Cophonologies by Phase *

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NELS 48 · October 28, 2017

1 Introduction

- **Observation:** In a given language, certain phonological alternations are seen only in specific morphological contexts.
  - For example, in Alabama the onset of the penultimate syllable is geminated in imperfective constructions.

(1) **Alabama imperfective gemination** (Hardy and Montler 1988, 400-401)

	Base	**Imperfective**	**Gloss**
a.	balaaka	bállaaka	'lie down'
b.	cokooli	cókkooli	'sit down'
c.	atakaali	atákkaali	'hang up one object'
d.	atakli	áttakli	'hang more than one object'

- **Question:** How does the phonological component know which grammar to apply in any particular instance of spell-out?
  - How does the phonological component in Alabama know when the domain being spelled out is imperfective, and thus gemination should occur?
- **In this talk** we propose a model of the syntax-phonology interface combining Cophonology Theory (Orgun 1996; Inkelas et al. 1997; Anttila 2002; Inkelas and Zoll 2005, 2007) with Phase Theory (Chomsky 2001; Abels 2012; Bošković 2014), which allows cophonologies to scope over spelled-out chunks of syntax.
- We adopt central assumptions of mainstream syntax and phonology:
  - Phonology and morphology are interpreted from syntactic structures.
  - Phonological processes are modeled using ranked or weighted constraints.
- **Primary contribution:** An enriched conception of Vocabulary Items:

  (a) (Supra)segmental features
  (b) Prosodic content
  (c) A subranking of constraints

*Thanks to our Moro and Guébie consultants, and to comments from Sharon Inkelas. All mistakes are our own. We use the following abbreviations: SG = singular, PL = plural, IRR = irrealis, PROG = progressive, IMPF = imperfective, PFV = perfective, ACC = accusative, Q = polar question particle, 1 = first person, 2 = second person, 3 = third person

Roadmap

2 The Model: Cophonologies by phase

2.1 Cophonologies

- We propose a uniform analysis of process morphology and morphologically conditioned phonology.

(2) **Inkelas's Generalization** (Inkelas 2008, 2014)
Morphologically conditioned phonology and process morphology make reference to the same phonological operations in terms of *Substance, Scope*, and *Layering.*

- Process morphology and morphologically conditioned phonology should be modeled with the same tools.
- Process morphology is more easily modeled with constraint rankings than with concatenative morphology (Inkelas and Zoll 2007; Inkelas 2008, 2014).
  - Contra the purely item-based view of Benua (1997); Alderete (2001); Wolf (2007); Bermúdez-Otero (2012); Trommer and Zimmermann (2014); Bye and Svenonius (2010); Köhnlein (2016).
- Both processes should be modeled with *cophonologies*, the association of constraint rankings with particular morphemes or featural content.

(3) **Our proposal**
Vocabulary Items (Halle and Marantz 1994) associate morphosyntactic features with three phonological components:
a. Featural content ($\mathcal{F}$): Tonal or segmental features of VI
b. Prosodic content ($\mathcal{P}$): Place in prosodic hierarchy, including prosodic subcategorization.[1]
c. A constraint subranking ($\mathcal{R}$): A partial constraint ranking that overrides a default master constraint ranking (Anttila 2002) (or which combine in a weighted constraint model).

- Any of $\mathcal{F}$, $\mathcal{P}$ or $\mathcal{R}$ can be null for a particular VI.
- Consider a hypothetical verbalizing suffix *-ga*, which, with its host, corresponds to a prosodic word and which is associated with the constraint-ranking B≫A:

(4) *Vocabulary Item*: $[v] \longleftrightarrow \begin{Bmatrix} \mathcal{F}: & /\text{ga}/ \\ \mathcal{P}: & [-X]_\omega \\ \mathcal{R}: & \text{B} \gg \text{A} \end{Bmatrix}$

(5) a. Master Ranking (or Weighting): A≫B≫C
b. Active constraint ranking (or weighting) for $[_\omega -ga\ ]$: B≫A≫C

[1] This component of the VI may be dispensable, if a direct mapping approach like that in (Pak 2008) is adopted. However see Bennett et al. (2015) for another examples of prosodic content inserted during vocabulary insertion.

