Scalar tone shift as evidence for morphology without morphemes*

Hannah Sande

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1 Item-based versus process morphology

While much recent literature has claimed that all morphology involves affixation of morphemes with underlying (abstract) phonological representations (Benua, 1997; Alderete, 2001; Wolf, 2007; Gouskova and Linzen, 2015; Zimmermann, 2013; Trommer and Zimmermann, 2014; Köhnlein, 2016), subtractive, scalar, metathesizing, and replacive morphology pose challenges for the view that all morphology is item-based. Hockett (1954); Anderson (1992) famously raise this debate, both coming down in favor of the need for process morphology. Here I look at a novel pattern of scalar tone shift from Guébie (Kru), reraising Anderson (1992)[63]'s question: "Is it possible to reduce all of morphology to affixation [...]? If not, the item-based theory should probably be rejected." I demonstrate that indeed there is no workable underlying representation of the Guébie imperfective morpheme, and on the basis of Guébie scalar tone shift and countless other morphologically conditioned phonological processes across languages, we should give up a purely item-based view of morphology. I propose an alternative solution based in the morphological operations of Distributed Morphology (Halle and Marantz, 1994) and constraint-based phonology.

2 Guébie scalar tone shift

Guébie is a tonal language with four distinct tone heights, marked here with numbers 1-4 where 4 is high[1]. Attested tone melodies on lexical roots include all level tones (1, 2, 3, 4), along with those contours represented in (1).

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[1]The data presented here come from three fieldtrips to Gnagbodougnoa, Côte d'Ivoire along with eight months of working with a Guébie speaker in the US. There are 7,000 Guébie speakers spread across seven villages, and there is only one remaining monolingual speaker that I know of.

(1) **Attested contours**

	1	**2**	**3**	**4**
1	-	∅	✓	∅
2	∅	-	✓	✓
3	✓	✓	-	∅
4	✓	✓	∅	-

The tones along the vertical axis in (1) represent the first tone of a two-tone contour. Those along the horizontal axis are the second tone of a two-tone contour. A *checkmark* marks those contours attested in Guébie, a ∅ marks those unattested, and there is a - where the tones on the horizontal and vertical axis are identical, resulting in a level tone instead of a contour. The tones indicated by "-" are level tones. These are, in fact, attested in Guébie, but they are level melodies, not contour tones.

Word order in Guébie alternates between SAuxOV and SVO. When auxiliaries (which mark tense, polarity, and mood) are present, there is no inflection on verbs (2a). However, when there is no auxiliary, the verb surfaces immediately after the subject, and in exactly these cases the verb is inflected for aspect (2c, 3). Nothing can ever intervene between subject and auxiliary or subject and inflected verb.

In all contexts except SVO clauses with imperfective aspect, any given verb surfaces with a consistent tone melody (2).

(2) **Default tone constructions**

a. *SAuxOV*

e^{4} ji^{3} ɟa^{31} li^{3}
1SG.NOM FUT coconuts eat

'I will eat a coconut.'

b. *Imperative*

li^{3}
eat.IMP

'Eat!'

c. *Perfective*

e^{4} li^{3} ɟa-ɓe$^{3.1}$ kubə$^{3.1}$
1SG.NOM eat.PFV coconuts-SG yesterday

'I ate a coconut yesterday.'

However, in imperfective SVO contexts, tone on the verb surfaces one step lower on the four-height tone scale, (3).

(3) **Tone one step below default in imperfective constructions**

Imperfective

e^{4} li^{2} ɟa^{31} koko$^{4.4}$
1SG.NOM eat.IPFV coconuts everyday

'I eat coconuts everyday.'

The perfective and imperfective form of a verb are identical (segmentally and syntactically, SVO), except for the tone on the verb.

(4) **Tone lowering in imperfective contexts**

a. Perfective: Lexical tone

e^{4} li^{3} ɟa-ɓə$^{3.1}$
1SG.NOM eat.PFV coconuts-SG

'I ate a coconut.'

b. Imperfective: One step lower

e^{4} li^{2} ɟa-ɓə$^{3.1}$
1SG.NOM eat.IPFV coconut-SG

'I am eating a coconut.'

Here we see a tone change triggered by a particular morphosyntactic environment, similar to the tonal overlay phenomena recently discussed by McPherson and Heath (2016), though the Guébie data are scalar.

On polysyllabic verbs, only the first level tone is affected by the scalar tone shift (5).

(5) **Only the first syllable lowers**

a. ju^{4} gbala$^{3.4}$ si^{3}
boy climb.PFV trees

'A boy climbed trees'

b. ju^{4} gbala$^{2.4}$ si^{3}
boy climb.IPFV trees

'A boy climbs trees'

When a polysyllabic verb has a level tone melody, the same tone across multiple syllables, tone on all syllables lowers (6).

(6) **The OCP effect at play in Guébie scalar tone shift**

a. a^{2} ka^{3} dibo-ə$^{3.1.2}$ bala$^{2.2}$
1PL.NOM IRR plantain-PL harvest

'We would harvest plantains'

b. a^{2} bala$^{1.1}$ dibo-ə$^{3.1.2}$
1PL.NOM harvest.IPFV plantain-PL
trans 'We harvest plantains'

In the case of contour tones, only the first tone level is lowered in the imperfective (7).

(7) **Only the first tone of a contour lowers**

a. ɟaci$^{23.1}$ pa^{31} gɔlɔ$^{3.3}$
Jachi flip.PFV boat

'Jachi flipped the boat.'

b. ɟaci$^{23.1}$ pa^{21} gɔlɔ$^{3.3}$
Jachi flip.IPFV boat
'Jachi flips the boat.'

Given the data in (5-7), we can restate the imperfective scalar tone shift by saying that the first tone level of a verbal tone melody surfaces one step lower in imperfective contexts than elsewhere, (8).

(8) **Imperfective scalar tone shift**

Default tone	≫	**Imperfective tone**
4		3
3		2
2		1
1		1

When a verb is low-toned by default, we might expect it to lower further, to a super-low, 0, in the the imperfective. Instead, it remains tone 1. However, the result is not complete neutralization between perfective and imperfective contexts; instead, contrast between perfective and imperfective verbs is maintained by raising the final tone of the subject when the verb is already low, (9).

