Emergent cyclicity?

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Introduction

§1 This talk has two goals:

- to argue that stratal-cyclic approaches to morphosyntactic conditioning in phonology are superior to output-output (OO) correspondence;
- to explore the possibility that phonological cyclicity itself may not be an innately specified property of grammars, but rather may emerge from more fundamental mechanisms in the course of language acquisition and use.

§2 I review (and update) three empirical arguments for the cycle and against OO-correspondence:

- *Phonologically masked bases*

  There exist instances of morphosyntactically triggered opacity in which the transparent surface bases required by OO-correspondence are absent (masked) for phonological reasons:

  e.g. Quito Spanish /s/-voicing (Bermúdez-Otero 2011: §6; *pace* Colina 2009).

- *Absent bases in noncanonical paradigms*

  There exist cases of morphosyntactically triggered opacity in which the paradigm cell required by OO-correspondence to provide the surface base is empty, owing to deponency, defectiveness, etc:

  e.g. Albanian stress (Trommer 2006, 2009; Bermúdez-Otero 2011: §8).

- *Russian-doll patterns*

  In dialect typology, in variation, and in change, cyclic misapplication within a small morphosyntactic domain entails misapplication within larger domains; but current versions of OO-correspondence either stipulate this fact innately or leave it unexplained:

  e.g. English /l/-darkening (Bermúdez-Otero 2011: §8, Turton 2011; cf. Hayes 2000: 102).

§3 However, nativist theories of the cycle (e.g. Phase Theory) faces two serious challenges:

- Cyclic effects can
  display irregularities e.g. *imp*[ɔ́]*rt* ~ *ìmp*[ɔ̀]*rtátion* vs *transp*[ɔ́]*rt* ~ *tránsp*[ə]*rtátion;*
  sustain anticyclic exceptions e.g. English idiolects with *c*[aɪ]*cle* ~ *c*[ɪ]*clic* ~ *c*[aɪ]*clicity*.

- The semantics-phonology correlations predicted by Phase Theory (e.g. Marvin 2002: 39, Arad 2003: 740) do not necessarily hold (as noted also by Scheer 2010, 2011):

  e.g. when used as an argument-structure nominal (Borer 2003: §4), *tránsp*[ə]*rtátion* inherits the argument structure of *transp*[ɔ́]*rt* but not its foot structure (Bermúdez-Otero forthcoming-b: §3.3.3; ; cf. Chomsky and Halle 1968: 39, 112, 116).

§4 I therefore consider whether an alternative emergentist approach to the origins of cyclicity can make UG's task lighter whilst making more accurate empirical predictions:

- I suggest that stratum-internal cyclic effects at the stem level (SL) emerge when three factors come together: nonanalytic ('whole-form') listing of stem-level constructs,
  morphosyntactic blocking,
  and high-ranking faithfulness.

  This correctly predicts that stem-level cyclic effects will sustain irregularities and will show effects not only of semantic compositionality but also of the relative token frequency of base and derived forms.

  (Bermúdez-Otero and McMahon 2006: 398-400; Collie 2007, 2008; Bermúdez-Otero forthcoming-b: §3.3.)
- I tentatively broach the possibility that phonological stratification, and so interstratal cyclicity, may emerge from a sequenced bootstrap model of phonological acquisition (e.g. Lappin and Shieber 2007: 424-25, also Quartz 1999: 54) involving the staged bottom-up morphosyntactic segmentation of surface forms by the learner.

THREE ARGUMENTS FOR THE CYCLE

Two approaches to morphosyntactically induced misapplication

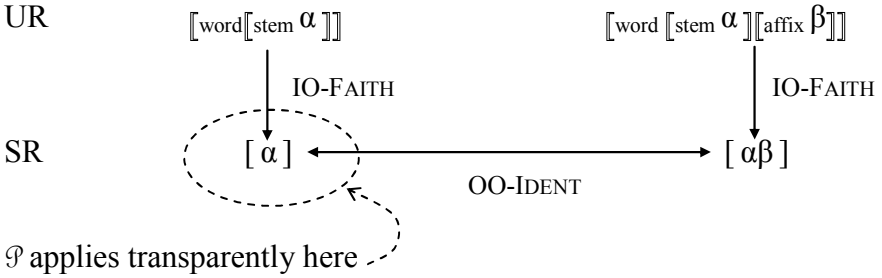
An instance of the issue: a phonological process $\mathcal{P}$ misapplies in the presence of affix /-β/.

I focus on morphological structure causing misapplication directly, rather than indirectly via prosodic alignment: i.e. in Scheer's (2010) terms our focus is on 'procedural' rather than 'representational' morphosyntactic intervention.

This presupposes that we have independent criteria for distinguishing between the two types of morphosyntactic conditioning:

- for discussion in the context of OO-correspondence, see e.g. Raffelsiefen (2005);
- for treatments of the issue in Lexical Phonology, see Booj and Rubach (1984) and Booij (1988, 1992);
- for a Stratal OT approach, see Bermúdez-Otero and Luís (2009) and Bermúdez-Otero (2011: §4).

