

## Foundations of Stratal Phonology

Ricardo Bermúdez-Otero  
(University of Manchester)

Session 1 (Computation I)  
in

Alternation types: **computation, storage, history**  
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### INTRODUCTION TO THE COURSE

#### Agenda

§1 Course topic: **alternation**, i.e. contextual variation in the form of linguistic exponents.

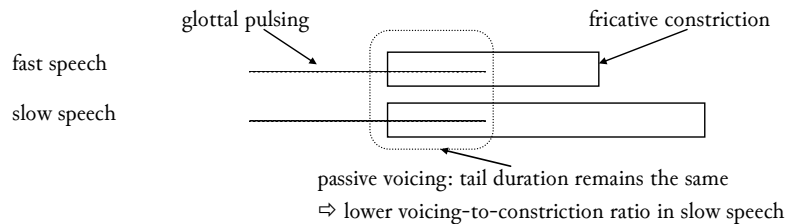
§2 Alternation comprises an extremely wide variety of phenomena:

(i) Strong suppletion conditioned by syntactic features:

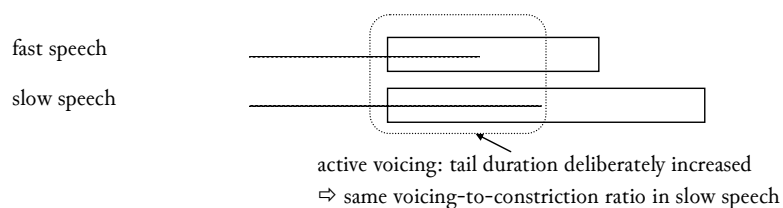
English	<i>go</i>	/gəʊ/	'go' (elsewhere form)	< Gmc etymon meaning 'walk'
	<i>went</i>	/wɛnt/	'go.PST'	< Gmc etymon meaning 'turn'

(ii) Gradient phonetic variation sensitive to continuous parameters:

Quito Spanish /s/-voicing	<i>más</i>	/mas/	[maS]	'more'
(Strycharczuk 2012: ch. 6)	<i>más alto</i>	/mas alto/	[ma.za.l̥.t̥o]	'taller'



cf. speakers with categorical phonological voicing (►⊖): /mas alto/ [ma.za.l̥.t̥o]



§3 The task:

- (i) To map the space between §2i and §2ii, focusing mainly on **phonologically driven alternation**.
- (ii) To provide a **fine-grained** taxonomy, considering a wide range of criteria
  - continuous vs categorical
  - domain size
  - unbounded cyclic reapplication or one-off across-the-board application
  - structure-preserving or allophonic
  - lexical exceptions or not
  - etc.
- (iii) To provide a **principled** taxonomy, deduced from the interaction of three elements:
  - a constraint-based stratal-cyclic theory of **phonological computation** (e.g. Bermúdez-Otero 2010, 2011, 2018; Kiparsky 2000, 2015);
  - an approach to **lexical storage** under which entries may be either nonanalytic or analytic, and may be linked by nonproductive schemata (Bermúdez-Otero 2012: §2.3, 2013b);
  - an account of the **diachronic life cycle** of phonological patterns (Bermúdez-Otero 2015; Bermúdez-Otero & Trousdale 2012: §2; Kiparsky 1995).

#### Background

sicut locutus est ad patres nostros  
Vulgate, Luke 1:55

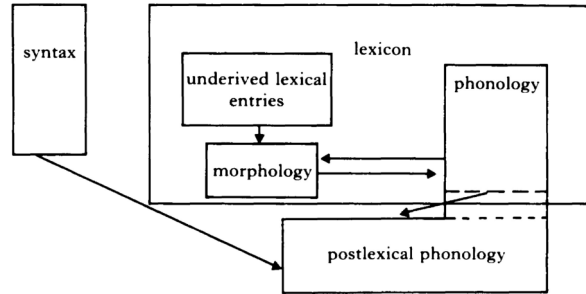
§4 This agenda has roots in **early Structuralism**,  
specially Kruszewski (1881), on which see Williams (1993: §3.4)  
Baudouin de Courtenay (1895)

- (i) Kruszewski aims at theory rather than description (cf. §3iii).
- (ii) Kruszewski attends to several of the criteria in §3i and §3ii:
  - gradience ('quantitative') vs categoricity ('qualitative'),
  - phonological ('phonetic') vs morphosyntactic conditioning,
  - automaticity ('necessity') vs exceptions.
- (iii) Kruszewski already
  - pursues an 'amphichronic' approach (Kiparsky 2006, Bermúdez-Otero 2015),
  - and provides an early formulation of the life cycle of phonological processes (cf. §3iii):  
phonetic variation > morphophonology > expence.

