertation.
Rolle, Nicholas & Florian Lionnet. 2020. Phantom structure: A representational account of floating tone association. In Hyunah Baek, Chikako Takahashi & Alex Hong-Lun Yeung (eds.), Supplemental Proceedings of the 2019 Annual Meeting on Phonology. Washington, DC: Linguistic Society of America.
Rose, Sharon, & Rachel Walker. 2004. A Typology of Consonant Agreement as Correspondence. Language 80 (3): 475–531.
Shih, Stephanie S., & Sharon Inkelas. 2018. Autosegmental aims in surface-optimizing phonology. *Linguistic Inquiry* 50.1 (2018): 137-196.
Smith, Peter W., Beata Moskal, Ting Xu, Jungmin Kang, and Jonathan David Bobaljik. 2019. Case and number suppletion in pronouns. Natural Language & Linguistic Theory 37(3): 1029-1101.
Speas, Peggy. 1991. Functional Heads and the Mirror Principle. *Lingua* 84(2-3):181–214.
Starke, Michal. 2009. Nanosyntax: A short primer on a new approach to language. In Nanosyntax, Peter Svenonius, Gillian Ramchand, Michal Starke & Knut Tarald Taraldsen (eds). Special issue of Tromsø Working Papers on Language and Linguistics: Nordlyd 36(1): 1–6.
Stump, Gregory T. 2001. Inflectional morphology: A theory of paradigm structure. Vol. 93. Cambridge University Press.
Svenonius, Peter. 2012. Look both ways: Outward-looking allomorphy in Icelandic participles. Ms., University of Tromsø. [LingBuzz/001519].
Svenonius, Peter. 2016. Spans and words. In *Morphological metatheory* (2016): 201-222.
Trommer, Jochen (ed.). 2012. *The morphology and phonology of exponence*. Oxford: Oxford University Press.
Vafaeian, Ghazaleh. 2013. Typology of nominal and adjectival suppletion. *Sprachtypologie und Universalienforschung* 66(2): 112-140.
van der Wal, Jenneke. 2008. Agreement in thetic sentences in Bantu and Romance. In C. De Cat & K. Demuth (eds), *The Bantu-Romance connection: Aa comparative investigation of verbal agreement, DPs, and information structure*, 323-350. Amsterdam/Philadelphia: John Benjamins.
van der Wal, Jenneke. 2009. Word order and information structure in Makhuwa-Enahara. LOT, Utrecht.
Veselinova, Ljuba. 2006. Suppletion in verb paradigms. *Typological Studies in Language* 67 . John Benjamins.
Wee, Lian-Hee. 2019. *Phonological tone*. Cambridge University Press.
Welmers, Wm. E. 1973. African language structures. Berkeley: University of California Press.
Willard, E. Rainbow. 2004. Dominance Effects in a Dialect of Mam Maya. Presentation at the session Syllables, Feet, and Meter, Annual meeting of the Linguistic Society of America. Boston, 9 January, 2004.
Wolf, Matthew. 2008. Optimal interleaving: Serial phonology-morphology interaction in a constraint-based model. Dissertation, University of Massachusetts Amherst.
Wolf, Matthew. 2013. Candidate chains, unfaithful spell-out, and outwards-looking phonologically-conditioned allomorphy. Morphology 23(2). 145–178.
Wolf, Matthew. 2015. Lexical insertion occurs in the phonological component. Understanding Allomorphy: Perspectives from Optimality Theory. London: Equinox Publishing.
Yip, Moira. 2002. Tone. Cambridge University Press.

9 Appendices

9.1 Appendix 1: Special TAM allomorphy with the negative

In Section 3.1 above, we showed that various permutations of clause and verb structure do not affect the allomorphy. As stated there, one context which does affect normal allomorphy is negation. Let us begin by establishing basic facts about verbal negation in Cilungu. In most TAM designations, negative morphology is marked by a prefix /táa-/ (~

/tá-/) NEG that appears after the SM but before TAM prefixes. Before negative prefixes, all SMs become toneless which we notate with a superscript i.e. /ᴓtáa-/.[31]

(79) SMs become toneless before negative /ᴓtáa-/

a. Negative Present Progressive
/ **tú-ᴓtáa**-ku-ful-a / \ **tu-táa**-ku-ful-a \ [**tù**táàkùfùlà]
SM-NEG-TAM-wash-FV 'we are not washing' [B07:184]
Cf. (Affirmative) Present Progressive: / **tú-**ku-ful-a / [**tú**kúfúlà] 'we are washing' [B14:40]

b. Negative Future Progressive
/ **tú-ᴓtá**-la-áa-ziik-a / \ **tu-tá**-la-áa-ziik-a \ [**tù**tálàázííkà]
SM-NEG-TAM-TAM-bury-FV 'we will be burying' [B07:518]
Cf. (Affirmative) Future Progressive: / **tú-**la-áa-ziik-il-a / [**tú**làázííkílà] 'we will be burying for' [B07:247]

This tonal effect from negative prefixes is found across the full range of TAM and SM contexts.