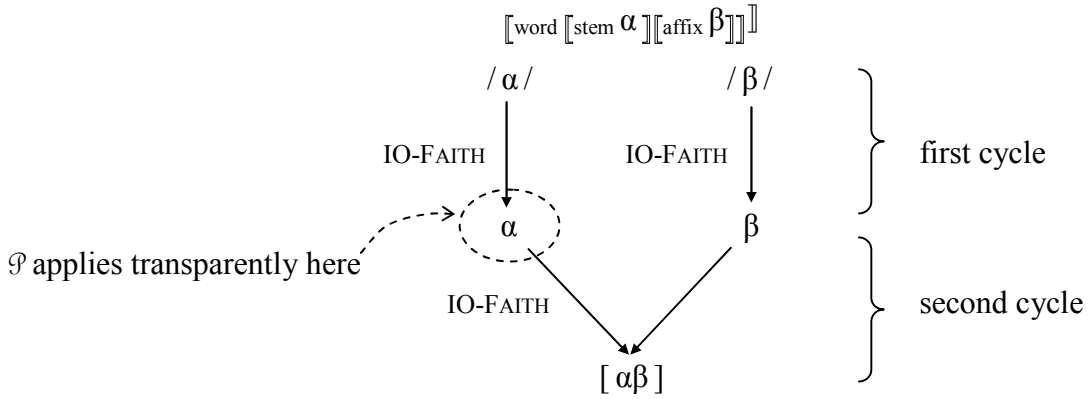
§5 The OO-correspondence approach:



⇨ $\mathcal{P}$ must apply transparently in some appropriately related expression.

E.g. Benua (1995, 1997), Kenstowicz (1996), Kager (1999), McCarthy (2005), etc; though Burzio (1996, 1998, 2002, etc.) does not countenance URs.

§6 The stratal-cyclic approach:



⇨ 𝒫 must apply transparently in some morphosyntactic subconstituent.

Phonologically masked bases (Bermúdez-Otero 2011: §6)

§7 /s/ *in Highland Ecuadorian Spanish* (Robinson 1979, Lipski 1989):

- [s] in the onset

gasa	/gasa/	['ga.**s**a]	'gauze'
ganso	/gaNso/	['gan.**s**o]	'gander'
da sueño	/da sueɲo/	[ˌd̪a.'**s**we.ɲo]	'makes one sleepy'
el sueño	/el sueɲo/	[el.'**s**we.ɲo]	'the dream'

- [s] in the coda before voiceless segments or utterance-finally

rasco	/rasko/	['ra**s**.ko]	'I scratch'
gas	/gas/	[ga**s**]	'gas'
gas caro	/gas karo/	[ˌga**s**.'ka.ro]	'expensive gas'

- [z] in the coda before voiced segments

rasgo	/rasgo/	['ra**z**.ɰo]	'feature'
plasma	/plasma/	['pla**z**.ma]	'plasma'
gas blanco	/gas blaNko/	[ˌga**z**.'β̪laŋ.ko]	'white gas'
gas noble	/gas noble/	[ˌga**z**.'no.β̪le]	'noble gas'

but, crucially, contextual voicing overapplies to word-final prevocalic consonants

	gas acre	/ga**s** akre/	[ˌga.'**z**a.kre]	'acrid gas'
cf.	*gasa*	/ga**s**a/	['ga.**s**a]	'gauze'
	has ido	/a**s** ido/	[a.'**z**i.ð̪o]	'hast gone'
cf.	*ha sido*	/a **s**ido/	[a.'**s**i.ð̪o]	'hath been'

§8 *The stratal-cyclic solution* (Bermúdez-Otero 2011: §6)

Key generalizations:

- /s/ becomes susceptible to convoicing when it occurs in the coda at the word level, i.e. in the coda prior to phrase-level resyllabification;

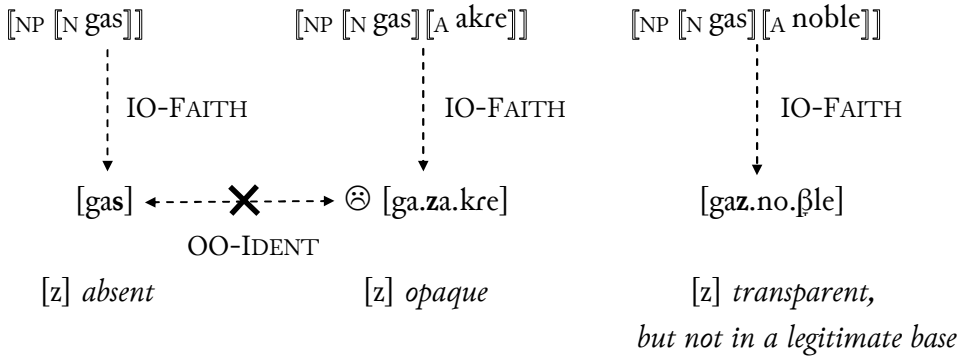
but
- contextual voicing itself applies at the phrase level, since it crosses word boundaries.

Analysis:

- at the word level (WL), coda /s/ loses its LARYNGEAL node;
- at the phrase level (PL), a delaryngealized input [S] acquires laryngeal specifications by context-sensitive defaults; laryngeally-specified input [s] remains unchanged.

E.g.	*gasa*	*gas*	*gas acre*
	[PL [WL gasa]]	[PL [WL gas]]	[PL [WL gas][WL akɾe]]
WL	ga.sa	gaS	gaS
PL	ga.sa	ga**s**	ga.**z**a.kɾe

§9 *The challenge to OO-correspondence*



☞ OO-IDENT fails because it relies on the transderivational transmission of surface properties; word-final prevocalic /s/ in Quito Spanish displays the cyclic transmission of a nonsurfacing property, viz. being a target for contextual voicing owing to delaryngealization.

§10 *Blocking OO-correspondence's escape routes (I)*

Q: Is the voicing of word-final prevocalic /s/ really opaque? What if word-final prevocalic /s/ really surfaced in the coda, rather than in the onset?

A: All dialects of Spanish, including Quito, have demonstrably categorical phonological processes that treat word-final prevocalic consonants as onsets. Denying phrase-level resyllabification incorrectly predicts that no such process should exist.