§5 This agenda was vigorously resumed in **rule-based Lexical Phonology** (Kiparsky 1982a,b).

(i) Lexical Phonology aimed to deliver architectural explanations of rule typology (cf. §3iii):

- the LP architecture according to Kaisse & Shaw (1985: 4):



- lexical vs postlexical phonological rules according to Kaisse & Shaw (1985):

lexical	postlexical
exceptions	no exceptions
cyclic reapplication	across-the-board
structure preserving	non-structure-preserving
non-derived environment blocking	apply in underived environments

(ii) In some versions of Lexical Phonology, assumptions about lexical storage play a key role in deriving key properties of phonological rules:

- “[...]cyclic rules apply in the lexicon [...]. The output of these rules [...] becomes part of [...]the] dictionary. Post-cyclic rules do not feed any dictionary [...]” (Pesetsky 1979: §5.0)
- “[...]E]ach form derived at Level 1 exists as an independent form in the list. [...]T]he Word level is distinguished by the fact that every possible derived form is actively derived [...]” (Borowsky 1993: 219-220).

**Preview**

§6 [ For a detailed syllabus, including reading suggestions, see <https://tinyurl.com/yy8vhup9> ]

*Computation*

- Cyclicity and stratification in present-day constraint-based Stratal Phonology. The problem of unbounded cyclic reapplication.
- Putative challenges to Stratal Phonology that do *not* require changes to the interface theory:
  - stratum-internal opacity,
  - paradigmatic dependencies without containment,
  - bracketing paradoxes.

*Colloquium talk*

- English /aɪ/-raising as a parade example of the approach to alternation in §3iii.

*Storage*

- An articulated theory of the stem level:
  - optimality-theoretic computation entails Chung’s Generalization;
  - nonanalytic lexical storage causes unbounded cyclic reapplication;
  - dual-route race processing causes diachronic lexical diffusion.
- A case study of two lexically restricted alternations in Spanish:
  - stored stem allomorphs linked by nonproductive schemas (‘via-rules’)
  - + phonologically driven allomorph selection.

*History*

- The diachronic life cycle of phonological processes and rule scattering:
  - modularity at the phonology-phonetics, morphology-phonology, and lexicon-phonology interfaces;
  - cyclic effects in variable phonological processes.
- The diachronic life cycle of affixes: the emergence of stratal splits.

THE CASE FOR A CYCLIC PHONOLOGY

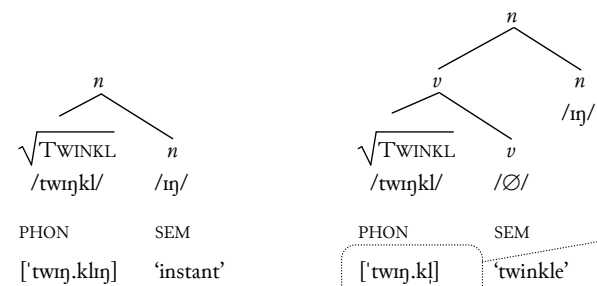
**Mirroring relationships between phonological and semantic interpretation**

§7 Striking examples of mirroring part-whole relationships in phonology part-whole relationships in semantics; Cf. Marantz (2013) on matching domains for ‘allomorphy’ and ‘allosemy’.

