Process morphology in a realizational theory [*]

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1 Introduction

- Here I demonstrate that process morphology need not be analyzed with an abstract underlying phonological representation.
  - Instead, by combining DM operations with Cophonology Theory, morphologically conditioned phonological processes emerge via constraint interaction.
- I describe a unique pattern of scalar tone shift motivated by phrase-level contrast based on original data from Guébie (Kru) [Côte d'Ivoire].
  - ▷ Tone on verbs shifts one step down in the imperfective.

(1) **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.'

  - ▷ A lexical low tone cannot lower further in imperfective contexts.
  - ▷ **Instead, the tone of the preceding word raises one step**.

(2) **Subject tone raises when verb is low**

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

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

- When the verb is already low, the subject raises to maintain contrast within the paradigm.

[*]Thanks to my Guébie consultants Sylvain Bodji, Olivier Agodio, Serikpa Emil, and Gnakouri. Thanks also to Sharon Inkelas, Larry Hyman, Peter Jenks, and Darya Kavitskaya for comments. I use the following abbreviations: SG = singular, PL = plural, IPFV = imperfective, PFV = perfective, IRR = irrealis, NOM = nominative, ACC = accusative, Q = polar question particle, 1 = first person, 2 = second person, 3 = third person.

- **Proposals**:
  1. The only URs needed to account for process morphology are morphosyntactic features (contra Trommer (2001); Zimmermann (2013); Trommer and Zimmermann (2014); Köhnlein (2016) who analyze process morphology as involving abstract phonological representations).
  2. By combining mechanisms of Cophonology Theory with Distributed Morphology we can model the phonological predictability of scalar tone shift in a realizational morphological theory.
  3. Constraints requiring contrast together with scalar faithfulness and markedness constraints (Mortensen 2006) can ensure subject tone raising and verb tone lowering in the right contexts.

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]
- Word order alternates between SAuxOV and SVO.
  - When auxiliaries are present, there is no inflection on verbs.
  - When there is no auxiliary, the verb surfaces immediately after the subject.
  - Nothing can ever intervene between subject and auxiliary or subject and inflected verb.
- A given verb shows the same tone melody in all contexts but the imperfective, (3).

(3) **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.'

- In imperfective contexts (SVO), tone on the verb surfaces one step lower on the four-height tone scale, (4).

[1]The data in this paper 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.

(4) **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.'

- Only the first tone of a verb is affected by the tone lowering process.

(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'

(6) **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.'

(7) **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'

- We can restate this shift by saying that the first tone level of a verbal tone melody surfaces one step lower in imperfective contexts than other contexts.

(8) **Imperfective scalar tone shift**

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

- Verbs with low tone in non-imperfective contexts do not lower to super-low tone, 0, in the imperfective.
- But, we do not see complete neutralization between perfective and imperfective contexts either.

- 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'

- This 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'

- When a verb has a low default tone, imperfective is differentiated from perfective by the final subject tone surfacing one step higher than it otherwise would.

- 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.

  - Such a scalar shift is as yet unattested in other languages (Mortensen 2006).

- This consistent tone change is represented in (11), 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.

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

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

- **Data summary**: 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.

3 Scalar shift in Distributed Morphology

3.1 Considering existing options

- We can start by asking what is the underlying representation of the imperfective morpheme in Guébie?
  - 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).
- 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 tone shift in Guébie is relational; there is no assimilation to or dissimilation from a target.
    - The table in (12) shows all possible tone combinations between perfective and imperfective for a subject with default tone 2.

(12) **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.
- No UR can adequately account for this shift; an item and arrangement model does not work.
- The imperfective lacks an underlying phonological representation, but triggers a phonological process.
- 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[2,3].

(13) **Vocabulary entries for the Guébie verb *li*, 'to eat'**
  - $li^2 \longleftrightarrow$ [IPFV]
  - li^3

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

[3]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.

  - For every verb whose 'elsewhere' form does not have tone 1 in Guébie, there must be two segmentally identical vocabulary entries, one whose tone is exactly one step lower than the other.
  - For every possible subject that can surface before a low toned verb, there must be two entries, one whose final tone is exactly one step higher than the other.

- **Problem**: The suppletive allomorphy approach fails to capture the generalization that the relationship between imperfective verbs and other forms of the same verb is phonologically predictable.

- **Readjustment rules** involve transformational rules that apply to single lexical items or subsets of lexical items in certain morphosyntactic contexts.

  - The use of readjustment rules 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).
  - 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.
    - Gribanova (2015) argues that with the right underlying representation we don't need readjustment rules, just regular phonological rules or constraints.

- **Problem**: The status of readjustment rules is questionable, and the proposed alternatives involve allomorphy and underlying representations.