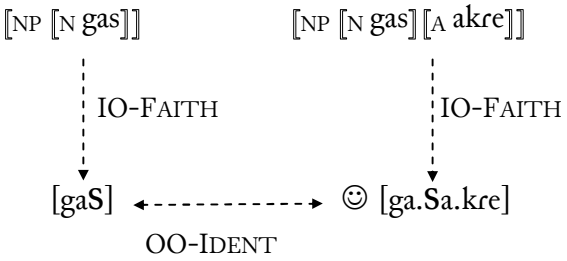
E.g. optional emphatic trilling of /ɾ/ only in the coda (Harris 1983: 70-71)

	[maɾ]~[ma**r**]	'sea'
	[ˌmaɾ.ˈne.ɯɾo]~[ˌma**r**.ˈne.ɯɾo]	'Black Sea'
but	[ˌma.ɾe.ˈxe.o], not *[ˌma.**r**e.ˈxe.o]	'Aegean Sea'

§11 *Blocking OO-correspondence's escape routes (II)*

Q: (Colina 2009: 8–10; cf. Bradley and Delforge 2006: 39, Bermúdez-Otero 2011: 2032–3)

Is the voicing of word-final prevocalic /s/ really phonological, i.e. categorical? What if word-final prevocalic /s/ really surfaced as delaryngealized [S] subject to passive voicing in the phonetics, rather than as categorically voiced [z]?



§12 A: Strycharczuk et al. (2011) measured the duration of voicing under 3 conditions:

(i)	*plasma*	/plasma/	'plasma'
(ii)	*gas noble*	/gas noble/	'noble gas'
(iii)	*gas acre*	/gas akɾe/	'acrid gas'

For a large subgroup of speakers, they found variation between two discrete options:

- partial (passive) voicing during frication (0–20 ms);
- full (categorical) voicing during frication (mean 47.8 ms).

All these speakers show a strongly bimodal distribution of tokens in the continuum of voicing duration during frication in every condition (i, ii, and iii).

☞ The voicing of word-final prevocalic /s/ is optional but categorical.

§13 *A possible diachronic scenario for the rise of Quito Spanish /s/-voicing*

1	Phonologization	Low perceptibility of laryngeal features in codas reinterpreted as phrase-level coda delaryngealization.
2	Domain narrowing	Coda delaryngealization percolates up to the word level.
3	Phonologization	Passive voicing of delaryngealized sibilants reinterpreted as phrase-level spreading

See Bermúdez-Otero (2007: 503–8, 2011: §3), and specially Bermúdez-Otero and Trousdale (forthcoming), on the life-cycle of phonological processes.

Absent bases in noncanonical paradigms (Trommer 2006, 2009; Bermúdez-Otero 2011: §8)

§14 *Stress assignment in Albanian polysyllables* (Trommer 2004)

- if the ultima is { either full-vowelled and closed / or headed by a non-mid vowel, } then stress the ultima;
- otherwise, stress the penultimate.

§15 *Partial opacity in verbs with canonical paradigms* (Trommer 2006, 2009)

formoj 'form' (NACT denotes 'nonactive')

			UR	SR	opaque stress?
ACT	SG	1	[GWord [Stem forɾmo-j]]	[foɾ.'moj]	no
		2	[GWord [Stem forɾmo-n]]	[foɾ.'mon]	no
		3	[GWord [Stem forɾmo-n]]	[foɾ.'mon]	no
	PL	1	[GWord [Stem forɾmo-j] [Affix mə]]	[foɾ.'moj.mə]	no
		2	[GWord [Stem forɾmo-n] [Affix ni]]	[foɾ.'mo.ni]	**yes:** *[foɾ.mo.'ni]
		3	[GWord [Stem forɾmo-j] [Affix nə]]	[foɾ.'moj.nə]	no
NACT	SG	1	[GWord [Stem forɾmo-j] [Affix he-m]]	[foɾ.'mo.hem]	**yes:** *[foɾ.mo.'hem]
		2	[GWord [Stem forɾmo-j] [Affix he-ʃ]]	[foɾ.'mo.heʃ]	**yes:** *[foɾ.mo.'heʃ]
		3	[GWord [Stem forɾmo-j] [Affix he-t]]	[foɾ.'mo.het]	**yes:** *[foɾ.mo.'het]
	PL	1	[GWord [Stem forɾmo-j] [Affix he-mi]]	[foɾ.'mo.he.mi]	**yes:** *[foɾ.mo.he.'mi]
		2	[GWord [Stem forɾmo-j] [Affix he-ni]]	[foɾ.'mo.he.ni]	**yes:** *[foɾ.mo.he.'ni]
		3	[GWord [Stem forɾmo-j] [Affix he-n]]	[foɾ.'mo.hen]	**yes:** *[foɾ.mo.'hen]

§15 *Stratal-cyclic analysis* (Trommer 2006)

- Stress assignment operates transparently in the stem cycle.
- Internal sandhi processes: (i) nn → n
  (ii) j → ∅ / __h
- Sample derivations:

		[WL [SL forɾmo-j]]	[WL [SL forɾmo-j] [SL he-m]]
SL	(stress assignment)	[foɾ.'moj]	[foɾ.'moj] [hem]
WL	(internal sandhi)	—	[foɾ.'mo.hem]
		'form[ACT.1SG]'	'form.NACT.1SG'

§16 *Complete absence of transparent forms throughout the paradigm in deponent verbs*

pendohem 'regret'
deponent: no diathesis alternation; its single form series is morphologically nonactive

			UR	SR	opaque stress?
ACT			—	—	—
NACT	SG	1	[GWord [Stem pendo-j] [Affix he-m]]	[pen.'do.hem]	**yes:** *[pen.do.'hem]
		2	[GWord [Stem pendo-j] [Affix he-ʃ]]	[pen.'do.heʃ]	**yes:** *[pen.do.'heʃ]
		3	[GWord [Stem pendo-j] [Affix he-t]]	[pen.'do.het]	**yes:** *[pen.do.'het]
	PL	1	[GWord [Stem pendo-j] [Affix he-mi]]	[pen.'do.he.mi]	**yes:** *[pen.do.he.'mi]
		2	[GWord [Stem pendo-j] [Affix he-ni]]	[pen.'do.he.ni]	**yes:** *[pen.do.he.'ni]
		3	[GWord [Stem pendo-j] [Affix he-n]]	[pen.'do.hen]	**yes:** *[pen.do.'hen]