§8 English *twinkling* (Marvin 2002: 31-41)

[ˈtwɪŋklɪŋ] ‘instant’

[ˈtwɪŋkɫɪŋ] ‘twinkle.GERUND’



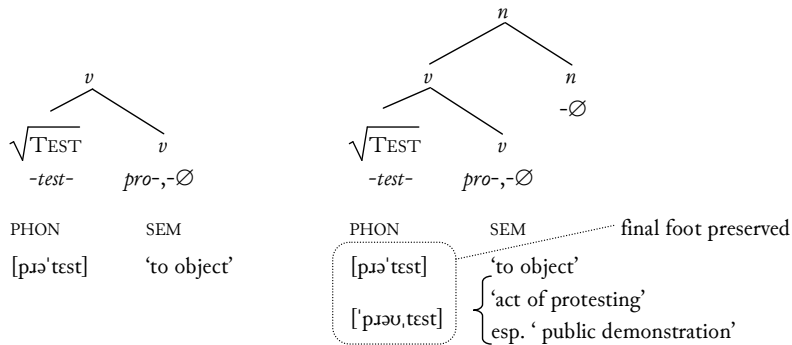
Also *lightning* [ˈlaɪ.tɪŋ] ‘⚡’

vs *lightening* [ˈlaɪ.tɪŋ.ɪŋ] ‘event of lightning’

§9 English *protest* (Kiparsky 1982b: 13)

*protést* 'to object'

*prótèst* 'act of protesting' / 'public demonstration'



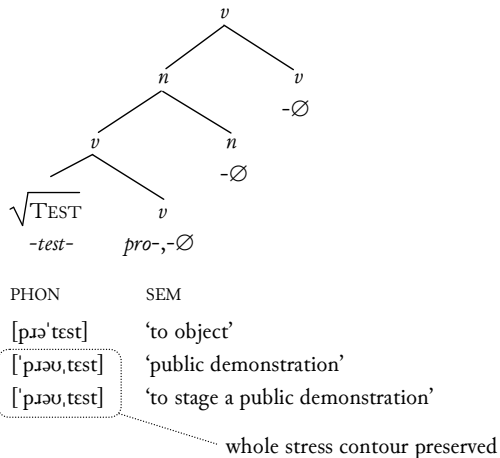
☞ All ∅-derived deverbal nouns preserve the final foot of the base (Bermúdez-Otero 2012: 74):

e.g. *adress<sub>V</sub>* ~ *adress<sub>N</sub>* (AmEng), *digest<sub>V</sub>* ~ *digest<sub>N</sub>*, etc

even though this is a marked minority pattern for underived nouns:

cf. unmarked *pár[ə]nt*, *cýpr[ə]ss* vs marked *wísənt*, *ábscèss*

*prótèst* 'to stage a public demonstration'



§10 A new example: English *specification*

- (i) A historical trap: Latin -i-fic-a -re > French *-ifier* > English *-ify*
- Latin -i-fic-a -tion-e-m > English -ific ation
- Latin *-i-fic-u-m* > English -ific

In Latin, semantic containment and segmental containment line up;  
In English, they do not ⇔ Segmental red herring.

(ii) Synchronic English constituency:

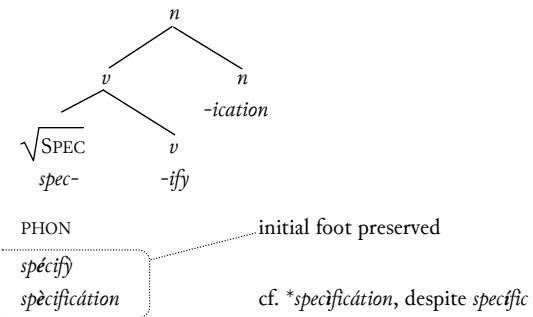
Productive pattern:  $-if_{\text{V}} + -ication_{\text{N}} \rightarrow -ification_{\text{N}}$

<i>amplify</i>	<i>amplification</i>	cf. <i>*amplific</i>
<i>certify</i>	<i>certification</i>	<i>*certific</i>
<i>clarify</i>	<i>clarification</i>	<i>*clarific</i>
<i>codify</i>	<i>codification</i>	<i>*codific</i>
...	...	

Zombies may seem like the purview of AMC dramas nowadays, but in 1997, English medical journal *The Lancet* published an intriguing set of case studies detailing three reports of **zombification** in Haiti. [...] Her parents accused her husband of **zombifying** her (he was jealous of her after she had had an affair).