(9) **Contrast for low-toned verbs maintained by raising the preceding tone**

a. ɛ^{3} ɓɔ^{1}
3SG.NOM wither.PFV
'It withered'

b. ɛ^{4} ɓɔ^{1}
3SG.NOM wither.IPFV
'It withers'

c. ɟaci$^{23.1}$ pa^{1}
Djatchi runPFV
'Djatchi ran'

d. ɟaci$^{23.2}$ pa^{1}
Djatchi run.IPFV
'Djatchi runs'

e. ju^{4} e^{4} ji^{2} ne^{2} pa^{1}
boy I know REL run.PFV
'The boy that I know ran.'

f. ju^{4} e^{4} ji^{2} ne^{3} pa^{1}
boy I know REL run.IPFV
'The boy that I know runs.'

The default low tone, 1, on the verbs 'wither, ran' in (9a,c,e) do not lower in imperfective contexts, (9b,d,f), but we see a change in the final subject tone between perfective and imperfective contexts. This scalar subject raising occurs even when the result is a super-high tone, tone 5, which is not found elsewhere in the language, (10).

(10) **Contrast is maintained even when it results in a super-high tone**

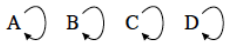
a. e^{4} pa^{1}
1SG.NOM run.PFV
'I ran'

b. e^{5} pa^{1}
1SG.NOM run.IPFV
'I run'

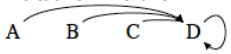
The scalar shift in Guébie, where the first tone of a verb lowers one step if possible, and if not the subject tone raises one step, represents a novel type of scale cross-linguistically. Mortensen (2006) presents a typology of phonologically scalar phenomena, introducing the five possible types of scales shown in (11).

(11) **Types of phonological scalar shifts** (from Mortensen 2006:56-67)

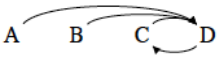
a. Identity mapping



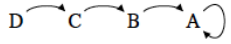
b. Neutralization



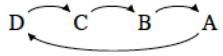
c. Bounceback



d. Chain shift



e. Circle chain



The scalar shift in Guébie is not attested in Mortensen's typology. While similar to a chain shift where tones lower one step on the scale in a particular context, we see that upon reaching the end of a scale a nearby word is scalarly affected. I call this a *collateral damage chain shift*.

An alternative way to think of the scalar tone shift in Guébie is as affecting the difference in scalar value between two words or morphemes. That is, this tonal shift affects the difference in tone height between the subject and verb, where the difference increases by one between the perfective and imperfective. This consistent and phonologically predictable tone change is represented formulaically in (12), where FST stands for Final Subject Tone, and IVT stands for Initial Verb Tone. *n* represents some number, namely, the difference between subject and verb tone in perfective contexts.

(12) **Consistent arithmetic relationship between perfective and imperfective**

Perfective	**Imperfective**
FST - IVT = n	FST - IVT = n + 1

A summary of the imperfective scalar tone shift in Guébie is this: the first tone height of a verb surfaces one step lower in the imperfective than elsewhere, unless the verb is already low, in which case the final subject tone raises one step in the imperfective. This scalar tone shift is situated within the larger context of Guébie grammatical tone phenomena. I provide an analysis of this particular scalar shift in section 3, and in section 4 I demonstrate that the proposed analysis extends to other instances of tonal and non-tonal morphology in Guébie.

3 Scalar shift in Distributed Morphology

3.1 Considering existing options

3.1.1 Underlying representations

Assuming for the time being that all morphology is affixal, we can start by asking what is the underlying representation of the imperfective morpheme in Guébie? Or, in Distributed Morphology (DM) terms, what is the vocabulary item inserted in imperfective contexts? For extant analyses of process morphology as item-based, see Benua (1997); Alderete (2001); Wolf (2007); Gouskova and Linzen (2015); Zimmermann (2013); Trommer and Zimmermann (2014).

We could think of the imperfective in Guébie as a floating tone or feature. This floating element would be responsible for subject tone raising when the verb is low toned, and verb tone lowering otherwise. While all level tone melodies (heights 1-4) and seven of twelve possible two-tone contours given the four tone heights of Guébie are present on Guébie roots and affixes, none of these level or contour melodies triggers raising or lowering of nearby tones. This weakens the argument that the imperfective morpheme is a floating tone, since there is no reason to believe that a given tone should trigger a raising or lowering process in this one context (imperfective), but nowhere else in the language. Not only that, but a floating element would need to be responsible for subject tone raising in certain contexts (when the verb is already low), but verb tone lowering otherwise. There is no tonal assimilation to or dissimilation from a particular tonal target; rather, this is a relational process between subject and verb tones.

We could consider a floating feature instead. A number of tonal features for four-tone-height languages have been proposed, (13).

(13) **Proposed features for 4-tone systems**

Yip (1980)	4	3	2	1
Upper	+	+	-	-
High	+	-	+	-

Clements (1983)	4	3	2	1
Feature 1	H	H	L	L
Feature 2	H	L	H	L

Bao (1999)	4	3	2	1
Stiff	+	+	-	-
Slack	-	+	-	+

In all proposed sets of binary features presented above, there is a single-feature difference between high and mid-high tones, and a single-feature difference between mid and low tones, but there are two feature values differentiating mid-high from mid tones. This means that a single floating feature could not be responsible for the shift from high-to-mid-high, mid-high-to-mid, and mid-to-low tones in Guébie. See Contreras (1969) for perhaps the first discussion of why binary features like those in (13) fail to account for scalar phenomena. If we assume that scalar lowering in imperfective contexts is a unitary phenomenon, a floating-feature account does not work[2].

Because there is no assimilation to or dissimilation from a target, just a relational shift in tone, there is no best underlying representation for the imperfective morpheme in Guébie. There is no single feature change or floating tone that would result in lowering one step in some contexts and raising one step others.