In TAM designations which appear with grammatical tone but show no allomorphy, the negative does not affect the grammatical tone. This is shown in the example below with the non-allomorphic TAM the Potential /ngá-...-a Ⓗ^{F}/. [Note the special short form /tá-/ here; see Bickmore 2007:240 for details.]

(80) Grammatical tone of non-allomorphic TAMs is unaffected in the Negative

a. / tú-ᴓtá-ngá-ziik-a Ⓗ^{F} / \ tu-tá-ngá-ziik-á \ [tùtáángázíìká] 'we cannot bury' [B:239]
b. / tú-ᴓtá-ngá-sópolol-a Ⓗ^{F} / \ tu-tá-ngá-sópolol-á \ [tùtáángásópólòlá] 'we cannot untie' [B:240]

In contrast and most relevant to this paper, the negative systematically affects those TAM designations which display grammatical tone allomorphy. Due to space, we cannot fully explicate all the facts about negation and grammatical tone. We neutrally summarize the basic facts about negation as they affect the grammatical tones in focus in this paper.

TAM designation	**Segments**				**Affirmative clause**			**Negative clause**		
					SM=H		SM=Ø	Root=H		Root=Ø
Yesterday Past	á-		-il	-e	Ⓗ^{F}	/	Ø	Ⓗ^{F}	=	Ⓗ^{F}
Yesterday Past Prog.	á-		-ang	-a	Ⓗ^{F}	/	Ø	Ⓗ^{F}	=	Ⓗ^{F}
Recent Perfect	á-			-a	Ⓗ^{F}	/	Ø		***n/a***	
Recent Perfect 2	á-	cí-		-a	Ⓗ^{F}	/	Ø		***n/a***	
Recent Past Prog.	á-	cí-	-ang	-a	Ⓗ^{F}	/	Ø		***n/a***	
Recent Past	á-	cí-	-il	-e	Ⓗ^{F}	/	Ⓗ^{2}	Ⓗ^{F}	/	Ⓗ^{2}
Perfect			-il	-e	Ⓗ$^{2\text{-}F}$	/	Ⓗ^{2}	Ⓗ^{F}	/	Ⓗ^{2}

Table 16: GT allomorphy in affirmative vs. negative clauses

We can start by examining those TAMs involving [RECENT] /á-/ and which show Ⓗ^{F}/Ø allomorphy in the affirmative. In the affirmative form of the Yesterday Past /á-...-il-e/, this TAM designation is exponed with Ⓗ^{F} if the SM is high-toned and Ø if the SM is toneless. In contrast, in the negative only the Ⓗ^{F} is found. All other aspects of this TAM remain the same in the negative.

[31] Other negative prefixes also trigger toneless forms of the subject markers, e.g. the Negative Habitual /síi-/ [B07:221].

(81) Negative of Yesterday Past– Allomorphy neutralized to Ⓗ^{F}

a.	/ tú-^{Ø}tá-á-ziik-il-e	Ⓗ^{F} /	\ tu-tá-á-ziik-il-é \	[tùtáázíìsìlé]	
	SM-NEG-TAM-bury-TAM-FV	TAM	‘we didn’t bury’	[B:253]	
b.	/ a-^{Ø}tá-á-ziik-il-e	Ⓗ^{F} /	\ a-tá-á-ziik-il-é \	[àtáázíìsìlé]	
	SM-NEG-TAM-bury-TAM-FV	TAM	‘he/she didn’t bury’	[B:253]	
c.	/ tú-^{Ø}tá-á-páapaatik-il-e	Ⓗ^{F} /	\ tu-tá-á-páapaatik-il-é \	[tùtáápáápáàtììké]	
	SM-NEG-TAM-flatten-TAM-FV	TAM	‘we didn’t flatten’	[B:253]	
d.	/ a-^{Ø}tá-á-lás-il-il-e	Ⓗ^{F} /	\ a-tá-á-lás-il-il-é \	[àtáálásíìlé]	
	SM-NEG-TAM-hit-APPL-TAM-FV	TAM	‘he/she didn’t hit for’	[B:253]	

The negative prefix /tá-/ neutralizes all SMs to Ø, and normally toneless SMs trigger the Ø allomorph of this TAM. Surprisingly, in this context only the Ⓗ^{F} is chosen. In the negative of Yesterday Past Progressive TAM designation /á-...-ang-a/, allomorphy is equally neutralized to Ⓗ^{F} as well, e.g. (Bickmore 2007:260). Note, however, that it is not possible to see what happens in the negative of the Recent Perfect TAM designations (e.g. /á-...-a/), because this form is not used in negative. Rather, the morphological form used is that of Perfect /-il-e/, collapsing the distinction between Recent Perfect and Perfect.