§17 *The stratal-cyclic analysis generalizes to deponent verbs without stipulation*

		⟦WL ⟦SL pendo-j⟧⟦SL he-m⟧ ⟧
SL	(stress assignment)	[pen.'doj] [hem]
WL	(internal sandhi)	[pen.'do.hem]
		'regret.1SG'

§18 *The failure of OO-correspondence*

a. ⟦GWord ⟦Stem formo-j⟧⟧ ⟦GWord ⟦Stem formo-j⟧⟦Affix he-m⟧⟧

IO-FAITH IO-FAITH

[for.'moj] ☺ [for.'mo.hem]

OO-IDENT

transparent stress *opaque stress*

b. ⟦GWord ⟦Stem pendo-j⟧⟦Affix he-m⟧⟧

IO-FAITH

?? ☹ [pen.'do.hem]

OO-IDENT

opaque stress

A conceivable way out is to posit not merely transderivational correspondence, but also transparadigmatic relationships (Blevins 2006); but these are difficult to motivate and constrain.

§18 *Comparing predictions*

- the cycle: same syntagmatic structure ⇩ same cyclic effects ✓
- OO-IDENT: different paradigms ⇩ different transderivational effects ✗

§19 *Blocking OO-correspondence's escape routes*

Q: What if Albanian verbs has been partly or wholly morphologized?

A: Whatever the merits of such an argument, OO-correspondence will remain in an anomalous position until enough languages are found in which systematic patterns of morphologically induced phonological misapplication fail to hold in noncanonical paradigms.

Russian-doll patterns

§20 *The Russian-Doll Theorem* (Bermúdez-Otero 2011: 2023):
Let there be the nested cyclic domains $[_{\gamma} \ldots [_{\beta} \ldots [_{\alpha} \ldots]_{\alpha} \ldots]_{\beta} \ldots]_{\gamma}$. If a phonological process $\mathcal{P}$ is opaque in β because its domain is α, then $\mathcal{P}$ is opaque in γ.

Corollary:
If a phonological process exhibits cyclic misapplication (as opposed to mere prosodic blocking) within a certain phonological configuration created by affixation, then it must also exhibit cyclic misapplication if the same configuration arises by word concatenation.

§21 *A Russian-doll pattern in phonological change*
(Garrett and Blevins 2009: 527-28; Bermúdez-Otero 2011: §3; Bermúdez-Otero and Trousdale forthcoming: §2.3)

- Postnasal plosive deletion: $g \rightarrow \varnothing \; / \; ŋ\_\_ \; \sigma]$
  the deletion of postnasal /g/ is opaque when a vowel follows.

- The life cycle of postnasal plosive deletion:

	Diachronic stage			
	0	1	2	3
elongate	ŋg	ŋg	ŋg	ŋg
prolong-er	ŋg	ŋg	ŋg	ŋ
prolong it	ŋg	ŋg	ŋ	ŋ
prolong ‖	ŋg	ŋ	ŋ	ŋ

0	Early Modern English	no deletion	
1	Elphinston's formal register	PL /g/-deletion	transparent
2	Elphinston's colloquial register	WL /g/-deletion	overapplication in phrasal domains
3	Present-day English	SL /g/-deletion	overapplication in word *and* [phrase domains

§22 *A Russian-doll pattern in (dialectal) variation*
(Bermúdez-Otero 2011: §8, Turton 2011; cf. Hayes 2000)

- /l/-darkening: $l \rightarrow ɫ \; / \; \underset{|}{\text{Rh}}\_\_$ darkening is opaque when a vowel follows.

- Varieties of present-day English:

	1	2	3
Healey	l	l	l
heal-ing	l	l	ɫ
heal it	l	ɫ	ɫ
heal ‖	ɫ	ɫ	ɫ

1	Conservative RP	(Cruttenden 2001: 201)	PL darkening	transparent
2	USA(1)	(Sproat and Fujimura 1993)	WL darkening	opaque in phrases
3	USA(2)	(Olive et al. 1993: 212-15)	SL darkening	opaque in words [*and* phrases

§23 *The problem for OO-correspondence: not a theorem, but a stipulation in UG (Hayes 2000: 102)*

(a) hi:ɬ — hi:.ɬɪt

OO-IDENT(PHRASAL)

(b) hi:ɬ — hi:.ɬɪŋ

OO-IDENT(MORPHOLOGICAL)

(c) If *CODA[l] ≫ OO-IDENT(MORPHOLOGICAL) ≫ *[ɬ] ≫ OO-IDENT(PHRASAL)
then impossible dialect with [hi:ɬ, hi:**l** ɪt, hi:ɬɪŋ]

(d) Hayes's solution: UG stipulates OO-IDENT(PHRASAL) ≫ OO-IDENT(MORPHOLOGICAL)

> "In the present approach, employing Optimality Theory and Paradigm Uniformity, an appropriate implementation of this idea would be to suppose that the Paradigm Uniformity constraints are a priori stricter for higher levels —for example, stricter in phrases than in words. For the case at hand we can suppose that there are separate constraints of Paradigm Uniformity for phrasal versus morphological contexts, with the former ranked within UG as necessarily stricter than the latter."

SOME CHALLENGES FOR (THE NATIVIST THEORY OF) THE PHONOLOGICAL CYCLE

Nativist approaches to the cycle (classical Lexical Phonology, Phase Theory)

§24 *Key assumptions*

- The fact that phonology is cyclic is stipulated in UG as part of the overall blueprint for the architecture of grammar.
- Given the innate principles of the cycle, plus the language-specific settings of the relevant parameters, the morphosyntactic structure of a linguistic expression rigidly determines the course of its cyclic phonological derivation.