The table in (14) shows all possible tone combinations between perfective and imperfective for a subject with default tone 2. When a default tone 2 subject is followed

[2]See McPherson (2016) for a recent binary feature account of a scalar tone shift in Seenku. A featural account works for Seenku because there are only two underlying tones which undergo shift: extra-low becomes low, and high becomes extra-high in plural contexts. A featural analysis becomes obsolete in a system with more than two underlying tones, like the four-tone system of Guébie.

by a default high- or mid-high-toned verb, the difference between subject and verb tone decreases in the imperfective. However, when a tone 2 subject is followed by a mid- or low-toned verb, the difference between subject and verb tone increases in the imperfective.

(14) **Tone shift patterns for a subject with tone 2**

	Perfective	Imperfective	Change in tone difference
a.	2 4	2 3	Decrease
b.	2 3	2 2	Decrease (to equal)
c.	2 2	2 1	Increase
d.	2 1	3 1	Increase

It is not the case that imperfective tone shift always results in the verb tone surfacing further from or nearer to the subject tone, so we cannot say that there is a floating tone or tonal feature which docks on the verb and undergoes assimilation to or dissimilation from the subject tone.

While we could posit some (abstract) underlying representation (UR) for the imperfective morpheme in Guébie, it would not be a predictive analysis. That is, no matter what we posit as the UR, we would need to state in rules or constraints that the effect of that UR, whether it is a floating low tone, a floating feature, or a floating smiley face, involves lowering the verb tone one step in imperfective contexts, unless the verb tone is already low, in which case the subject tone raises. Any account of this sort simply restates the observable data, failing to make any predictions or insights.

I propose that there is no adequate UR to account for Guébie scalar tone shift. An item and arrangement model does not work. We have found with this case study from Guébie that it is not possible, or at least not desirable, to reduce all morphology to affixation. Returning to Anderson (1992)[63]'s statement quoted in section 1, "Is it possible to reduce all of morphology to affixation [...]? If not, the item-based theory should probably be rejected", we can conclude that a complete theory of morphology will allow for non-affixal as well as affixal morphology. Thus, I claim that the imperfective morpheme in Guébie lacks an underlying phonological representation, and instead triggers a phonological process. My proposal for incorporating a model of process morphology into a Distributed Morphology-based theory is given in sections 3, 3.3, but first in section 3.1.2 I demonstrate that the current state of Distributed Morphology cannot satisfactorily handle productive morphologically conditioned phonological processes.

3.1.2 Distributed Morphology tools

In DM, morphologically conditioned phonology, including process morphology like umlaut or scalar shift, is handled in one of two ways:

1. Suppletive Allomorphy (Halle and Marantz, 1993, 1994; Embick and Noyer, 2007; Embick and Halle, 2005; Harley, 2014; Siddiqi, 2009; Haugen and Siddiqi, 2013)

2. Readjustment rules (Halle and Marantz, 1993, 1994; Marantz, 1997; Embick and Noyer, 2001; Pfau, 2002; Embick and Halle, 2005)

Here I argue that neither suppletive allomorphy nor readjustment rules adequately account for morphologically conditioned phonology.

Suppletive Allomorphy involves separately listed lexical items or vocabulary items, each inserted into a derivation in distinct morphosyntactic environments before the

phonological grammar applies[3,4]. In the early days of DM, allomorphy was only possible for functional morphemes. Now, though, most DM practitioners agree that both lexical and functional elements can have listed allomorphs (Siddiqi, 2009; Harley, 2014; Toosarvandani, to appear). For the verb 'eat' in Guébie, which I will use in a number of examples throughout this and the following sections, there would be two lexically listed allomorphs on a suppletive allomorphy account, (15).

(15) **Vocabulary entries for the Guébie verb *li*, 'to eat'**

- $\text{li}^2 \longleftrightarrow [\text{IPFV}]$
- li^3

The tone 2 allomorph would be inserted in the environment of an imperfective feature, and the tone three allomorph would be inserted everywhere else. However, suppletive allomorphy does not imply that any regular phonological relationship holds between one form of a vocabulary item (VI) and another. Thus, on such an account it would be coincidental that every verb whose 'elsewhere' form does not have tone 1 would have two segmentally identical vocabulary entries, one inserted in imperfective contexts whose tone is exactly one step lower than the allomorph underspecified for insertion environment.

While the suppletive allomorphy account is already uneconomical when considering only verbal vocabulary entries, we should also consider that every possible subject that can surface before a low toned verb must also have two entries, one whose final tone is exactly one step higher than the other. This would get us the surface result of subject tone raising in contexts where the verb tone is low.

The problem with a suppletive allomorphy approach should be obvious; it results in an uneconomical lexicon. It fails to capture the generalization that the relationship between imperfective verbs and other forms of the same verb is phonologically predictable.

The alternative method used to account for morphologically conditioned phonology in Distributed Morphology involves readjustment rules. These are transformational rules that apply to single lexical items or subsets of lexical items in certain morphosyntactic contexts. However, the use of readjustment rules in the theory has been argued against for two main reasons: 1) There is no theory of what a readjustment rule can look like; they are unconstrained (Siddiqi, 2009; Bye and Svenonius, 2012; Gribanova, 2015). 2) They involve transformational rules, which are otherwise absent from DM and the Minimalist Program in general (Siddiqi, 2009, 42). While I will not delve further into these two arguments against the use of readjustment rules, I will assume that an analysis that does not need them is preferable to one that does.

There have been a number of suggestions for eliminating readjustment rules from the grammar. Siddiqi (2009) proposes root allomorphy as an alternative to readjustment rules. That is, for Siddiqi, all instances of readjustment rules can be restated as lexically listed suppletive allomorphy. We have already seen that such an approach would be highly uneconomical for Guébie.

A second suggestion for eliminating readjustment rules comes from Gribanova (2015). Gribanova argues that for Russian vowel alternations, with the right abstract underlying

[3]While vocabulary insertion is generally thought to occur before phonology, Trommer (2001); Wolf (2008) assume that vocabulary is inserted during the phonological component.