<https://tinyurl.com/7ngubwd> (accessed on 2 Dec 2013, bolface supplied)

(iii) Stress preservation tracks synchronic constituency, despite the segmental red herring:



Theoretical implications

§11 (i) Phonology is cyclic:

“the computation of the phonological form of the parts precedes and feeds the computation of the phonological form of the whole” (Bermúdez-Otero 2018: 103)

(ii) Phonological and semantic interpretation run off the same syntactic (word-syntactic and phrase-syntactic) constituent structure.

§12 That's the easy bit. Now for the tough questions:

(i) Which grammatical constituents trigger cycles of phonological interpretation?

My answer: Shockingly few, and not the ones many syntacticians would expect!  
(Bermúdez-Otero 2018: 100, 109)

The fact that, in §8-§10, and in general, cyclic phonological domains correspond to domains of semantic interpretation does *not* entail that every cyclic domain in semantics, syntax, or even morphology corresponds to a cyclic domain in phonology.

(ii) Why is phonology cyclic?

My answer: Apparently not because a single grammar-wide cyclic engine!

- not phases (cf. Embick 2010)
- not HPSG-style unification (cf. Orgun 1996)

(Bermúdez-Otero 2018: 109)

Let's look at the evidence.

STEM-LEVEL, WORD-LEVEL, AND PHRASE-LEVEL PHONOLOGY

**Three levels**

§13 Three-level systems in the history of phonological theory:

<i>Structuralism</i>	<i>Rule-based LP</i>	<i>Harmonic Phonology</i> <i>Cognitive Phonology</i>	<i>Stratal OT</i>
(Z. S. Harris 1951)	(Booij & Rubach 1987)	(Goldsmith 1993, Lakoff 1993)	(Kiparsky 2015)
morphophonemic	cyclic	M(orphemic)	stem
phonemic	postcyclic	W(ord)	word
phonetic	postlexical	P(honetic)	phrase

Not numerological mysticism, but a response to recurrent empirical patterns.

**Phrase-level phonology**

§14 *Spanish emphatic trilling* (J. Harris 1983: 70-71)

(i) /r/ is optionally trilled in the coda only:

Rh  
|  
r → r /         

/mar/ [mar]~[mar] 'sea'	/mar-e-s/ [ma.res], <b>not</b> *[ma.res] 'sea.PL'
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(ii) Word-final prevocalic consonants resyllabify into the onset (though cf. Strycharczuk & Kohlberger 2016), and so /r/ escapes trilling in this position:

/mar negro/ [mar.ne.ɯro]~[mar.ne.ɯro] 'Black Sea'	/mar exeo/ [ma.re.xe.o], <b>not</b> *[ma.re.xe.o] 'Aegean Sea'
---	--

(iii) One-off across-the-board application over whole utterances.

No effect of /r/ position in smaller cyclic domains; no misapplication.

**Prosodic bounding:** Word-final prevocalic /r/ can trill if, and only if, a strong phrasal prosodic boundary blocks resyllabification into the onset:

/el mar oi/  
[el.mar.oi] ✓  
'the sea, today'

**Word-level phonology**

§15 *Spanish nasal velarization* (Ramsammy 2013; also my own idiolect)

(i) A nasal becomes velar in the coda by default when not followed by a consonant to which it can assimilate:

[nasal] → [DOR] / $\begin{array}{c} \text{Rh} \\   \\ \text{---} \\ \swarrow \\ \text{C-PLACE} \end{array}$	
/tren/ [tɾeŋ] 'train'	/tren-e-s/ [tɾe.nes], <b>not</b> *[tɾe.ɲes] 'train.PL'

(ii) Velarization overapplies to word-final prevocalic nasals resyllabified into the onset:

/tren es/  
[tɾe.ɲes], **not** \*[tɾe.nes]  
'train is'

Velarization applies in a single cycle over the entire grammatical word and is counterbled by phrase-level resyllabification:

		[[tren][es]]
Ů	velarization	tɾeŋ
Ɇ	resyllabification	tɾe.ɲes

(iii) One-off across-the-board application over whole grammatical words.