§25 *The strong predictions of Phase Theory*

- Phonological and semantic interpretation run on the same syntactically determined cycles (phases).
- Semantical compositionality and phonological cyclicity should rigidly mirror each other.

(E.g. Marvin 2002: 39, Arad 2003: 740, Embick and Marantz 2008: 11, Embick 2010.)

Problems

§26 *Irregularity of certain cyclic effects*

In present-day English, cyclic stress preservation is notoriously irregular among stem-level derivatives containing pretonic sequences of two heavy syllables of which the second is closed by a sonorant consonant

See Chomsky and Halle (1968: 38-39, 116, 161), Liberman and Prince (1977: 299-304), Kiparsky (1979: 428-29), Halle and Kenstowicz (1991: 460-61), Burzio (1994: §6.3), Pater (2000), Marvin (2002: 60-70), Hammond (2003), Collie (2007: ch. 2), and Kraska-Szlenk (2007: §8.1.2), among others.

a. the cyclic pattern		*cond*[é]*mn*	*còmd*[ɛ̀]*mn-átion*
		imp[ɔ́]*rt*	*ìmp*[ɔ̀]*rt-átion*
	cf.	*cómp*[ə]*nsàte*	*còmp*[ə]*nsát-ion*
		cónt[ə]*mplàte*	*còmt*[ə]*mplát-ion*
b. the noncyclic pattern		*cons*[ə́]*rve*	*còns*[ə]*rv-átion*
		tràns[ɔ́]*rt*	*tràns*[ə]*rt-átion*

§27 *Partial decorrelation with semantics*

- Correlation suggested by Chomsky and Halle (1968: 39, 112, 116), restated using the terminology of Borer (2003: §4):

  semantics of argument-structure nominal ⇨ cyclic stress pattern
  semantics of referential nominal ⇨ noncyclic stress pattern

  e.g. a. *còmd*[ɛ̀]*nsátion* [[N [V condense] ation] 'act of condensing'
  Andrew's skilful cond[ɛ̀]*nsation of the argument into a few sentences helped me to see the point.*

  b. *còmd*[ə]*nsátion* [[N [V condense] ation] 'condensed substance'
  I used a cloth to wipe the cond[ə]*nsation from the windscreen.*

- But the correlation does not in fact hold up:

  In Noboa, *the plaintiffs argued that the airline's transp*[ə]*rtation of the human ashes in the valuable cargo section of the aircraft* [...] *was sufficient to justify a finding of wilful misconduct on the part of the airline.*

  (International Air Transport Association, *The Liability Reporter*, 9, February 2006)

- There is a crucial effect of relative token frequency missed by this approach: see §40 below.

§28 *Anticyclic effects*

English idiolects with *c*[aɪ]*cle* ~ *c*[ɪ]*clic* ~ *c*[aɪ]*clicity* (see e.g. Collie 2008: 524-525)

Time for an alternative?

§29 An alternative agenda:

to consider whether an emergentist approach to the origins of cyclicity can make UG's task lighter whilst making more accurate empirical predictions.

THE EMERGENCE OF STEM-LEVEL CYCLICITY

The stem level is special

§30 Stratum-internal cyclicity in classic rule-based Lexical Phonology:

- Stem level ('level one'): internally cyclic
  every stem-level category defines a cyclic domain
  e.g. ⟦SL ⟦SL ⟦SL *origin* ⟧ *al* ⟧ *ity* ⟧
- Word level ('level two'): internally noncyclic
  only the outermost category defines a cyclic domain
  e.g. ⟦WL ⟦SL *memory* ⟧ *less-ness* ⟧

E.g. the cyclic and postcyclic levels in Booij and Rubach (1984, 1987), Kiparsky (1985), etc.

This is approximately correct:

- internal cyclic effects at the stem level display irregularity

but

- it is true that the word level is internally noncyclic (Bermúdez-Otero forthcoming-a: ch. 2, *pace* Orgun 1996)

But why should it be so?

§31 My proposal:

- Effects equivalent to internal cyclicity at the stem level are reflections of special properties of stem-level constructions.
- These effects arise whenever three ingredients are simultaneously present:
  (i) *Nonanalytic listing of stem-level outputs*
  Phonological output representations generated by the stem-level phonology are stored in the permanent lexicon.
  (ii) *Morphological blocking*
  A lexically listed item blocks the online grammatical derivation of a competitor.
  (iii) *High-ranking faithfulness*
  High-ranking faithfulness preserves some phonological property of inputs.

First proposed by Bermúdez-Otero and McMahon (2006: §3.4). Developed in Collie (2007, 2008) and Bermúdez-Otero (forthcoming-b: §3.3.).

Nonanalytic listing

§32 Psycholinguistic evidence for two types of listing (Stemberger and MacWhinney 1986, 1988)

(i) English speakers make significantly fewerb production errors in high-frequency than in low-frequency regular past-tense forms:

e.g. experiment in Stemberger and MacWhinney (1988: 106)

verb type	trials	errors	rate
low frequency	700	28	.037
high frequency	700	13	.017

If production accuracy if facilitated by lexical listing,
then high-frequency regular past-tense forms are lexically listed.

(ii) Affix shifts: e.g. *Tell-us-ing* for *tell-ing us*
Let go-ing for *lett-ing go*

Affix shifts affect high-frequency regularly inflected forms at rates that do not reliaby differ from those of low-frequency regularly inflected forms.

If affix shifts imply that inflected items enter the computation as two pieces,
then those inflected forms that are listed must be listed analytically: as sequences of two pieces.