[4]One could consider Archangeli and Pulleyblank (forthcoming)'s emergent morphology to be a suppletive allomorphy approach where all allomorphs are possible output candidates and the optimal one is chosen given the morphophonological environment.

phonological representation we do not need readjustment rules. Instead, regular phonological rules or constraints act on the abstract UR to determine the optimal output. While this approach seems appropriate for Russian, we have already seen that there is no appropriate underlying representation for the Guébie imperfective morpheme.

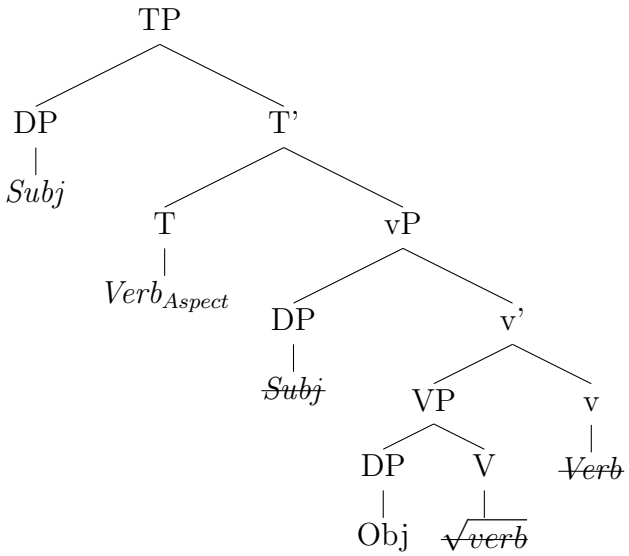
In the following sections I propose a model of DM that avoids both suppletive allomorphy and readjustment rules, and accounts for morphologically conditioned phonological processes without abstract underlying phonological representations.

3.2 The structure of the model

This section presents a novel model of realizational morphology combining aspects of Distributed Morphology (DM) (Halle and Marantz, 1993, 1994) with morpheme-specific grammars of constraint evaluation as per Cophonology Thoery (Itô and Mester, 1995; Anttila, 2002; Inkelas and Zoll, 2005). I begin by describing my assumptions about the morphological component of the grammar, then talk about the output of morphology which I assume is the input to the phonological component, and describe the interworkings of the phonological component.

Like DM, the model of the morphology/phonology interface presented here assumes that syntactic structure is the input to the morphological component. The syntactic structure of a regular transitive verb in Guébie, argued for by Sande (In Press), is given in (16). A hierarchical structure of this type is assumed to be both the output of syntax and the input to morphology.

(16) **The input to morphology**



Following DM, I assume that morphological operations apply to the hierarchical syntactic structure in (16), though I set aside the debate about exactly which operations are necessary to account for cross-linguistic morphological data (see Embick and Noyer 2001, 2007 for more on this subject).

As for the question of how often syntactic structure is spelled out, or sent to the morphological component, there are at least three current proposals in the Distributed Morphology literature. The first is that morphophonological spellout occurs at syntactic phase boundaries (Marvin, 2002; Embick, 2010; Jenks and Rose, 2015). The second is that morphological operations apply cyclically at every instance of syntactic merge (Bobaljik, 2000; Matushansky, 2006). The third is that morphophonological domains do not align

in any predictable way with syntactic domains (Deal and Wolf, 2013). For this purposes of this paper, I assume that the spellout-by-phase approach is correct, and that relevant phases are at least DP, vP, and CP, though this decision is not crucial for the proposed analysis.

Unlike the suppletive allomorphy approach dismissed in section 3.1.2, there is no need for duplicate vocabulary entries for each verb on this model. Instead, each verb has only one entry, unspecified for insertion context. The tonal difference between imperfective and imperfective verb forms will fall out later, during the phonological component. The single vocabulary entry proposed for the verb 'eat' is given in (17).

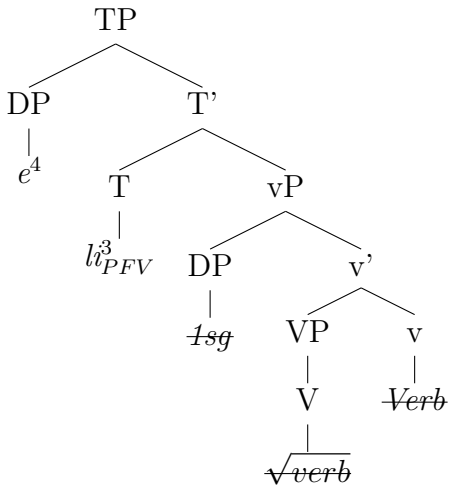
(17) **Vocabulary entry for the Guébie verb *li*, 'to eat'**

- li^3

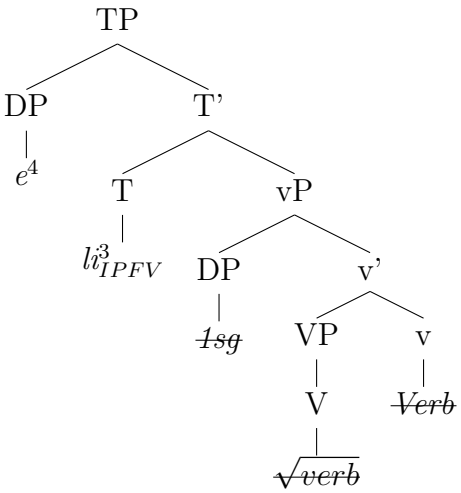
Due to its lack of specified insertion context, the vocabulary entry in (17) will be inserted in both perfective and imperfective contexts. For this reason, perfective and imperfective derivations will look (almost) identical during the morphological component, as shown in (18), where li^3 has been inserted in to both the perfective and imperfective structures..

(18) **Morphological structure after vocabulary insertion**
Guébie perfective and imperfective *li*, 'to eat'

a. Perfective 'I ate'



b. Imperfective: 'I eat'



After vocabulary items are inserted, they are linearized. Even at this point the imperfective and perfective derivations are identical except for the presence of an imperfective or perfective feature (19).