- Neither readjustment rules nor suppletive allomorphy are reasonable models of process morphology.

3.2 The structure of the model

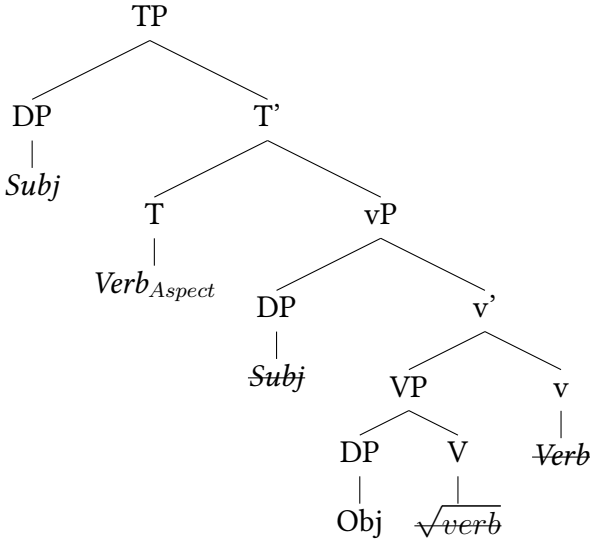
- Here I propose a novel model of realizational morphology combining DM mechanisms (Halle and Marantz 1993, 1994) with morpheme-specific grammars of constraint evaluation as per Cophonology Thoery (Itô and Mester 1995; Anttila 2002; Inkelas and Zoll 2005).

The morphology:

- Like DM, this model assumes that syntactic structure is the input to morphology.

  - The syntactic structure of a transitive verb in Guébie, argued for by Sande (In Press), is given in (14).

(14) **The input to morphology**



- Morphological operations apply to the hierarchical syntactic output, (14).
- I set aside the debate about how often syntactic structure is spelled out.
  - There are two prominent proposals on the domain of spell-out:
    1. Spellout occurs at syntactic phase boundaries (Marvin 2002; Embick 2010; Jenks and Rose 2015).
    2. Spellout occurs at every instance of syntactic merge (Bobaljik 2000; Matushansky 2006).
  - For our purposes I assume the domain of spellout is the syntactic phase (vP, CP, DP).
- Unlike the suppletive allomorphy approach, here there is only one vocabulary entry for each verb, unspecified for insertion environment.
  - The tonal difference between imperfective forms and other forms of the verb is determined later by the phonology.

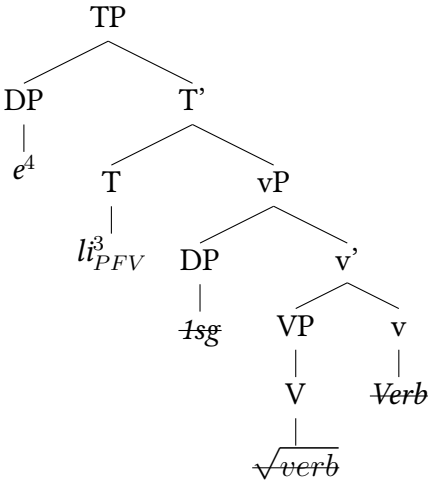
(15) **Vocabulary entry for the Guébie verb *li*, 'to eat'**

- li^3

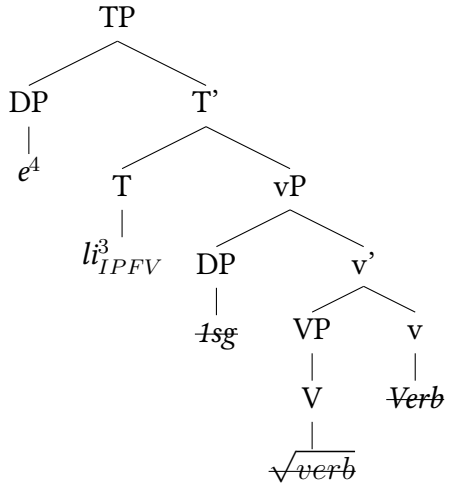
- In Guébie, the syntactic structure is identical in imperfective and perfective constructions.
- And because there is only one vocabulary entry for each verb, the same vocabulary item is inserted in both imperfective and perfective constructions, (16).

(16) **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 (17).

(17) **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.
  - Note that in this model, morphosyntactic features are preserved through morphology, including Linearization, and are available to the phonology.