To accommodate these facts from negation, we adjust our realizational rules of [RECENT] as follows (cf. 43):

(82)

[T:RECENT]	↔	á-	Ⓗ^{F} /	[NEG]	___
	↔	á-	Ⓗ^{F} /	H—τ—[SM]	___
	↔	á-	Ø		

In the context of the feature [NEGATION] ([NEG]), the grammatical tone is uniformly Ⓗ^{F}.

Next, let us look at the effects of negation on the other two allomorphic TAMs designations, the Recent Past /á-cí-... -il-e/ with Ⓗ^{F} ~ Ⓗ^{2} allomorphy, and Perfect /-il-e/ with Ⓗ$^{2\text{-}F}$ ~ Ⓗ^{2} allomorphy. Starting with the Recent Past, in affirmative clauses the grammatical tone is Ⓗ^{F} with high-toned SMs but with toneless SMs it becomes Ⓗ^{2}. In the negative, however, the allomorphy pairing remains but the trigger shifts to the tone value of the *root*. Consider the example below, with high-toned roots /**só**polol/ ‘untie’ and /**lé**et/ ‘bring’. In the negative (and only in the negative), such high-toned roots trigger the Ⓗ^{F} form of the Recent Past. Like all contexts with a negative prefix, the tone of the SM is neutralized to Ø.

(83) Negative of Recent Past – Trigger is H-toned root

a.	/ tú-^{Ø}tá-á-cí-**só**polol-il-e	Ⓗ^{F} /	\ tu-tá-á-cí-**só**polol-il-é \	[tùtáácísópólwìlé]	
	SM-NEG-TAM-just-**untie**-TAM-FV	TAM	‘we didn’t recently untie’	[B14:49]	
	/ a-^{Ø}tá-á-cí-**só**polol-il-e	Ⓗ^{F} /	\ a-tá-á-cí-**só**polol-il-é \	[àtáácísópólwìlé]	
	SM-NEG-TAM-just-**untie**-TAM-FV	TAM	‘he/she didn’t recently untie’	[B14:49]	
b.	/ tú-^{Ø}tá-á-cí-mu-**lé**et-il-e	Ⓗ^{F} /	\ tu-tá-á-cí-mu-**lé**et-il-é \	[tùtáácímúˡléésìlé]	
	SM-NEG-TAM-just-OM-**bring**-TAM-FV	TAM	‘we didn’t recently bring him/her’	[B07:265]	
	/ a-^{Ø}tá-á-cí-mu-**lé**et-il-il-e	Ⓗ^{F} /	\ a-tá-á-cí-mu-**lé**et-il-il-é \	[àtáácímúˡléétîlé]	
	SM-NEG-TAM-just-OM-**bring**-APPL-TAM-FV	TAM	‘he/she didn’t recently bring for him/her’	[B07:265]	

In contrast, toneless roots /**lon**dolol/ ‘explain’, /**zi**ik/ ‘bury’, and /**ful**/ ‘wash’ trigger the Ⓗ^{2} form.

(84) Negative of Recent Past – Trigger is toneless root

a. / tú-ᵠtá-á-cí-**lon**dolol-il-e Ⓗ² / \ tu-tá-á-cí-**lon**dól-il-e \ [tùtáácílóòndólwíílè]
SM-NEG-TAM-just-**explain**-TAM-FV TAM 'we didn't recently explain' [B07:265]
/ a-ᵠtá-á-cí-**zi**ik-il-e Ⓗ² / \ a-tá-á-cí-**zi**ík-il-e \ [àtáácízîzílè]
SM-NEG-TAM-just-**bury**-TAM-FV TAM 'he/she didn't recently bury' [B07:265]

b. / tú-ᵠtá-á-cí-mu-**ful**-il-e Ⓗ² / \ tu-tá-á-cí-mu-**ful**-íl-e \ [tùtáácímúfùzílè]
SM-NEG-TAM-just-OM-**wash**-TAM-FV TAM 'we didn't recently wash him/her' [B14:49]
/ a-ᵠtá-á-cí-mu-**fu**l-il-e Ⓗ² / \ a-tá-á-cí-mu-**fu**l-íl-e \ [àtáácímúfùzílè]
SM-NEG-TAM-just-OM-**wash**-TAM-FV TAM 'he/she didn't recently wash him/her' [B14:49]

Informally, we can characterize the tone of the root acting as a 'secondary trigger'. Under normal conditions, it is the tone of the SM that triggers allomorphy (the primary trigger), but under negation it is the tone of the root that triggers allomorphy (the secondary trigger). We emphasize that when negation is not present, the tone of the verb root is irrelevant for allomorphic selection, e.g. below /**só**polol/ 'untie' plays no role conditioning grammatical tone; it is controlled solely by the subject marker.