2.2 Cophonologies by phase

- *Phase theory*: Syntactic structure is transferred to PF in constituents called phases, a process called Spell-Out (Chomsky 2000, 2001).
- Spell-Out includes separate operations of *linearization* and *vocabulary insertion*, with morphological operations taking place in-between (Embick and Noyer 2001, 2007; Pak 2008; Embick 2010).
- Phonological operations apply directly to the material that is spelled out at each phase.
  - Earlier versions of this model are adopted in Pak (2008); Jenks and Rose (2015), and Sande (2017).
- What's a phase?
  - Lexically specified categories (e.g. C, D) (Chomsky 2000, 2001; Marvin 2002).
  - Word forming heads and some derivational morphemes (e.g. n, v) (Arad 2003; Embick 2010).
  - Phase size can vary with syntactic processes such as head-movement (Gallego and Uriagereka 2007) or the size of extended projections (Bošković 2014).

(6) **Cophonologies by Phase (CBP):** Cophonologies take scope over the phase in which they are interpreted.

  - Sub-rankings within a phase are inherited by the phase head, and scope over the entire phase domain.

- We survey four case studies where syntactic heads trigger a phonological process, modeled in CBP, with constraint sub-rankings whose domain is a phase:

Case study 1: Hebrew shows that process morphology can be triggered by category-defining heads (v and n).

Case study 2: Kuria shows phonological processes triggered by tense-aspect morphology that crosses word boundaries within a phase.

Case study 3: Guébie shows that phonological processes are suspended until the phase is completed, even if triggered by lower elements.

Case study 4: Dogon shows that multiple phase-internal cophonologies accumulate, that conflicts can be resolved with constraint weighting, and that completed phases can resist further change.

3 Case study 1: Hebrew category-specific prosodic shape

- Verbs are disyllabic, but the prosodic shape of nouns is less restricted (Bat-El 1994; Smith 2011).
- This categorical difference is most clearly seen in loan words, (7).

(7) **The prosodic shape of Hebrew nouns vs. verbs** (Bat-El 1994, 577-578)

Noun		**Verb**	
xantariʃ	'nonsense'	xintreʃ	'talk nonsense'
télegraf	'telegraph'	tilgref	'telegraph'
sinxróni	'synchronic'	sinxren	'synchronize'
ksilofon	'xylophone'	ksilfen	'play the xylophone'
nostálgia	'nostalgia'	nistelg	'be nostalgic'
flirt	'flirt'	flirtet	'to flirt'
blof	'bluff'	bilef	'to bluff'

- The disyllabic verbal template with vowels [i,e] is derived in CBP via vocabulary insertion and constraint-based evaluation[2].

(8) a. Verbal syntactic structure (before linearization)

vP

v $\sqrt{\text{TELEGRAPH}}$

b. Linearization

$v \frown \sqrt{\text{TELEGRAPH}}$

c. $[v] \longleftrightarrow \left\{ \begin{array}{ll} \mathcal{F}: & \text{i,e} \\ \mathcal{P}: & \omega \\ \mathcal{R}: & \omega{=}\sigma\sigma \gg \textsc{Faith} \end{array} \right\}$

d. $[\sqrt{\text{TELEGRAPH}}] \longleftrightarrow \left\{ \begin{array}{ll} \mathcal{F}: & \text{télegraf} \\ \mathcal{P}: & \emptyset \\ \mathcal{R}: & \emptyset \end{array} \right\}$

e. Vocabulary insertion

/i,e télegraf/

f. Phonological constraint-based evaluation

/i,e télegraf/	$\omega{=}\sigma\sigma$	FAITH
a. [té.le.graf]	*!	
b. [tí.li.gref]	*!	
c. ☞[til.gref]		*