No effect of word-internal morphological structure (in the relevant dialects):

<i>in-bóspit-o</i>	[i.nos.pi.t̪o]	‘inhospitable’	bound base: * <i>bóspito</i>
<i>in-audit-o</i>	[i.nau.ʃi.t̪o]	‘unheard-of’	bound base: * <i>audito</i>
<i>en-orgull-ec-e-r</i>	[e.nor.ɥu.je.θer]	‘make proud’	free base: <i>orgullo</i>
<i>in-oportun-o</i>	[i.no.por.t̪u.no]	‘inopportune’	free base: <i>oportuno</i>

(iv) **Prosodic bounding:** some (though not all) tokens of orthographic <h> correspond to lexically idiosyncratic barriers to word-level syllabification (cf. French *b-aspiré*).

	<i>anbelar</i>	<i>en-bebrar</i>
Ů	aŋ.e.lar	eŋ.e.brar
Ɇ	a.ɲe.lar	e.ɲe.βrar
	‘to long for’	‘to thread’

Dialects with velarization of prefix-final prevocalic nasals exist (e.g. Robinson 2012; cf. iii): these may be assumed to have a stem-initial  $\omega$ -boundary which blocks word-level resyllabification in a similar fashion.

### Stem-level phonology

§16 *Western Armenian high vowel deletion* (Khanjian 2009; Dolatian 2018, 2019)

(i) Primary stress falls on the rightmost full (i.e. non-schwa) vowel in the grammatical word, which excludes phrasal enclitics:

kórdz̄	‘work’
kórdz̄-avór	‘worker’
kórdz̄-avor-nér	‘workers’
kórdz̄-avor-ner-óv	‘with workers’
kórdz̄-avor-ner-óv-ə	‘with the workers’
kórdz̄-avor-ner-óv=en	‘(they) are with the workers’

(ii) A stressed high vowel in the base deletes when destressed in the derivative:

irigún	‘evening’
irign-anál, *irigun-anál	‘to become evening’

Standard faithfulness constraints generate this phonological derived environment effect straightforwardly:

irigún	RIGHTMOSTSTRESS	IDENT-stress	MAX-highV
(a) irigún-anal	*!		
(b) irigun-anál		*!	
(c) irign-anál			*

IDENT-stress: If  $\alpha\beta$ , assign \* if stress( $\alpha$ ) $\neq$ stress( $\beta$ )

Candidate (c) does not fulfil the first *if*-clause and so satisfies IDENT-stress vacuously.

(iii) When deletion creates an unsyllabifiable cluster, an epenthetic schwa is inserted:

aznív	‘honest’
aznəv-utjún, *aznv-utjún	‘honesty’

(iv) **Sublexical domains:** The domain of high vowel deletion excludes word-level (mostly inflectional) suffixes. Stress shift to a word-level suffix counterfeeds high vowel deletion.

<i>base</i>	amusín		‘husband’
<i>stem-level affixation</i>	amun-agán	(deletion)	‘marital’
<i>word-level affixation</i>	amusín-óv	(no deletion)	‘husband-INS’
	amusín-nér		‘husband-PL’
	amusín-ner-óv		‘husband-PL-INS’
		[ <sub>WL</sub> [ <sub>SL</sub> amusin] ner-ov]	

Ɇ	stress, deletion	amusín	IDENT-stress $\gg$ MAX-highV
Ů	stress, no deletion	amusinneróv	MAX-highV $\gg$ IDENT-stress

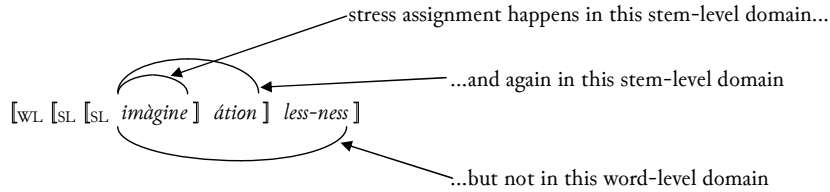
(v) **Unbounded cyclic reapplication:** Every stem-level suffix triggers a new cycle of the stem-level phonology, where deletion reapplies.