(85) Tone of root is inactive when *not* in the Negative (H root /sópolol/ 'untie')

a. / **tú**-á-cí-sópolol-il-e Ⓗ^F / \ **tú**-á-cí-sópolol-il-é \ [twáácísópólwìílé] 'we recently untied' [B14:49]
b. / **u**-á-cí-sópolol-il-e Ⓗ² / \ **a**-á-cí-sópólol-il-e \ [wàácísópólwíílè] 'he/she recently untied' [B07:265]

The most complicated case under negation is the Perfect TAM designation (Ⓗ^2-F ~ Ⓗ² allomorphy in affirmative clauses). In the negative, the trigger of allomorphy shifts to the tone of the root (as above), but with an additional change: high-toned roots now trigger Ⓗ^F (rather than Ⓗ^2-F). The Perfect thus has three grammatical tone allomorphs.

(86) Perfect allomorphy in the negative - Ⓗ^F ~ Ⓗ²

a. H-toned root
/ tú-ᵠtá-**pá**apaatik-il-e Ⓗ^F / \ tu-tá-**pá**apaatik-il-é \ [tùtápáápáàtìíké]
SM-NEG-flatten-PERF-FV PERF 'they haven't flattened' [B14:50]
/ a-ᵠtá-**pá**apaatik-il-e Ⓗ^F / \ a-tá-**pá**apaatik-il-é \ [àtápáápáàtìíké]
SM-NEG-flatten-PERF-FV PERF 'he/she hasn't flattened' [B14:50]

b. Toneless root
/ yá-ᵠtá-mu-**su**kilil-il-e Ⓗ² / \ ya-tá-mu-**su**kíl-il-e \ [yàtámúsùkílíílè]
SM-NEG-OM-accompany-PERF-FV PERF 'they haven't accompanied him/her' [B14:50]
/ a-ᵠtá-mu-**su**kilil-il-e Ⓗ² / \ a-tá-mu-**su**kíl-il-e \ [àtámúsùkílíílè]
SM-NEG-OM-accompany-PERF-FV PERF 'he/she hasn't accompanied him/her' [B14:50]

We can account for this if we amend the list of allomorphs exponing [PERFECT], i.e. grammatical tone co-exponed with suffixal /-il/. One new allomorph is conditioned by the presence of negation and a high tone on the root. We specify the root high as "H—τ—[ROOT]".[32]

(87) [ASP:PERFECT] ↔ -il Ⓗ^F / [NEG] & H—τ—[ROOT] ___

We can now summarize a list of allomorphs for [PERFECT], as below. Notice that for the second allomorph, we add the condition [POS] as it is conditioned only in affirmative clauses.

[32] An alternative conception for this allomorph is that it is conditioned by a high-tone initial stem: (ŕ…___)STEM. Because roots are the only morphs that begin stems, and roots only contrast for tone on the initial TBU, the two cannot be differentiated.

(88) [ASP:PERFECT] ↔ -il Ⓗ^{F} / [NEG] & H—τ—[ROOT] ___
↔ -il Ⓗ$^{2\text{-}F}$ / [POS] & H—τ—[SM] ___
↔ -il Ⓗ^{2} / ['just'] ___
↔ -il Ⓗ^{2}

In Section 4.1, we pointed out that there are contexts where two allomorphs could be conditioned by the environment, e.g. when there is both a high-toned SM and the presence of /cí-/ 'just'. There, we alluded to a principled reason why the former (with tones /-il Ⓗ$^{2\text{-}F}$/) would be chosen over the latter (with /-il Ⓗ^{2}/, boxed to indicate it is not overwritten by other tone). Here, we see that the /-il Ⓗ$^{2\text{-}F}$/ form needs two conditioners in its context, while the /-il Ⓗ^{2}/ form has only one. We therefore take the /-il Ⓗ$^{2\text{-}F}$/ form as having a more specific environment, which takes priority over less specific environments.