(9) a. Nominal syntactic structure (before linearization)

nP

n $\sqrt{\text{TELEGRAPH}}$

b. Linearization

$n \frown \sqrt{\text{TELEGRAPH}}$

c. $[n] \longleftrightarrow \left\{ \begin{array}{ll} \mathcal{F}: & \emptyset \\ \mathcal{P}: & \omega \\ \mathcal{R}: & \textsc{Faith} \gg \omega{=}\sigma\sigma \end{array} \right\}$

d. $[\sqrt{\text{TELEGRAPH}}] \longleftrightarrow \left\{ \begin{array}{ll} \mathcal{F}: & \text{télegraph} \\ \mathcal{P}: & \emptyset \\ \mathcal{R}: & \emptyset \end{array} \right\}$

e. Vocabulary insertion

/télegraf/

f. Phonological constraint-based evaluation

/télegraf/	FAITH	$\omega{=}\sigma\sigma$
a. [til.gref]	*!	
b. ☞[télegraf]		*

[2]Although left out of the representations used here, CBP is entirely compatible with an autosegmental representation of templatic morphology (cf. McCarthy 1981).

Summary

- Lexical categories like v trigger verb-specific process morphology in Hebrew via constraints on prosodic structure.
- If v is a phase, and is associated with a subranking, such processes are expected.

4 Case study 2: Kuria tone melodies

- Tense/aspect prefixes (TA, bold below) have lexically specified tone patterns. (Marlo et al. 2015)
- Different TAs assign H to the first, second, third, or fourth mora of the verb (underlined), and from there spreads to the penultimate TBU.

(10) **Mora-counting H assignment in Kuria verb stems**

μ1	n-to-**o**-[hóótóótér-a]	FOC-1PL-TA-[reassure-FV]	'we have reassured'
μ2	n-to-**oka**-[hoótóóté-éy-a]	FOC-1PL-TA-[reassure-PFV-FV]	'we have been reassuring'
μ3	n-to-**re**-[hootóótér-a]	FOC-1PL-TA-[reassure-FV]	'we will reassure'
μ4	to-**ra**-[hootoótér-a]	1PL-TA-[reassure-FV]	'we are about to reassure'

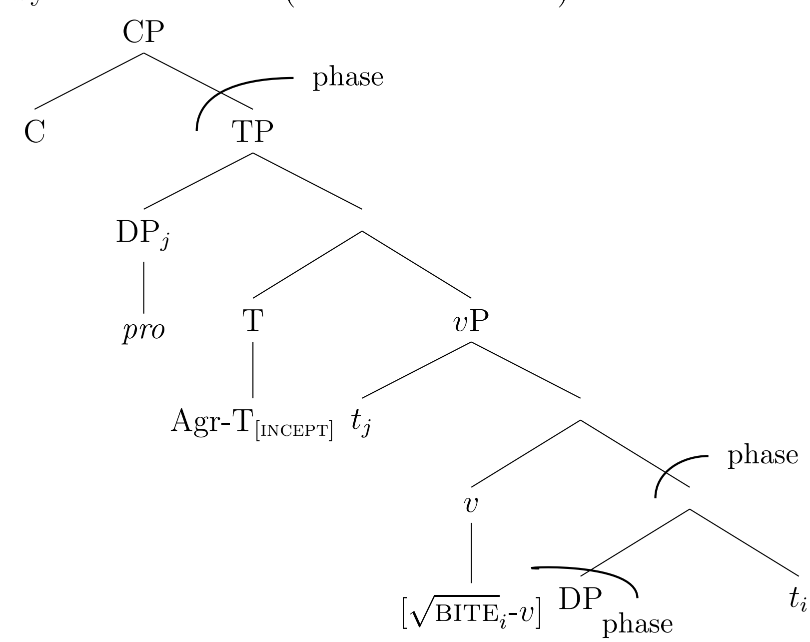
- The domain of this H-assignment is phrasal, including the object:

(11) **Mora-counting H assignment into object position**

μ4	to-**ra**-[rom-a eɣétɔ́ɔ́kɛ]	'we are about to bite a banana'
μ4	to-**ra**-[ry-a eɣetɔ́ɔ́kɛ]	'we are about to eat a banana'

- The CBP model easily accommodates the ability of word-internally, morphologically-triggered phonological operations to span words:

(12) a. Syntactic structure (before linearization)



b. Linearization (completed phases in brackets)
Agr⌢$T_{[\text{INCEPT}]}$ ⌢ [$\sqrt{\text{BITE}}$-v] ⌢[DP]

c. [T,INCEPTIVE] ⟷ $\left\{\begin{array}{ll} \mathcal{F}: & /\text{ra}/ \\ \mathcal{P}: & \text{X-}[\ \ ]_\phi \\ \mathcal{R}: & \mu 4_\phi, \text{SPREAD-(H, R)} \gg \text{IDENT-TONE} \end{array}\right\}$

d. Vocabulary insertion
/to-ra-rom-a [eɣetɔ́ɔ́kɛ]/

e. Phonological constraint-based evaluation

/to-ra-rom-a eɣetɔ́ɔ́kɛ/	$\mu 4_\phi$	SPREAD-(H, R)	IDENT-TONE
a. [to-ra-rom-a eɣetɔ́ɔ́kɛ]	*!		
b. ☞[to-ra-rom-a eɣétɔ́ɔ́kɛ]			*

- Note that the object has already been spelled-out as part of the lower DP phase.
- We assume that the phonology of previously spelled-out phases is manipulable during higher phases (cf. McPherson and Heath 2016's violable IDENTPHASE constraints).

Summary

- Word-internally triggered cophonologies take scope over their entire spell-out domain.

5 Case study 3: Guébie

- The distinction between perfective and imperfective aspect, realized on T in Guébie, is marked by a scalar tone shift (Sande 2017).
  - This scalar tone shift is realized on the verbal head, or on the immediately preceding phonological word, the final word of the subject DP.
- Guébie has four underlying tone heights, marked 1-4, where 4 is high.
- Tone on a verbal head surfaces one step lower in imperfective contexts than elsewhere.

(13) **Verb tone lowering in imperfective contexts**
a. e^{4} $\underline{li^{3}}$ ɟa-ɓə$^{3.1}$ 1SG.NOM eat.PFV coconuts-SG 'I ate a coconut.'
b. e^{4} $\underline{li^{2}}$ ɟa-ɓə$^{3.1}$ 1SG.NOM eat.IPFV coconuts-SG 'I am eating a coconut.'

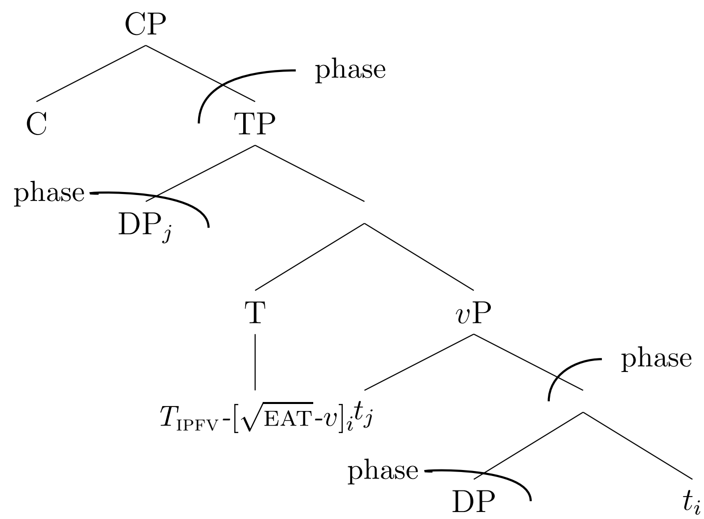
- When the underlying tone of a verb is already low (tone 1), it does not lower further to super-low. Instead, the final tone of the subject raises one step.

(14) **Subject tone raising when imperfective verb is already low**
a. ɟaci$^{23.1}$ pa^{1} Djatchi run.PFV 'Djatchi ran.'
b. $\underline{\text{ɟaci}^{23.2}}$ pa^{1} Djatchi run.IPFV 'Djatchi runs.'

- Crucially the tonal shift, which is triggered by the imperfective T-head, can affect the subject tone, (14), which is in the specifier of TP.

- While this process is difficult to account for in most constraint-based models, both because of its scalar nature and the fact that it crosses word boundaries, it follows naturally from CBP:
  - Cophonologies of vocabulary items are inherited by the phase head containing them, and they apply to the whole spell-out domain, here TP (complement of the phase head C).