§33 But lexical listing has phonological consequences when it is nonanalytic (Kaye 1995), i.e. when the lexical entry contains a phonological representation with no internal domain structure.

Notably, nonanalytic listing gives rise to exceptions:

nonanalytic	✓	ARABIC ↔	$[_{\omega}\,[_{\Sigma'}\,[_{\Sigma^{\circ}}\,\text{'æ}^{\mu}\text{.ɹæ}^{\mu}]\text{bɪk}]]$	(penult stress blocked)
analytic	✗	ARABIC ↔	$[\![_{\text{SL}}\,\text{æɹæb - ɪk}]\!]$	($\rightarrow_{\text{SL}}$ $^{*}[_{\omega}\,[_{\Sigma'}\,\text{æ}[_{\Sigma^{\circ}}\,\text{'ɹæ}^{\mu}\text{.bɪ}^{\mu}\text{k}]]]$)

§34 Postulate: ☞ stem-level constructions are listed nonanalytically.

Cf. the absence of exceptions in a word-level construction: past-tense inflection with /d/

/-d/	→ [-ɪd]	after /t, d/	['pæt-ɪd, 'æd-ɪd]
	[-t]	after voiceless segments other than /t/	[tɹæp-t, pæk-t, kə'læps-t, pætʃ-t]
	[-d]	elsewhere	

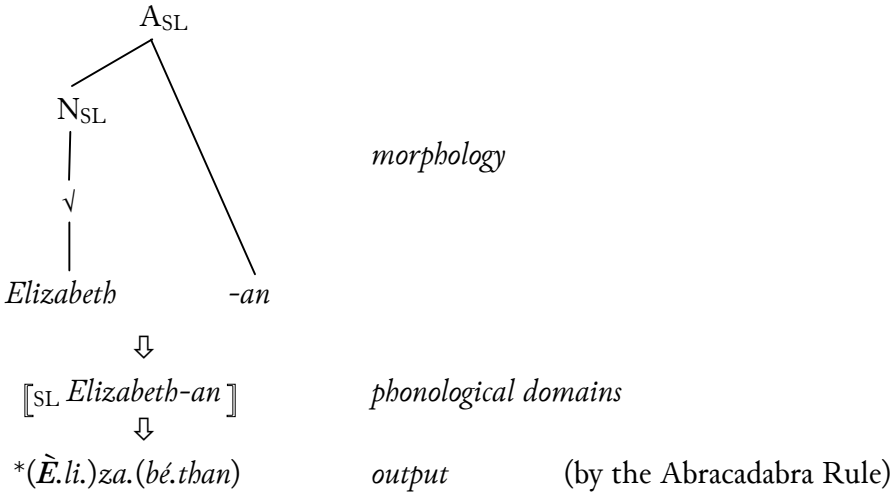
This alternation is strictly exceptionless (Albright and Hayes 2003: 151) because it is always computed online, the relevant forms being either unlisted or listed analytically.

§35 If stem-level outputs are listed nonanalytically, then stem-level morphological and phonological processes work as 'lexical redundancy rules' in the sense of Jackendoff (1975):

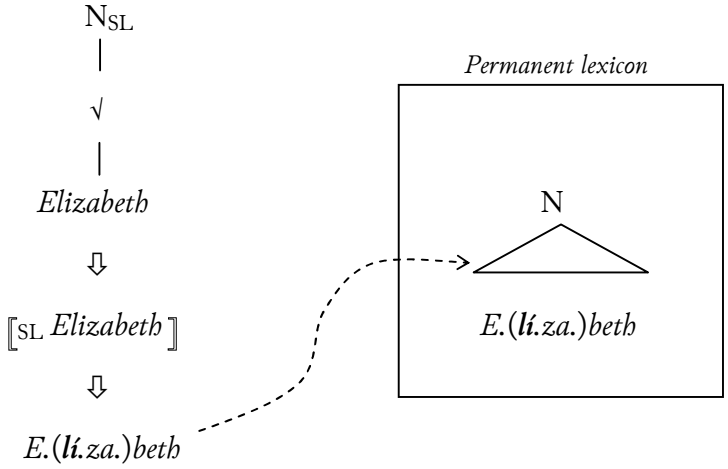
- they redundantly capture relationships between stored items;
- they apply online when a search of the lexicon retains nothing.

From nonanalytic listing to stem-level cyclicity via blocking

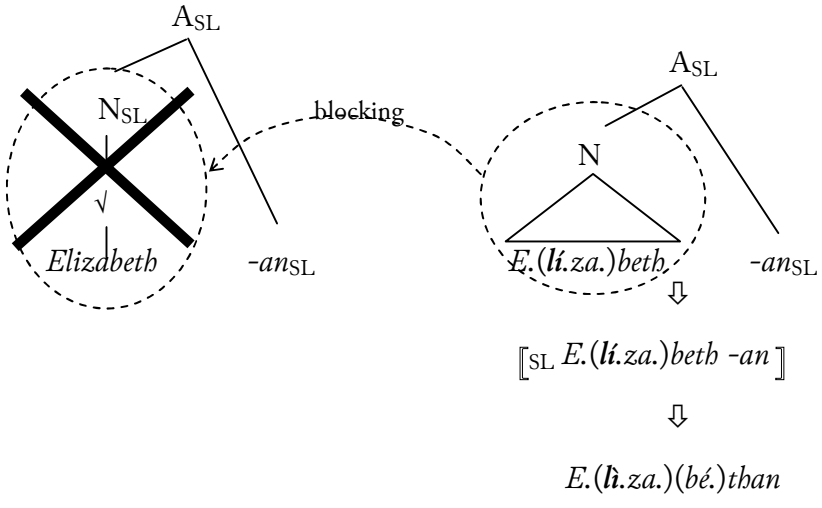
§36 The alternative to avoid: derivation from the root in one fell swoop.