9.2 Appendix 2: Unexpected form of TAMs with Ⓗ^{F}/Ø in certain phonological contexts

This appendix shows that in a small set of phonological contexts, those TAMs with Ⓗ^{F}/Ø allomorphy show an unexpected surface form, as if the wrong allomorph were selected. For example, in the Yesterday Past TAM designation /á-...-il-e/ we demonstrated that toneless SMs trigger the Ø form rather than the Ⓗ^{F} form. However, in a limited number of phonological contexts, the expected surface allomorphy is not found. In the example below, the verb forms end in a high tone in the intermediate and surface forms (surfacing with a downstep ˡ) rather than the expected form with final low. This occurs with both toneless roots (a.) and high-toned roots (b.). The input forms are provided with the grammatical tone allomorph which correctly generates the attested output (in this example, Ⓗ^{F}), compared to the other allomorph which does not generate it (Ø).

(89) Unexpected pattern: Toneless SM does *not* co-occur with the Ø form of the Yesterday Past

a.	/ **u**-á-luk-il-e	Ⓗ^{F} /	\ **u**-á-luk-il-é \	[wààlúsíˡlé]
	SM-TAM-weave-TAM-FV	TAM	'he/she wove'	[B07:245]
	Cf. */ **u**-á-luk-il-e	Ø /	*\ **u**-á-luk-il-e \	*[wààlúsílè]
b.	/ **u**-á-lás-il-e	Ⓗ^{F} /	\ **u**-á-lás-il-é \	[wààlásíˡlé]
	SM-TAM-hit-TAM-FV	TAM	'he/she hit'	[B07:249]
	Cf. */ **u**-á-lás-il-e	Ø /	*\ **u**-á-lás-il-e \	*[wààlásílè]

The generalization here is that if the root is short enough and there is a high tone at the left edge of the stem, then these factors override the toneless SM's requirement for the Ø form.

The exact conditions on when and where the 'wrong' allomorphic form appears to be complex, and all details have not yet been worked out. For example, if the verbal word is not at the end of an ιP, the expected allomorph Ø is found instead. Compare (b.) above with its use followed by the adjunct /sáaná/ 'a lot' below:

(90) / **u**-á-lás-il-e Ø sáaná / \ **u**-á-lás-il-e sáaná \ [wààlásílè sáàná] *[wààlásíˡlé sáàná][33]
SM-TAM-hit-TAM-FV TAM a.lot 'he/she hit a lot' [B07:249]

Further, if the root consists of only a toneless long vowel then a toneless SM appears with the expected Ø form of the TAM (91a.). However, if the roots consists only of a high-toned long vowel then the SM unexpectedly appears with the Ⓗ^{F} of the TAM (b.).

[33] This cannot be attributed to general tonology preventing downstep before a high tone or a word boundary, attested in many examples, e.g. [yààngándéˡméˡlá sáàná] 'they can plant for me a lot' [B07:490], [úkúˡshá sáàná] 'to grind a lot' [B07:467], [úkúˡsóˡpólólá ˡsáàná] 'to untie a lot' [B07:466], *inter alia* .

(91)

a.	/ **u**-á-ziik-il-e	Ø /	\ **u**-á-ziik-il-e \	[wààzîsìlè]	
	SM-TAM-bury-TAM-FV	TAM	'he/she buried'	[B07:246]	
	Cf. */ **u**-á-ziik-il-e	Ⓗ^{F} /	*\ **u**-á-ziik-il-é \	*[wààzîsìlé]	
b.	/ **u**-á-léet-il-e	Ⓗ^{F} /	\ **u**-á-léet-il-é \	[wààléésìlé]	
	SM-TAM-bring-TAM-FV	TAM	'he/she brought'	[B07:251]	
	Cf. */ **u**-á-léet-il-e	Ø /	*\ **u**-á-léet-il-e \	*[wààléésílè]	

Note, however, that the expected Ø allomorph is triggered by the toneless SMs if there is an object marker of any meaning or tone value, and regardless of underlying tone or length of the root. This is shown below with /mu-/ 'him/her' and /mú-/ 'you (pl.)'.

(92) Return to expected patterns

a.	/ **u**-á-mu-lás-il-e	Ø /	\ **u**-á-mu-lás-il-e \	[wààmúlásìlè]	
	SM-TAM-OM-hit-TAM-FV	TAM	'he/she hit him/her'	[B07:252]	
	Cf. */ **u**-á-mu-lás-il-e	Ⓗ^{F} /	*\ **u**-á-mu-lás-il-é \	*[wààmúlásìlé]	
b.	/ **u**-á-mú-lás-il-e	Ø /	\ **u**-á-mú-lás-il-e \	[wààmúlásílè]	
	SM-TAM-OM-hit-TAM-FV	TAM	'he/she hit you (pl.)'	[B07:251]	
	Cf. */ **u**-á-mú-lás-il-e	Ⓗ^{F} /	*\ **u**-á-mú-lás-il-é \	*[wààmúlásíˡlé]	

The patterns above were shown with Yesterday Past. Other TAM designations show limited supporting evidence for unexpected allomorphy selection, e.g. the Recent Perfect /á-...-a/. First consider the short roots below (/lem/ 'grab' and /lém/ 'plant'), where the surface forms appear with the expected Ø allomorph.