	d̄zín	‘birth (esp. of animals)’
	d̄zən-únt <sub>SL</sub>	‘birth’
	d̄zən-ənt <sub>SL</sub> -ót̄s <sub>SL</sub>	‘genesis’
cf.	d̄zən-únt <sub>SL</sub> -í <sub>WL</sub>	‘birth-GEN’
		[ <sub>SL</sub> [ <sub>SL</sub> [ <sub>SL</sub> d̄zin] unt] ot̄s]
Ɇ	stress	d̄zín
Ɇ	stress, deletion	d̄zənúnt
Ɇ	stress, deletion	d̄zənəntót̄s

STEM-LEVEL CYCLICITY IS SPECIAL

Abundant evidence for stem-level cyclicity

§17 English stress assignment



Stress assignment cannot apply in a single pass over *imagination* because this would yield \**imáginátion* by the Abracadabra Rule:

cf. *àbracadàbra, dèlicatèssen, Mèditerrànean, càtamarán, etc.*

§18 English trisyllabic shortening

[sL [sL [sL metre ] ical ] ity ]		
mètre	the initial $\sigma$ does not qualify for TSS	(normal nonapplication)
métrical	the initial $\sigma$ qualifies for TSS	(normal application)
mètricality	the initial $\sigma$ does not qualify for TSS	(cyclic overapplication)

Trisyllabic shortening cannot apply in a single pass over *metricality* because this would produce \**mètricality*:

cf. *fàte ~ fàtal ~ fàtáality*

§19 Spanish high vocoid syllabification (Bermúdez-Otero 2013a: 67-71, 2016: 408-413)

(i) Mid-vowel diphthongization under stress diagnoses a stem-level/word-level distinction:

SL	[bjéx-o]	'old/old_man'	normal application
	[bex-éθ-Ø]	'old_age'	normal nonapplication
WL	[bjex-ón-Ø]	'old_man.AUG'	} overapplication
	[bjex-áθ-o]	'old_man.AUG'	
	[bjex-eθiɾ-o]	'old(_man).DIM'	
	[bjex-ísim-o]	'old.SUPL'	
	[a-βjex-á-r]	'make_old.INF'	

(ii) Cole (1995: 95) claims that there is no evidence for recursive cyclic domains in the stem-level phonology of Spanish.

But high vocoid syllabification provides that evidence: a prevocalic high vocoid fails to glide if stressed in the previous cycle.

UR	[sL [sL pronunθj-a] mos]	[sL [sL telegɾafi-a] mos]
first cycle	pro.nún.θja	te.le.gra.fi.a
second cycle	pro.nun.θjá.mos	te.le.gra.fi.á.mos
	'pronounce.1SG.PRS.IND'	'telegraph.1SG.PRS.IND'

- Diphthongization identifies *-mos* as stem-level: e.g. *cuént-a ~ cont-á-mos* 'count.3SG~1PL'.
- A single-cycle derivation of *pronunciamos* and *telegɾafiamos* would neutralize the underlying distinction between /ja/ and /ia/ to [ja], as unstressed prevocalic high vocoids cannot resist gliding outside the word-initial syllable.

The word-level is noncyclic

§20 Indonesian stress (Bermúdez-Otero 2018: 106-109)<sup>1</sup>

(i) Suffixes are incorporated into the same prosodic word as the stem, whereas prefixes are prosodically adjoined (Cohn 1989: 200ff):

( $\omega$ bicára)	'speak'
( $\omega'$ məm ( $\omega$ bicará-kan))	'speak about'
( $\omega'$ məm ( $\omega$ bicàra-kán-ña))	'speak about it'

- (ii) • Within  $\omega^0$ , primary stress falls on the penult.
  - Secondary prominence is assigned to every second syllable to its left.
- except obligatory stress on  $\omega^0$ -initial  $\sigma$   
no clash within  $\omega^0$

bicára	*bicára	'speak'
màjarakat		'society'
xàtulistíwa	*xàtùlistíwa, *xatùlistíwa, *xatulistíwa	'equator'
èrodinámika		'aerodynamics'

(iii) Stem-level *-(n)isasi* 'ization' (< Dutch *-is-atie*) triggers reapplication of regular stress assignment, overwriting the metrical contour of the base:

amérika	(exceptional proparoxytone)	'America'
àmèrikà-nisási	*amèrika-nisási	'Americanization'