§37 Now assume nonanalytic listing. Then,



§38 Now, by morphological blocking,



Predicting frequency effects

§39 The success of blocking depends on token frequency.

This is presumably because high token frequency raises resting activation, which in turn increases speed of retrieval, which in turn affects the outcome of the race between lexicon and grammar.

(Aronoff and Anshen 1998: 240 and references therein; see also Hay 2003)

§40 Therefore, if internal cyclicity at the stem level emerges from blocking, then it too should vary according to token frequency. This is correct:

			tokens per millions words in spoken section of COCA		
			base		derivative
a.	*cyclic stress*				
	cond[é]mn	còmd[è]mn-átion	7.09	>	2.57
	imp[ɔ́]rt	ìmp[ɔ]rt-átion	5.15	>	0.62
b.	*variable stress*				
	cond[é]nse	còmd[è~ə]ns-átion	0.28	≈	0.22
c.	*noncyclic stress*				
	cons[ə́]rve	còns[ə]rv-átion	1.65	<	9.11
	tràmsp[ɔ́]rt	tràmsp[ə]rt-átion	7.23	<	23.54

In a careful statistical study, Collie (2007, 2008) finds a similar effect of relative token frequency on cyclic stress transfer among stem-level derivatives with trisyllabic pretonic sequences of the types *σ̆σ̆σ́*... and *σ̆σ̆σ́*...: e.g. *antìcipát-ion ~ ànticipát-ion* (cf. *antícipate*).

§41 This approach can cope with countercyclic effects, which are intractable in classic Lexical Phonology:

e.g. in idiolects with *c*[aɪ]*cle ~ c*[ɪ]*clic ~ c*[aɪ]*clicity*
stored *c*[ɪ]*clic* fails to block *c*[aɪ]*cl-ic-ity*
(I have observed this paradigm in the speech of my former colleague Dr John Hutton.)

Emergentist approaches to the cycle can incorporate insights from usage-based models of grammar (e.g. the rôle of frequency).

The rôle of faithfulness

§42 In an OT-based cyclic model, a property of a listed input will be preserved in the output only if the relevant faithfulness constraint is ranked high at the stem level:

/E(líza)beth-an/	IDENT-FootHead	ALIGN(ω,L;Σ,L)
(Èli)za(bé)than	*!	
E(lìza)(bé)than ☜		*

§43 However, by Richness of the Base, this entails that prespecified foot-heads in the UR of monomorphemic items can also block the Abracadabra Rule:

/ap**ó**theosis/	IDENT-FootHead	ALIGN(ω,L;Σ,L)
(àpo)the(ó)sis	*!	
a(pòthe)(ó)sis ☜		*

§44 Thus, Chung's Generalization is derived as a theorem:

Chung's Generalization (after Chung 1983: 63)
If a stem-level phonological process can sustain lexical exceptions in monomorphemic items, then it can show cyclic misapplication in complex stem-level forms, and vice versa.

Prediction independently derived in Bermúdez-Otero and McMahon (2006: 400) and in Kiparsky (2007).

§45 Another case: *cond*[ɛ́]*mn* → *còn*d[ɛ̀]*mn-átion*
imp[ɔ́]*rt* → *ìmp*[ɔ̀]*rt-átion*

predicts the existence of forms like *chìmp*[æ̀]*nzée*
Mòz[æ̀]*mbíque*

§46 Yet another problem for OO-correspondence:

Since IO-faithfulness and OO-identity constraints can be ranked independently, compliance with Chung's Generalization—of which we have seen so many examples in this paper—becomes purely accidental.

STRATIFICATION AND INTERSTRATAL CYCLICITY EMERGE TOO?

§47 *Key assumption: bottom-up grammatical segmentation of phonological stimuli*

During successive stages of acquisition, the child discovers that certain substrings of phonological material in the primary linguistic data are exponents of morphosyntactic units.

This process of grammatical segmentation of phonological stimuli proceeds roughly in a bottom-up direction:

(1) *Stage of unsegmented utterances:* [ˌmʌmiˌlʌvzˈbeɪbi]

Initially, the child only has access to surface phonological forms corresponding to utterances, as show by:

- learning phrasal prosody *in utero* (Mehler et al. 1988): no lexicon
  degraded segmental information
- storage of multiword units (Peters 1983, Arnon 2009): *All gone!*
  Give-it the ball.

(2) *Whole-word stage:* [[ˌmʌmi][ˌlʌvz][ˈbeɪbi]]

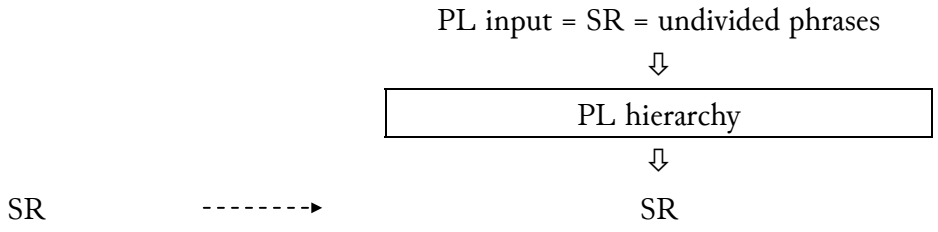
Later, the child discovers that substrings of surface forms correspond to grammatical words.