(93)

a.	/ **u**-á-lem-a	Ø /	\ **u**-á-lem-a \	[wààlémà]	
	SM-TAM-grab-FV	TAM	'he/she has just grabbed'	[B07:269]	
	Cf. */ **u**-á-lem-a	Ⓗ^{F} /	*\ **u**-á-lem-á \	*[wààlémá] ~ *[wààléˡmá]	
b.	/ **u**-á-lém-a	Ø /	\ **u**-á-lém-a \	[wààlémà]	
	SM-TAM-plant-FV	TAM	'he/she has just planted'	[B07:269]	
	Cf. */ **u**-á-lém-a	Ⓗ^{F} /	*\ **u**-á-lém-á \	*[wààlémá] ~ *[wààléˡmá]	

In contrast, if the root is augmented with the derivational suffix /-il/ applicative, then the surface form appears to have selected the unexpected Ⓗ^{F} allomorph.

(94) Unexpected forms

a.	/ **u**-á-lem-il-a	Ⓗ^{F} /	\ **u**-á-lem-il-á \	[wààlémé˥lá]	
	SM-TAM-grab-APPL-FV	TAM	'he/she has just grabbed for [someone]'	[B07:269]	
	Cf. */ **u**-á-lem-il-a	Ø /	*\ **u**-á-lem-il-a \	*[wààlémélà]	
b.	/ **u**-á-lém-il-a	Ⓗ^{F} /	\ **u**-á-lém-il-á \	[wààlémé˥lá]	
	SM-TAM-plant-APPL-FV	TAM	'he/she has just planted for [someone]'	[B07:269]	
	Cf. */ **u**-á-lém-il-a	Ø /	*\ **u**-á-lém-il-a \	*[wààlémélà]	

Certain vowel-initial short roots also appear to select for the wrong allomorph, e.g. /el/ '(to) fish' occurs with Ⓗ^{F} in the Recent Perfect rather than Ø.

(95) / **u**-á-el-á Ⓗ^{F} / \ **u**-á-el-á Ⓗ^{F} \ [wèélá] 'he/she has just fished' [B07:271] Cf. *[wèélà]

Like with the Yesterday Past, the relevant generalization conditioning this unexpected allomorph choice appears to be the size of the root/stem and the presence of a nearby high tone.

9.3 Appendix 3: Reciprocal PCA

In this appendix, we show that there is reciprocal phonologically-conditional allomorphy between exponents of SMs and exponents of T, hereafter called Reciprocal PCA. We refer to this as a weak version of Reciprocal PCA because no two exponents condition each other (i.e. a single SM exponent and a single T exponent in the same output referencing each other). Rather, some exponents of SM depend on T and vice versa, but not in the same output form.

The relevant data involve the class 1 subject marker (expressing 3SG co-reference), which was one of the special toneless SMs. In Table 2, we listed the class 1 (3SG) subject marker with two allomorphs, /u-/ and /a-/ (both toneless). Bickmore (2007:29) shows that the /u/ allomorph is only used next to exponents of the shape /a/, and the /a/ allomorph is used in all other contexts. This can straightforwardly be understood as a dissimilation effect, whereby two exponents of the shape /a/ cannot be adjacent (a kind of 'repeated morph constraint' – Menn & MacWhinney 1984). Examples of /u-/ allomorphy with the toneless tense prefix /a-/ [REMOTE] (in Far Past /a-...-il-e Ⓗ$^{2\text{-}F}$/) and high-toned /á-/ [RECENT] (in the Yesterday Past /á-...-il-e Ⓗ^{F} ~ Ø/) are in example immediately below (SM in bold); the elsewhere allomorph /a-/ follows this.