(15) a. Syntactic structure (before linearization)



b. Linearization
$[\text{DP}]\frown \text{T}_{\text{IPFV}} \frown [\sqrt{\text{EAT}}\text{-}v] \frown [\text{DP}]$

c. $[\text{T,IMPERFECTIVE}] \longleftrightarrow \left\{ \begin{array}{ll} \mathcal{F}: & \emptyset \\ \mathcal{P}: & \emptyset \\ \mathcal{R}: & \text{PITCHDROP} \gg \text{IDENT-TONE} \end{array} \right\}$

d. Vocabulary insertion
/[e^4] [li^3] [ɟabə$^{3.1}$]/

- Here there is no underlying segmental or suprasegmental content to the imperfective morpheme.
- However, there is a cophonology associated with the T head, which is inherited by the CP phase containing the imperfective morpheme, and triggers a pitch drop between subject and inflected verb (cf. Sande 2017).
- This overrides the default ranking of IDENT-TONE ≫ PITCHDROP, only in imperfective clauses.

(16) Phonological constraint-based evaluation

/e^4 li^3 ɟabə$^{3.1}$/	PITCHDROP	IDENT-TONE
a. [e^4 li^3 ɟabə$^{3.1}$]	*!	
b. ☞[e^4 li^2 ɟabə$^{3.1}$]		*

Summary

- Phonological processes are suspended until the phase is completed (a processes triggered by T$_{ipfv}$ applies to the entire CP containing that T head).
- Cophonologies (sub-rankings) triggered by heads lower than the phase head are inherited by the phase head and take scope over their entire spell-out domain.

6 Case study 4: Dogon

- Certain modifiers within a DP assign a tone melody to other elements inside that DP (McPherson and Heath 2016).
    - An inalienable possessor assigns a HL tone to its right (the noun).
    - An adjective assigns a L tone to its left (the noun, which can spread left to the inalienable possessor, if there is one: [[Poss] N] Adj].
- When both an inalienable possessor and an adjective are present, there is a conflict between the cophonologies associated with the possessor and the adjective.
    - Different Dogon languages resolve this conflict in different ways; in Nanga the lower cophonology seems to prevail while the opposite is true in Tommo So.
    - Thus, it is not the case that the highest (or lowest) sub-ranking within a phase always prevails.

(17) **Different cophonologies take precedence in different Dogon languages**

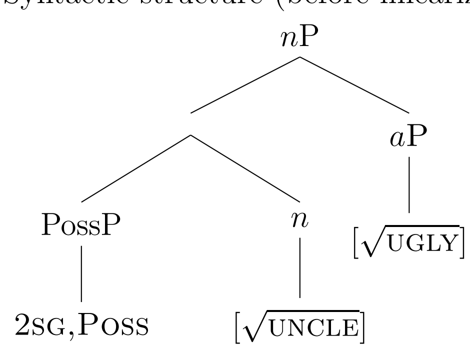
Nanga	Poss ^{HL}N Adj	ú **lésî** mɔ̀sí	2.SG uncle ugly	'Your ugly uncle' (cf. *lèsí*)
Tommo So	Poss N^{L} Adj	ú **bàbè** mɔ̀ɲjú	2.SG uncle ugly	'Your ugly uncle' (cf. *bàbé*)

- Both the possessor and adjective trigger cophonologies where tone melody assignments (HL or L) are stronger than IDENT-TONE.
- Cophonologies are inherited by the higher DP phase
- The difference in which melody surfaces in a given language is determined by the relative strength (weight) of the constraints in that language (McPherson 2014).
    - In Nanga, possessor tone assignment outweighs adjective assignment, but vice versa in Tommo So.
    - We model this weighted-constraint interaction in Harmonic Grammar (Legendre et al. 1990; Smolensky and Legendre 2006).