(3) *Stage of stems and affixes:* [[ˌmʌmi][[ˌlʌv]z][ˈbeɪbi]]

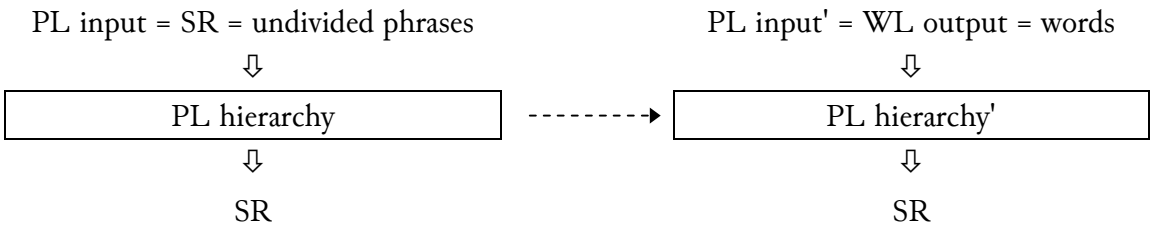
Later still, she learns that different portions of the phonological form of words correspond to roots, stems, and affixes.

§48 OT interpretationm: (1) pure phonotactic learning under the identity map
(2) discovery of morphosyntactic segmentation of domain
(3) analysis of alternations in the domain

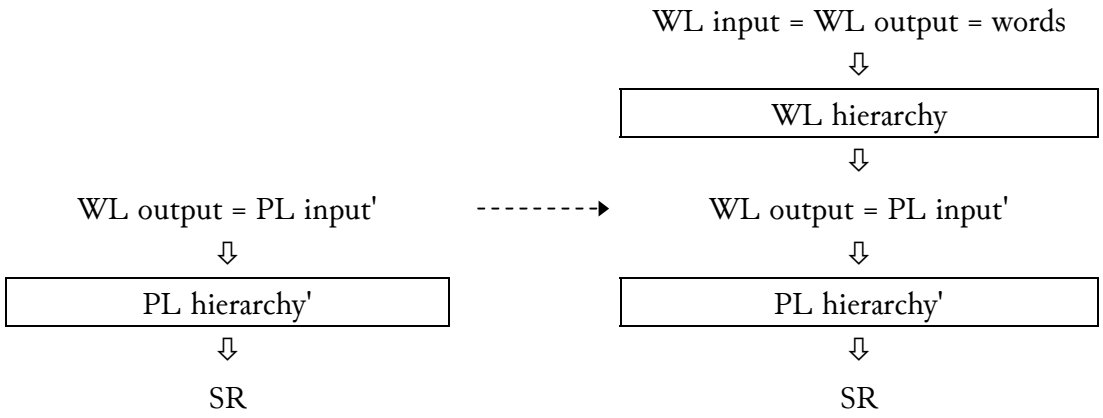
a. *Stage of unsegmented utterances: pure phonotactic learning over SRs*



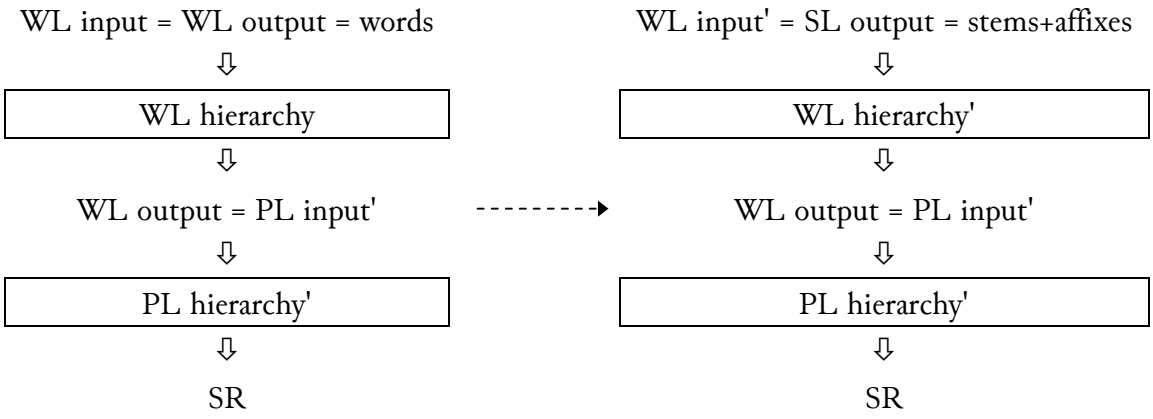
b. *Whole-word stage (I): acquisition of phrase-level alternations*



c. *Whole-word stage (II): pure phonotactic learning over PL inputs*



d. *Stage of stems and affixes (I): acquisition of word-level alternations*



§49 A case of hierarchical constructive development?

> This work [*sc.* recent research on unsupervised machine learning of grammar] also suggests a sequenced bootstrap model of language learning in which each level of structure acquired provides the input to [the acquisition of] a higher successor component of grammar. (Lappin and Shieber 2007: 424-25)

The generality of hierarchical constructive development has been emphasized in neoconstructivist approaches to cognition (Karmiloff-Smith 1992, 1994, 1998; Quartz 1999):

> This hierarchical organization of representations combined with its hierarchical developmental pattern lends support to the view of development as a cascade of increasingly complex representational structures, in which construction in some regions depends on the prior development of others. (Quartz 1999: 54)

CONCLUSION

§50
- The interface between morphosyntax and phonology is cyclic;
- but strongly nativist approaches to the cycle encounter difficulties over
  irregular cyclic effects
  and decorrelations between semantic compositionality and phonological cyclic effects.
- The solution *may* be an approach where cyclicity is not innately stipulated by rather emerges
  from nonanalytic listing and blocking in the case of stem-level cyclic effects
  and from staged bottom-up morphosyntacitc segmentation in the case of interstratal cyclicity.

§51 Q: Does postulating emergence imply a rejection of the methods of formal phonology?

A: No!

- Incorporating insights from machine learning, processing models, and usage-based theories can increase empirical adequacy
  and reduce the need to postulate innate domain-specific knowledge.
- But we still need formal research to tell us what computational properties should emerge from our models of accquisition, processing, and use:

  we wouldn't know that phonology was cyclic if generative phonology hadn't told us so.

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