(96) Class 1 (3SG) SM allomorph /u-/

a. With /a-/ [REMOTE] in Far Past' [B07:8]
/ **u**-a-mu-fuk-il-il-e Ⓗ$^{2\text{-}F}$ / [**wàà**mùfùkíílé] 'he/she harvested for him/her'

b. With /á-/ [RECENT] in Yesterday Past [B07:8]
/ **u**-á-mu-fuk-il-il-e Ø / [**wàà**múfúkìílè] 'he/she harvested for him/her (yesterday)'

(97) Class 1 (3SG) SM allomorph /a-/ (elsewhere)

a.	/ **a**-cí-líi-ful-a /	[**à**cílîfùlà]	'he/she is still washing'	[B07:114]
	/ **a**-ngá-ful-a Ⓗ^{F} /	[**àà**ngáfú!lá]	'he/she can wash'	[B07:114]
	/ **a**-léet-il-e Ⓗ^{2} /	[**à**léésílè]	'he/she has brought'	[B07:294]
b.	/ **a**-anz-a Ⓗ$^{2\text{-}F}$ /	[**à**áánzá]	'and then he/she spread'	[Second author field notes]
	/ **a**-elek-il-e Ⓗ^{2} /	[**à**éélé!sílè]	'he/she has cooked'	[B07:519]
	/ **a**-ómolol-a Ⓗ$^{2\text{-}F}$ Mulenga /	[**à**óómólólá Múlééngà]	'and then he/she pulled down M.'	[B07:522]

(97) demonstrates that the /a-/ allomorph occurs both before consonants (a.) before vowel-initial roots including /a/ (b.). This allomorphy specifically applies only between two exponents of the shape /a/ (and specifically short a). In contexts when the next exponent is long a, the /a-/ allomorph of the SM is chosen and not /u-/. This is seen with TAM prefixes /aa-/ (in Past Inceptive /Ⓗaa-...-a/) and /áa-/ (in Hortative /Ⓗáa-…-a/), both with long vowels. Note that in the examples below, a sequence of three [a]'s is reduced to two.

(98)

a.	/ **a-**Ⓗ**aa**-ful-a /	\ **á-aa**-ful-a /	[**áá**fúlà]	'and then he/she started to wash'	[B07:115]
	/ **a-**Ⓗ**aa**-sukil-il-a /	\ **á-aa**-sukil-il-a \	[**áá**súkílílà]	'and then he/she started to accompany'	[B07:196]
b.	/ **a-**Ⓗ**áa**-ful-a /	\ **á-áa**-ful-a \	[**àà**fùlà]	'let him/her start washing'	[B07:115]
	/ **a-**Ⓗ**áa**-sukil-il-a /	\ **á-áa**-sukil-il-a \	[**àà**sùkìlìlà]	'let him/her start accompanying'	[B07:208]

Critical confirmation of these allomorphy facts comes from outside of the TAM system, involving the associative construction. Here, the allomorph /u-/ is chosen before another exponent of shape /a/. The associative construction expresses possession or association between two noun phrases, and has the general structure as below, consisting of the possessed NP, an inflected linker morpheme /-a/ ASSOCIATIVE LINKER (LINK), and the possessor NP (appearing without its preprefix (PP), i.e. augment):

(99)

NP	AGR+/-a/	NP
Possessed	LINK	Possessor

This linker morpheme /-a/ must agree with the possessed noun to its left, e.g. below the linker agrees with the possessed NP *imiti* 'trees' (class 4) and not the possessor NP *mulimi* 'farmer' (class 1).

(100) / **í-mi**-ti **i**-a mu-limi / [ímítì yàà mùlìmì]
PP.4-CL4-tree **CL4**-LINK CL1-farmer 'the farmer's trees' [B07:440]

Bickmore (2007:438) details how agreement markers on the linker are segmentally and tonally identical to the subject markers on verbs (Table 2). We therefore assume that they are the same exponent in two different contexts: on verbs, and before LINK. Thus, we predict the behavior of the class 1 (3SG) prefix /a-/~/u-/ to be identical in both verb and LINK contexts. This prediction is borne out. Because it appears before the linking marker whose shape is /a/, the allomorph which is chosen is /u-/.

(101)

a. / Ø-Ø-yemba **u-a** mu-limi / [yèèmbà **wàà** mùlìmì]
PP.1a-CL1a-lake **CL1-LINK** CL1-farmer 'the farmer's lake' [B07:439]

b. / ú-mu-limi **u-a** mu-ána / [úmúlìmì **wàà** mwàánà]
PP.1-CL1-farmer **CL1-LINK** CL1-child 'the child's farmer' [B07:440]

c. / ú-mu-enyi **u-a**-kúe / [úmwéènyì **wàà**kwé]
PP.1-CL1-guest **CL1-LINK**-his/her 'his/her guest' [B07:439]

Moreover, the agreement marking on the linker is toneless if its equivalent SM is toneless, e.g. CL1 /u-/ in (101), CL4 /i-/ (100), and CL9 /i-/ (not shown). Likewise, it is high-toned if the SM is high-toned. This is predicted if agreement on linkers constitute the same exponents as the subject markers. Contrast /u-/ above with the segmentally-identical class 3 /ú-/, with H tone.[34]

(102) / ú-mu-lomo **ú-a** ci-bungú / [úmúlòmò **wáá** cíùùngú]
PP.3-CL3-mouth **CL3-LINK** CL7-caterpillar 'the caterpillar's mouth' [B07:440]

The use of identical exponents in both LINK and verb environments is not trivial. Compare the Class 1 (3SG) marking on nouns and agreement adjectives – /mu-/ in bold below – which is not found on the linker in associative constructions (just as it is not used as a subject marker).