<sup>1</sup> A note on the data. My Indonesian data come from Cohn (1989) and Cohn & McCarthy (1998). I avoid examples containing schwa, which Cohn (1989: 174) describes as metrically invisible. Goedemans & van Zanten (2007) have recently argued that Indonesian, or at least Javanese Indonesian, has no word stress at all. There is, however, solid phonetic evidence of the presence of stress in other varieties of Malay (Kaland 2019). Donca Steriade reports that the stress pattern observed by Cohn actually occurs in the L2 Indonesian of native speakers of Toba Batak; this would be consistent with Goedemans & van Zanten's findings (Sören Tebay, pers. comm., 6 Jul 2019).

- (iv) Word-level suffixes reassign primary stress at the right edge, but otherwise preserve the metrical contour of the base, subject only to clash avoidance:

(<sub>ω</sub> bicára) 'speak'  
 (<sub>ω</sub> məm (<sub>ω</sub> bicará-kan)) \*(<sub>ω</sub> məm (<sub>ω</sub> bicará-kan)) 'speak about'  
 right-edge primary stress, clash avoidance, but **initial lapse!**

- (v) Forms with two word-level suffixes preserve the metrical contour of the **remote** base:

(<sub>ω</sub> bicára) 'speak'  
 (<sub>ω</sub> məm (<sub>ω</sub> bicará-kan)) 'speak about'  
 (<sub>ω</sub> məm (<sub>ω</sub> bicàra-kán-ña)) { \*(<sub>ω</sub> məm (<sub>ω</sub> bicara-kán-ña)) } 'speak about it'  
 \*(<sub>ω</sub> məm (<sub>ω</sub> bicara-kán-ña)) }

*Ergo* there is a single pass through the word-level phonology:

[<sub>WL</sub> mən [<sub>SL</sub> bicara] kan-ña]  
 S̩ɛ (<sub>ω</sub> bicára)  
 ʊɛ (<sub>ω</sub> məm (<sub>ω</sub> bicàrakánña))

### Puzzles at the phrase level

- §21 There are no solid examples of unbounded cyclic reapplication of **segmental** processes in the stem-level phonology:

i.e. no Armenian-like cases of cyclic reapplication (§16v) involving cyclic domains  
 larger than the grammatical word  
 but smaller than the utterance.

This is a well-known issue, which Scheer (2011: §786) labels the 'word spell-out mystery'.

- §22 Phrasal **stress** assignment can often be analysed cyclically, but typically such analyses can be recast into a single-step parallel derivation of phrasal prosodic structure.

The latter has been the prevalent approach since the birth of Metrical and Prosodic Phonology (Lieberman & Prince 1977, Nespó & Vogel 1986). Note that we need phrasal prosody to be available in parallel to phrase-level segmental processes subject to prosodic bounding (§14iii).

- §23 The best prima facie arguments for cyclicity at the phrase level all come from **tone**: e.g.

- *Dominant tone asymmetry* (e.g. Rolle 2018)

Inward tonal overwriting only:

in a configuration [[α] β], a tonal melody associated with β can overwrite that of α, but not vice versa.

E.g. Izon the tones of outer modifiers in the NP dominate those of the N;  
 the tones of TAM auxiliaries dominate those of the V;  
 etc.

Argument assumes cycles over **syntactic** phrases.

- '*McHugh cyclicity*' (McHugh 1990, 2006; Jones 2014; Gjersøe 2016)

Arguments assume cycles over **prosodic** phrases!

- §24 Whatever the right account of putative cyclic effects in phrasal tonology is, it should not overgenerate cycles of phrase-level segmental phonology.

### The prospects for single-engine cyclic theories

- §25 They look dim (§12):

- Phase Theory: If syntactic phasehood drives phonological cyclicity, where are the segmental cyclic misapplication effects associated with CP, vP, and DP?
- HPSG unification: Too many cycles! Every node is cyclic in Orgun (1996).

- §26 Later in the course... (► 3, 4)

More evidence that stem-level cyclicity is *sui generis* and special: lexical irregularity frequency effects.

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