(19) **Input to phonology for Guébie perfective and imperfective *li*, 'to eat'**

a. $/\text{e}^4\ \text{li}^3{}_{IPFV}/$

b. $/\text{e}^4\ \text{li}^3{}_{PFV}/$

After linearization, the string of vocabulary items and morphosyntactic features is evaluated by the phonological grammar. It is during the phonological component that the tone in imperfective contexts undergoes shift. Note that in this model, morphosyntactic features are preserved through morphology, including Linearization, and are available to the phonology. This assumption contradicts Bobaljik (2000)'s proposed Rewrite Rule, which says that morphosyntactic features are erased upon insertion of vocabulary items;

however, I follow the growing body of literature arguing against the Rewrite Rule (cf. Gribanova and Harizanov 2015; Winchester 2016, and Match Theory constraints which reference hierarchical structure, Selkirk 2011).

Now considering the structure of the phonological component, I follow Cophonology Theory (Itô and Mester, 1995; Anttila, 2002; Inkelas and Zoll, 2005) in saying that languages have multiple distinct morpheme-specific phonological grammars. I assume that not every morpheme has a distinct grammar; rather, there are morpheme-specific grammars as well as an 'elsewhere' grammar. If the phase or spellout domain being evaluated contains a morpheme for which there is a morpheme-specific phonological grammar, that grammar applies, as in the Guébie imperfective. Otherwise, the 'elsewhere' phonological grammar applies, as in the Guébie perfective.

The choice of Cophonology Theory over any other constraint-based theory of phonological evaluation is crucial for two reasons: 1) We need distinct phonological phenomena to apply to different subsets of the grammar, and 2) We need the perfective morpheme to be evaluated by a distinct phonological grammar from the imperfective. While a number of constraint-based theories involve multiple distinct phonological grammars within the same language (cf. Stratal OT (Bermúdez-Otero, 1999; Kiparsky, 2000, 2008), Lexical Phonology and Morphology (Kiparsky, 1982)), Cophonology Theory allows the trigger for a given grammar to be the presence of a particular morpheme. This differs from stratal theories, which assume roots, stems, and words can be evaluated on the basis of distinct phonological rules or constraints. In a stratal account, there would be no way to ensure that perfective and imperfective verbs were evaluated by distinct grammars, since there is no reason to assume that they are introduced in distinct strata or in distinct structural positions. In the proposed Cophonology-based model, the phonological constraints specific to the imperfective and elsewhere cophonologies are what determine the tonal difference between perfective and imperfective forms in Guébie ([e^4 li^3] vs [e^4 li^2]).

In this section I have demonstrated that process morphology can be accounted for in a DM-based theory of morphology, as long as we allow for the following: 1) Morphosyntactic features that remain in the derivation through morphological operations and are available to the phonology, and 2) The phonological component assigning a phonological grammar to each spellout domain based on such features. That is, we need not say that all morphology is item-based.

The specific constraints relevant for scalar tone shift in imperfective grammar and to avoid scalar shift in elsewhere contexts are discussed in section 3.3.

3.3 The constraints relevant for Guébie tone shift

The input to the phonological component is made up of vocabulary items and morphosyntactic features. Possible outputs are evaluated by constraints ranked differently based on the morphosyntactic construction in question. Crucially for the Guébie imperfective, the optimal output candidate must be tonally different than the input. Thus, we need a constraint motivating the difference between input and output tone. I propose the use of Transderivational Antifaithfulness (Alderete, 2001), though I acknowledge that this constraint, (20) could equally be replaced by Kurisu (2001)'s definition of RealizeMorph or Mortensen (2006)'s Diff.

(20) **¬Id-Tone**
Assign one violation if the tone pattern of the candidate in question is identical to the tone of the input.

When ¬ID-TONE is active, or highly ranked, candidates whose tone melody differs from the input grammar candidate) will be preferred.

The second crucial aspect of a constraint-based analysis of Guébie tone shift is that candidates and inputs cannot only consist of a verb, because the imperfective tone shift also affects subjects, (9, 10). For this reason I evaluate multiword candidates of subject and verb together.

Support for the subject and verb being simultaneously evaluated in the phonology comes from the fact that they are in the same spellout domain (phase). There is no distinction between words and phrases in DM, so there is no need to treat inflectional paradigms within words differently from those that span words within a syntactic phase. All elements that are spelled out together should be evaluated together phonologically.

Along with the antifaithfulness constraint ¬ID-TONE, we need a corresponding faithfulness constraint. This identity constraint must be defined in a scalar manner, where the further along the scale an output element is from the original input, the more violations are incurred (cf. Kirchner 1997). The scalar evaluation of ID-TONE is necessary to ensure that the optimal candidate only minimally differs on the tonal scale from the corresponding input tone (22c).

(21) **ID-Tone**
Assign one violation for each step on the tone scale that an output tone differs from its corresponding input tone.

The following tableau shows the ranking of the antifaithfulness and corresponding faithfulness constraint in the imperfective grammar. I set aside discussion of the elsewhere grammar for now, knowing that faithfulness must be undominated in the elsewhere (perfective) context.

(22) **¬ID-Tone ≫ ID-Tone**

$e^4\ li^3_{ipfv}$	¬ID-TONE	ID-TONE
a. ☞$e^4\ li^2$		*
b. $e^4\ li^3$	*!	
c. $e^4\ li^1$		**!

While the above constraints get us the unfaithful candidate in the imperfective, there are four possible ways in which a multiword candidate could satisfy the ¬ID-Tone constraint, but only two are attested in Guébie, (23).

(23) **Options for tone antifaithfulness**

	Raising	**Lowering**
Subject	✓	-
Verb	-	✓

While we see two of the four possible tonal antifaithfulness strategies, we need to not only ensure that the others (verbal tone raising and subject tone lowering) never occur, but also that each of subject tone raising and verb tone lowering occur in the right context. I propose the use of Mortensen (2006)'s NOHIGHER and HIGHER constraints, targeted

towards specific syntactic nodes[5] Precedence for phonological constraints needing access to syntactic structure comes from Match Theory (Selkirk, 2011).

(24) **NoHigher(T)** (Mortensen, 2006, 14)
For each element in T, assign one violation if its tone surfaces higher on the tone scale than the corresponding input tone.