(103) / ú-**mu**-limi **mu**-táli / [ú**mú**lìmì **mù**tálì]
PP-CL1-farmer CL1-tall 'tall farmer' (Class 1) [B07:26]

Taken altogether, these data show that the class 1 (3SG) features will be exponed as /u-/ before all exponents of the phonological shape [a], and the allomorph /a-/ appears elsewhere. The triggering contexts /á-/ [T:RECENT], /a-/ [T:REMOTE], and /-a/ LINK are not a grammatically natural class. We can write the following realizational rules for this maker of agreement:

(104) [φ:CL1] ↔ u- / ___ /a-/
↔ a-

This a/u alternation is specifically a quirk of the class 1 (3SG) morpheme, and not generalizable as a phonological rule. With other instances of two exponents /a-a-/ in a row which do not contain the class 1 morpheme, they do not trigger any dissimilation rule. For example, a copulative construction is formed with a prefix /a-/, meaning 'it is (a) ___'. An example set is below:

[34] Note that in Table 2, we actually stated that the underlying form of this class 3 subject marker is /gú-/ rather than /ú-/. This has to do with complex rules of vowel hiatus resolution and consonant emergence before nasal consonants, topics outside of our scope here. Nothing affects our analysis whether it is underlying /gú-/ or /ú-/ for class 3.

(105) Copulative with prefix /a-/ COP

a.	/ musáto /	[mùsátò]	‘python’
	/ **a**-musáto /	[**à**músátò]	‘it is a python’
b.	/ cuulá /	[cùùlá]	‘frog’
	/ **a**-cuulá /	[**à**cúùlá]	‘it is a frog’
c.	/ í-sote /	[ísótè]	‘grass’
	/ **a**-í-sote /	[**ì**ísótè]	‘it is grass’
d.	/ ú-mu-limi /	[úmúlímì]	‘farmer’
	/ **a**-ú-mu-limi /	[**ù**múlímì]	‘it is a farmer’

The underlying shape of the vowel is seen before consonant initial NPs (a-b). For those which begin with a vowel, the vowel of the prefix assimilates and can only be detected via tone changes. If the stem is short enough (e.g. 2 morae), the initial syllable is rising (c.), otherwise it is low (d.).[35]

Examine now Class 6 nouns which are marked with the preprefix (augment) /á-/ and the class marker /ma-/, in (106). When the copulative /a-/ appears before the preprefix of the noun /á-/, no alternation with an [u] form is attested.

(106) No dissimilation of /a-/ COP before the class 6 preprefix /á-/

a.	/ á-ma-ue /	[á-má-wé]	‘stones’
	/ **a**-á-ma-ue /	[**à**-má-wé]~[**à**á-má-wé]	‘they are stones’
b.	/ á-ma-fua /	[á-má-fwá]	‘leaves’
	/ **a**-á-ma-fua /	[**à**-má-fwá]~[**à**á-má-fwá]	‘they are leaves’
c.	/ á-ma-papiko /	[á-má-pápíkò]	‘wings’
	/ **a**-á-ma-papiko /	[**à**-má-pápíkò]	‘they are wings’

The lack of an u~a alternation here is predicted under an allomorphy analysis.

Having established this, recall that realizational rules for TAMs with recent past /á-/ show grammatical tone allomorphy (repeated from 82):

(107) [T:RECENT] ↔ á- Ⓗ^{F} / [NEG] ___
↔ á- Ⓗ^{F} / H—τ—[SM] ___
↔ á- Ø

Given these realizational rules, we can now see the (weak) reciprocal PCA between agreement (φ) and tense (T). The realization of [T:RECENT] is dependent on the phonological value of the φ exponent to its left. Equally, the realization of [φ:CL1] is dependent on the phonological shape of what is to its right, which includes T. This mutual dependency is naturally captured if exponence is simultaneous and exponents have access to the phonological shapes of their neighbors. It is not naturally captured under purely inside-out or outside-in models of exponence.

[35] We refer to the shape of this copulative as /a-/, but due to its tonal properties it may be better thought of as /á-/ or /a$^{Ⓗ}$-/ with a floating tone. This issue is orthogonal to our discussion.