The phonology:

- I follow Cophonology Theory in saying that languages have multiple morpheme-specific phonological grammars.
    - Differing from Cophonology Theory, I propose that not every morpheme has a distinct grammar; rather, there are morpheme-specific grammars as well as an 'elsewhere' grammar.
- If the phase 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.
    - Theories of the interaction of morphology with phonology that are less appropriate for the Guébie data because the same phonological grammar would apply to a perfective verb and an imperfective verb include:
        - Stratal OT (Bermúdez-Otero 1999; Kiparsky 2000, 2008)
        - Lexical Phonology and Morphology (Kiparsky 1982)
        - Global evaluation of tonal overlays (McPherson and Heath 2016)
- 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]).
- The specific constraints relevant for the imperfective and elsewhere phonologies in Guébie are discussed in section 3.3.
- **Interim summary**: Process morphology can be accounted for in DM as long as we allow for the following:
    1. Morphosyntactic features remain in the derivation through morphological operations and are available to phonology.
    2. The phonological component assigns a phonological grammar to each phase based on such features.

3.3 The constraints relevant for Guébie tone shift

- Crucial to the analysis of Guébie scalar tone shift is that despite input similarity, imperfective and perfective subject-verb strings must differ in tone in the output.
- Thus, there must be a constraint which motivates a difference between input and output tone.
- I propose the use of Transderivational Antifaithfulness (Alderete 2001), which assumes that every faithfulness constraint has a converse antifaithfulness constraint[4].
- Specifically for Guébie, I propose the tonal antifaithfulness constraint in (18).

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

- With ¬Id-Tone active in the imperfective-specific grammar, candidates whose tone melody differs from the input (and thus from the optimal elsewhere (perfective) grammar candidate) will be preferred.

[4]The faithfulness and antifaithfulness constraints used here are theoretically equivalent to Mortensen (2006)'s scalar identity and anti-identity constraints

- Crucially, 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.
- 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).

(19) **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.

(20) **¬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:

(21) **Options for tone antifaithfulness**

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

- We need to ensure tone lowering on the verb and tone raising on the subject, each in the right context, and avoid verb tone raising and subject tone lowering.

(22) **NoHigher(Verb)** (Mortensen 2006:14)
For each verb tone in the output, assign one violation if it surfaces higher on the tone scale than the corresponding input tone.

(23) **Higher(Noun)** (Mortensen 2006:14)
For each tone on a noun in the output, assign one violation if it does not surface higher on the tone scale than the corresponding input tone.

- To ensure verb lowering is preferred to subject raising, ID-Noun is proposed. Such a constraint is motivated by a general category difference between nouns and verbs across languages (Smith 2011).

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

(25) **¬ID-Tone ≫ ID-Tone, NoHigher(V) ≫ ID-Noun ≫ Higher(N)**

$e^4\ li^3_{ipfv}$	¬ID-Tone	ID-Tone	NoHigher(V)	ID-Noun	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. $e^3\ li^3$		*		*!	*

- The above ranking accounts for those cases where the verb has input tone higher than 1; however, these constraints are not enough to account for cases of subject tone raising when the verb is already low.

(26) **¬ID-Tone ≫ ID-Tone, NoHigher(V) ≫ ID-Noun ≫ Higher(N)**

$e^4\ pa^1_{ipfv}$	¬ID-Tone	ID-Tone	NoHigher(V)	ID-Noun	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 candidate b in (26) does not win, I propose a markedness constraint *0 which ensures no superlow tones in the output.

(27) ***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, (28).

(28) **¬ID-Tone, *0 ≫ ID-Tone, NoHigher(V) ≫ ID-Noun ≫ Higher(N)**

$e^4\ pa^1_{ipfv}$	¬ID-Tone	*0	ID-Tone	NoHigher(V)	ID-Noun	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 (28) and (25) show that the proposed constraint ranking accounts for tonal shift in the imperfective grammar.
- The only crucial ranking in the elsewhere grammar is that ID-Tone outrank all markedness constraints.
  - This results in the default tone of the input vocabulary item always surfacing as optimal in elsewhere contexts.
- This analysis has the following benefits:
  - It results in the correct optimal candidates.
  - It uses constraints needed to account for scales crosslinguistically.
  - It captures the intuitive generalization about what is happening in the data:
    - In imperfective contexts only, the verb tone lowers if possible. If not, the subject tone raises.

4 Conclusion

- I demonstrate that the current structure of Distributed Morphology cannot adequately account for scalar tone shift or other instances of process morphology.
- I propose a synthesis of existing theoretical tools to fill that gap.
- The Guébie data and proposed model have the following implications:
  - The scalar tone shift in Guébie represents **a new type of tone scale** (Mortensen 2006).
  - 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 **without requiring abstract underlying phonological representations**.
- The scalar tone data presented here is situated within the larger context of Guébie tonal morphology, which includes other instances of scalar tone as well as tone replacement, which can also be accounted for with the analysis presented here.
- In future work I plan to test whether the proposed model accounts for other cases of process morphology and morphologically conditioned phonology.

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