(25) **Higher(DP)** (Mortensen, 2006, 14)
For each tone on a DP-internal in the output, assign one violation if it does not surface higher on the tone scale than the corresponding input tone.

Because Ds are considered to be syntactic phase heads, and the subject is inside a DP but its tone can be manipulated in imperfective contexts, our model must allow for the phonological content of spelled out phases to be manipulable. I follow Michaels (2013); Surkalović (2013); McPherson and Heath (2016) in saying that phonological content of phases is indeed manipulable after spellout, but that IDENT-PHASE constraints protect previously phonologically determined content. While DP phases must be available to tonal shift after spellout, we want to avoid our tonal shift affecting syntactic objects of the verb, and other content within the vP. This means that IDENT-PHASE(vP) must be highly ranked, while IDENT-PHASE(DP) is crucially outranked.

(26) **Ident-Phase(v)** (adapted from (McPherson and Heath, 2016, 613))
Assign one violation if the phonological content of a v phase is distinct in the output from the input.

(27) **Ident-Phase(D)** (adapted from (McPherson and Heath, 2016, 613))
Assign one violation if the phonological content of a D phase is distinct in the output from the input.

While these IDENT-PHASE constraints are necessary to rule out tone shift affecting an object DP, I only consider intransitive verbs here for the sake of simplicity. Thus, I leave the IDENT-PHASE constraints out of the following tableaux.

These constraints are ranked in (29 with the addition of ID-DP. This novel constraint ensures that verb tone lowering is the default tone antifaithfulness strategy, and that subject raising is a last resort strategy. This constraint is motivated by typological data showing that a number of languages tend to be more faithful to the input form of a noun than to other categories (Smith, 2011).

(28) **ID-DP**
Assign one violation for every output element that differs between an output DP and its corresponding input.

(29) **¬ID-Tone ≫ ID-Tone, NoHigher(V) ≫ ID-DP ≫ Higher(N)**

$e^4\ li^3_{ipfv}$	¬ID-TONE	ID-TONE	NOHIGHER(V)	ID-DP	HIGHER(N)
a. $e^4\ li^3$	*!				*
b. ☞$e^4\ li^2$		*			*
c. $e^4\ li^1$		**!			*
d. $e^4\ li^4$		*	*!		*
e. $e^5\ li^3$		*		*!	
f. $e^3\ li^3$		*		*!	*

[5]If our syntax is such that every DP has a D feature and every T has some inflectional feature, these constraints could target features rather than syntactic nodes.

The constraints in (29) rule out a faithful imperfective candidate (29a), as well as those candidates with are tonally antifaithful by lowering the verb to too far (29c), raising the verb (29d), raising the subject (29e), or lowering the subject (29f). This ranking accounts for all cases where the input of the verbal tone is higher than 1.

To account for subject raising in cases where the verb is already low, we need to say something more in order to get the correct output (30).

(30) **¬ID-Tone ≫ ID-Tone, NoHigher(V) ≫ ID-DP ≫ Higher(N)**

$e^4\ pa^1_{ipfv}$	¬ID-Tone	ID-Tone	NoHigher(V)	ID-DP	Higher(N)
a. $e^4\ pa^1$	*!				*
b. ☹ $e^4\ pa^0$		*			*
c. $e^4\ pa^2$		*	*!		*
d. $e^5\ pa^1$		*		*!	
e. $e^3\ pa^1$		*		*!	*

In order to ensure that the candidate with a superlow tone on the verb, candidate b in 30), does not win, I propose a markedness constraint *0 which ensures no superlow tones in the output.

(31) ***0**
Assign one violation for every instance of a superlow tone in the output.

The addition of this constraint results in the desired optimal candidate, (32).

(32) **¬ID-Tone, *0 ≫ ID-Tone, NoHigher(V) ≫ ID-DP ≫ Higher(N)**

$e^4\ pa^1_{ipfv}$	¬ID-Tone	*0	ID-Tone	NoHigher(V)	ID-DP	Higher(N)
a. $e^4\ pa^1$	*!					*
b. $e^4\ pa^0$		*!	*			*
c. $e^4\ pa^2$			*	*!		*
d. ☞$e^5\ pa^1$			*		*	
e. $e^3\ pa^1$			*		*	*!

The tableaux in (32) and (29) show that the proposed constraint ranking accounts for tonal shift in the imperfective grammar. While we have only accounted for cases of monosyllabic subjects and monosyllabic verbs here, it would be trivial to adapt the analysis to account for more complex cases of multiword subjects and polysyllabic verbs. Recall that only the final tone of the subject and first tone level of a verb are affected by the scalar tone shift in Guébie. In the context of a monosyllabic subject and verb, we can use constraints like Higher(DP), which say that all tones within a DP should surface higher in the output than they are in the input. However, in more complex cases, we need to align the effects of Higher(DP) and NoHigher(T) the the right and left edge of the DP and T, respectively.

One alternative to the alignment strategy is to propose a constraint that specifically targets the juncture between subject and verb. Such a constraint would be phrased as antifaithfulness to the tonal difference between subject and verb. While this gets us the right result, the typological value of this kind of constraint seems quite low. It is difficult to see whether any other cross-linguistic phenomenon would require a constraint that prefers antifaithfulness at the subject/verb juncture. If we could find motivation for such a constraint in the literature on syntactic boundaries that are overtly phonologically marked (Selkirk, 2011), or on surprisal effects (Levy, 2013), such a constraint would seem much more plausible.

In the elsewhere grammar, which evaluates subjects and verbs in perfective contexts, the only crucial ranking is that ID-TONE must outrank all markedness and antifaithfulness constraints. This will result in the faithful candidate surfacing every time, as is true of the perfective in Guébie.

The proposed analysis has the following benefits: it results in the correct optimal candidates, it uses constraints needed to account for scales and tonal overlays cross-linguistically (Mortensen, 2006; McPherson and Heath, 2016), and it captures the intuitive generalization about what is happening in the data: In imperfective contexts, the verb tone lowers if possible. If not, the subject raises.