(18) **Master weights**: IDENT-TONE=3, HL-RIGHT=1, L-LEFT=1

(19) **Nanga**

a. Syntactic structure (before linearization)



b. Linearization
2SG,POSS⌢N⌢Adj

c. [2SG,POSS] $\longleftrightarrow \begin{Bmatrix} \mathcal{F}: & \text{ú HL} \\ \mathcal{P}: & \omega \\ \mathcal{R}: & \text{ASSOCIATE-RIGHT}_{\omega}\text{=3, IDENT-TONE=1} \end{Bmatrix}$

d. [ADJ] $\longleftrightarrow \begin{Bmatrix} \mathcal{F}: & \text{L} \\ \mathcal{P}: & \omega \\ \mathcal{R}: & \text{ASSOCIATE-LEFT}_{\omega}\text{=2, IDENT-TONE=1} \end{Bmatrix}$

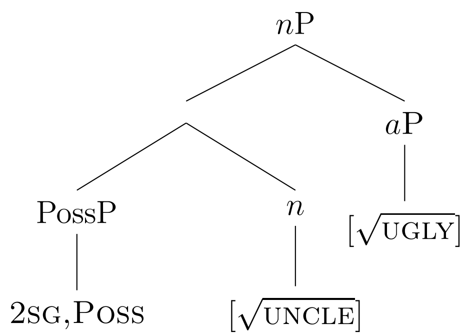
e. Vocabulary insertion
/ú lèsí mɔ̀sí́/

f. Phonological constraint-based evaluation

/ú **lèsí** mɔ̀sí́/	HL-RIGHT$_{\omega}$	L-LEFT$_{\iota}$	IDENT-TONE	
	3	2	1	**H**
a. ☞[ú **lésî** mɔ̀sí́]		1	1	3
b. [ú **lèsí** mɔ̀sí́]	1	1	1	6
c. [ù **lèsì** mɔ̀sí́]	1		1	4

(20) **Tommo So**

a. Syntactic structure (before linearization)



b. Linearization
2SG,POSS⌢N⌢Adj

c. [2SG.POSS] $\longleftrightarrow \begin{Bmatrix} \mathcal{F}: & \text{ú HL} \\ \mathcal{P}: & \omega \\ \mathcal{R}: & \text{ASSOCIATE-RIGHT}_{\omega}\text{=2, IDENT-TONE=1} \end{Bmatrix}$

d. [ADJ] $\longleftrightarrow \begin{Bmatrix} \mathcal{F}: & \text{L} \\ \mathcal{P}: & \omega \\ \mathcal{R}: & \text{ASSOCIATE-LEFT}_{\omega}\text{=3, IDENT-TONE=1} \end{Bmatrix}$

e. Vocabulary insertion
/ú bàbé mɔ̀ɲjú/

f. Phonological constraint-based evaluation

/ú **bàbé** mɔ̀ɲjú/	HL-RIGHT$_{\omega}$	L-LEFT$_{\omega}$	IDENT-TONE	
	2	3	1	**H**
a. ☞[ú **bàbè** mɔ̀ɲjú]	1		1	3
b. [ú **bàbé** mɔ̀ɲjú]	1	1	1	6
c. [ú **bábè** mɔ̀ɲjú]		1	1	4

- The analysis of the Dogon data proposed by McPherson and Heath (2016) relies on the ability of phonological constraints to reference syntactic structure (specifically c-command relationships).

- The CBP approach avoids direct reference of phonological constraints to syntactic structure.

Summary

- When multiple sub-rankings are triggered within a phase, they are all inherited by the phase head.
- Conflicting sub-rankings are resolved via constraint weights.

7 Implications and further extensions

- **Predictions and implications:**
  - CBP unifies process morphology and morphologically conditioned phonology.
  - While not discussed here, CBP also accounts for phonological processes previously analyzed as *syntactically* conditioned:
    - French liaison (Selkirk 1974; Pak 2008)
    - Xitsonga, Luganda prosody (Hyman et al. 1987; Selkirk 2011)
  - We predict that phonological processes that cross word or morpheme boundaries boundaries are subject to the constraint below:

(21) **The Phase Containment Principle**
Morphological operations conditioned internal to a phase cannot affect the phonology of phases that are not yet spelled out.

  - While we see instances of phase anti-faithfulness above, they involve over-writing of previously spelled-out phases (cf. d'Alessandro and Scheer 2015).
- **Extensions of the model:**
  - Other morphological processes expected to be subject to phase-internal optimization and the PCP include:
    - Outward-sensitive allomorphy
    - Portmanteaux morphemes
    - Multiple exponence
  - Future work will determine whether these processes can also be accounted for with Cophonologies by Phase.

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