One might ask whether other constraint-based models could also account for the Guébie scalar tone data. Specifically, an account that specifically requires contrast within cells of an inflectional paradigm seems ideal for the Guébie imperfective tone shift. However, one benefit of the Cophonology account is that we need Cophonologies to account for other tonal phenomena in Guébie as well, which I will show in the following section. It is unclear that a paradigm-based analysis like Optimal Paradigms (McCarthy, 2005) can be leveraged to account for any other phenomenon in Guébie. Despite the fact that an Optimal Paradigms analysis and constraints like (Padgett, 2003)'s *MERGE could also adequately account for the Guébie facts, I propose that a Cophonologies account of Guébie is preferable because it works to account for morphologically conditioned phonological process across the language.

4 Other instances of tonal morphology in Guébie

The scalar tone shift presented in section 2 is situated within a larger system of tonal morphophonology. In addition to the imperfective scalar tone shift, there are other instances of tonal morphology involving scalar shifts and tonal overlays (in McPherson and Heath 2016's terms). In this section I discuss two such tonal phenomena. The first is another instance of scalar tone shift, and the second is a tonal overlay process which I show can be handled by the same structure as the scalar data. What the tonal processes in Guébie have in common is that they all involve a systematic tone change in the environment of a particular morphosyntactic feature.

4.1 Scalar tone shift as case marking

Just like the scalar tone shift in imperfective contexts, there seems to be a scalar tonal relationship between nominative and accusative pronouns in Guébie. Object pronouns in Guébie, those that surface immediately after the auxiliary or inflected verb, display default or lexical tone (34), while those in subject position surface one step higher.

(33) **Object pronouns in Guébie**

	Human			**Non-human**	
	Singular	**Plural**		**Singular**	**Plural**
1st	e^3	a^1	**1st**	–	–
2nd	e^1	a^2	**2nd**	–	–
3rd	$ɔ^2$	wa^2	**3rd**	e^2,$ə^2$,u^2	i^2,wa^2

When they appear in subject position, pronouns surface immediately before the auxiliary or inflected verb, and systematically surface with tone one step higher than their object counterparts.

(34) **Subject pronouns in Guébie**

	Human			Non-human	
	Singular	**Plural**		**Singular**	**Plural**
1st	e^4	a^2	**1st**	–	–
2nd	e^2	a^3	**2nd**	–	–
3rd	$ɔ^3$	wa^3	**3rd**	e^3,$ə^3$,u^3	i^3,wa^3

I assume that the featural difference between subject and object pronouns is nominative versus accusative case. We know that tone raising on accusative pronouns is not a generally applicable tonal overlay or tone shift initiated by the verb affecting subjects in general, because only pronouns show a difference in tone when in object versus subject position (except when affected by the imperfective scalar tone shift discussed in section 2). Full noun phrases do not show a tonal difference between subject and object position, (35).

(35) **Full noun phrases do not show a case distinction**

a. ju^4 ni^4 $=ɔ^2$ ji^3
child see.PFV =3SG.ACC PART
'The child saw him.'

b. $ɔ^3$ ni^4 ju^4 ji^3
3SG.NOM see.PFV child PART
'He saw the child.'

The noun 'child' in (35) has the same tone in subject position (a) and object position (b). Just like in English, then, only pronouns show overt case distinctions. We could explain this by saying that pronouns contain a different amount of syntactic structure than other noun phrases in Guébie, or that the nominative case assigner in Guébie probes for a feature that only pronouns have, and that other nouns do not require case licensing (cf. Preminger 2011).

The analysis presented in section 3 easily extends to the nominative scalar tone shift. In the environment of a morphosyntactic nominative case feature, the nominative cophonology applies. In this cophonology, HIGHER(DP)[6] is highly ranked, IDENT-PHASE(DP) is crucially outranked, and IDENT-PHASE(vP) is undominated in order to avoid raising the tone of the object. The optimal candidate is then the one where the tone of the nominative pronoun is one step higher than the input tone.

There are two main supporting arguments for the claim that accusative pronouns show default tone, while the tone on nominative pronouns is derived. First, for languages that show case distinctions in Africa, it is normally nominative case which is marked (Creissels et al., 2008, 87-91). Thus, Guébie represents another case of a marked nominative language in Africa, conforming to the areal features of the Macro-Sudan Belt.

[6]For space reasons I do not go into the syntax of pronouns versus other noun phrases here, but any model of nominative case in Guébie must account for the fact that only pronouns are affected by this nominative tone raising. If syntactic properties of pronouns indeed convince us that pronouns contain more syntactic structure than other noun phrases, this constraint might actually target something larger than a DP, say a KP (case phrase). Alternatively, we could say that nouns need not be licensed by case in Guébie (see Jenks and Sande 2016's analysis of case in Moro), and only pronouns are ever assigned case to begin with, so the nominative cophonology will only ever apply when a pronoun is in subject position. Future work will illuminate which syntactic analysis makes better predictions for Guébie.

Second, we saw in section 3.3 that we already need a constraint HIGHER(DP), which applies to subjects but not objects or other DPs inside vP. This same constraint seems to be at work in the raising tone shift of nominative pronouns. If nominative pronouns had default tone, and accusative pronouns were derived, we would have to posit a NO-HIGHER(DP) constraint to be at play in accusative contexts, requiring contradictory constraints, NOHIGHER(DP) and HIGHER(DP) both to be present in the same grammar. By assuming that the accusative form of Guébie pronouns is the default, we avoid this constraint contradiction.

The fact that the same constraints (such as HIGHER(DP)) are needed elsewhere in the grammar supports their use to account for imperfective scalar tone shift. Unlike the tone on verbs, we cannot base our analysis of which form is default on the quality of the tones themselves (there is no superhigh pronoun tone, for example). Because the inventory of pronouns is limited to those in (34, 33), we cannot further probe the pronoun system for evidence that accusative is the default case. Either way, the model presented in section 3.2 and the constraints in 3.3 (with few adjustments if nominative is in fact the default form) can be used to account for both aspect and pronoun tone shift in Guébie.

I return briefly to the question of whether an Optimal Paradigms account (McCarthy, 2005) could just as adequately handle the Guébie data. This would involve evaluating a paradigm of nominative and accusative pronouns, where constraints preventing merger within a paradigm result in the tone change in nominative contexts. While this would work, I argue that it is not as favorable as a cophonologies account because Cophonology Theory but not Optimal Pardigms can also account for the tone data in section 4.2.

4.2 Tone replacement in noun-noun compounds

The third instance of morphological tone we will discuss here involves a tonal overlay, also called REPLACIVE TONE, on the second noun of a genitive noun-noun compound. Noun-noun compounds in Guébie always have an associative, or genitive, meaning. No matter which noun surfaces as the first or second noun in the compound, the tone of the second noun is always replaced with a level 2 tonal melody.

The data in (36) shows the default lexical tone for a number of Guébie nouns. This is the tone used on nouns in object position, focused position, subject position (except when followed by a tone-1 imperfective verb), as the object of a postpositional phrase, and as the first noun in a noun-noun compound. The data in (37) then shows those same nouns in noun-noun compounds, where the second noun of the compound always has a level tone-2 melody.

(36) **Default tone**

	Noun with default tone	**Gloss**
a.	ɲito$^{3.1}$	'fiancé'
b.	ju^{4}	'child'
c.	mana$^{3.3}$	'meat'
d.	di^{3}	'cut'
e.	ɲo^{31}	'person'
f.	bitə$^{2.3}$	'house'
g.	wəli$^{3.2}$	'top'

(37) **Noun-noun compounds in Guébie**

a. ɲito$^{3.1}$ ju^{2}
fiancé child
'daughter in-law'

b. mana$^{3.3}$ di-ɲo$^{2.2}$
meat cut-AGT
'butcher'

c. bitə$^{2.3}$ wəli$^{2.2}$
house top
'top of house'

Much like the scalar tone phenomena in the environment of a nominative or imperfective feature, we can analyze this tonal overlay as a phonological change motivated by constraints in the environment of a particular morphosyntactic feature. Here the relevant features is genitive. Unlike the previous cases, the genitive feature does not trigger a scalar process, but a tonal overlay. For other instances of tonal overlays analyzed via constraints, see McPherson and Heath (2016).

To account for this tonal overlay in genitive constructions, we could imagine a genitive-specific phonological grammar that ensures tone replacement of the second noun in the compound. In this genitive-specific grammar, a constraint like the one in (38), in the style of McPherson and Heath (2016)'s tone overlay constraints, ensures that the second noun of a compound surfaces with tone 2.

(38) **Noun Noun^{2}**
Assign one violation for every noun immediately following another noun that does not have a level tone melody of 2.

While there are instances of nouns followed immediately by other nouns in Guébie (indirect and direct objects in ditransitive constructions), the constraint above will be crucially outranked in the elsewhere grammar, and its effects will only apply in the genitive-specific phonology.

Just as the analysis proposed in 3 accounted for two instances of scalar tone shift in Guébie, it can also account for other instances of morphologically conditioned phonology such as tonal overlays. However, it is less clear how an Optimal Paradigms (OP) analysis, while perhaps able to account for inflectional tonal changes on verbs or case-based tonal differences on nouns, would be able to account for tonal overlays in genitive contexts. The most reasonable way to attempt an OP analysis of the genitive tonal overlay is to say that every noun forms a paradigm with that same noun when it is the syntactic head of a genitive noun-noun compound. However, there does not seem to be any kind of inflectional relationship between the noun of a genitive-noun construction and that same noun in any other context, so it does not seem reasonable to posit such a paradigm. If the genitive noun in the noun-noun compound underwent a tonal overlay, we could say it was in a case-based paradigm with the uninflected form of that noun, but it is the head noun, not the genitive noun of a compound which undergoes a tonal change in a genitive construction.

The Guébie genitive tonal overlay is predicted by Cophonology Theory plus tonal overlay constraints (McPherson and Heath, 2016), but not by an Optimal Paradigms

approach. Thus, we see that three distinct instances of tonal morphologically conditioned phonological processes in Guébie can be accounted for with the proposed analysis: Phonology has access to morphosyntactic featural information and assigns a phonological grammar to each spellout domain based on those morphosyntactic features.

5 Conclusion

I have shown that morphologically conditioned phonological processes such as Guébie scalar tone can be modeled without underlying phonological representations. The availability of morphosyntactic features to the phonological component of grammar is enough to trigger phonological change in the appropriate contexts. I see this as a benefit because syntactic and morphological operations already need to refer to morphosyntactic features, and we now know that the same features can be utilized by the phonological domain. We need not posit an extra layer of abstraction, abstract underlying phonological representations. This analysis extends to other areas of morphologically conditioned phonology in Guébie, to be discussed in future work.

The contributions of this paper to morphological theory are numerous. First, I have shown that existing DM mechanisms do not adequately account for morphologically conditioned phonology, and I have proposed a synthesis of existing theoretical tools to fill that gap. While I do not doubt the existence of root suppletion, it is not an adequate model of predictable morphologically conditioned phonology. The analysis proposed here makes clear predictions about which cross-linguistic phenomena involve root suppletion and which involve phonological processes triggered by morphosyntactic features: If a change is lexically conditioned, root suppletion is the right analysis, but if it is construction specific (triggered by a particular morphosyntactic feature or syntactic position), it involves constraint-driven phonological changes tied to particular cophonologies.

Second, the proposed analysis bears on the discussion of whether phonological content can be manipulated after spellout. Recall that the ranking of IDENT-PHASE constraints (McPherson and Heath, 2016) allowed for a candidate to surface as optimal (in imperfective subject raising contexts) despite lack of identity with the already spelled out subject DP. This analysis is built on the assumption that identity to previously spelled out phases or domains is violable.

Additionally, the scalar tone shift in Guébie represents a new type of tone scale, contributing to our understanding of the typology of phonologically scalar phenomena (Mortensen, 2006). In the Guébie tone shift, we see syntagmatic contrast maintained not just within words, but across multiple words within a morphosyntactic domain. By combining aspects of DM with Cophonology Theory, we get a model of realizational morphophonology that accounts for the predictability of morphologically conditioned phonological processes, including scalar tone shift, without requiring abstract underlying phonological representations.

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