Cyclicity

Ricardo Bermúdez-Otero (University of Manchester)

Forthcoming in: Marc van Oostendorp, Colin Ewen, Elizabeth Hume, and Keren Rice (eds).
The Blackwell companion to phonology. Malden, MA: Wiley-Blackwell.

Revised version (16 July 2010).

1. Introduction[1]

The phonology of a natural language will often treat the same string differently according to whether it is wholly contained within a single morph, or it arises through a morphological operation like affixation, or it straddles the edges of two adjacent grammatical words. In the generative tradition there is a widespread and long-standing consensus that such morphosyntactic conditioning effects may come about in two ways: representationally or procedurally (Scheer 2008: §3ff; see Table 1). Representational morphosyntactic conditioning occurs when phonological processes are sensitive to the presence or absence of certain phonological objects—boundary symbols in *SPE*, prosodic categories in most later frameworks—which are in turn positioned by reference to the edges of morphosyntactic units. In procedural morphosyntactic conditioning, in contrast, morphosyntax directly controls the amount of structure visible during a given round of phonological computation, either by submitting to the phonology only a morphosyntactic subconstituent of a complete linguistic expression (as in the theory of the cycle) or by allowing the phonology access to the surface representation of some morphosyntactically related expression (as in the theory of transderivational or output-output correspondence, henceforth 'OO-correspondence').

This chapter addresses current debates about procedural morphosyntactic conditioning in phonology, focusing in particular on the contest between the cycle and OO-correspondence (§5-§9); we shall be concerned with prosody only insofar as it raises the nontrivial problem of demarcating procedural from representational effects (§4). Much of the discussion will be taken up with three instances of morphosyntactically induced misapplication that challenge the basic premises of transderivational theories: in all three cases, the surface bases needed for an analysis relying on OO-correspondence appear to be unavailable for phonological or morphological reasons (§6-§8). As the argument unfolds, however, it will become clear that questions about morphosyntax-phonology interactions are intricately entangled with problems in every other area of phonology, notably including the theory of representations, the phonology-phonetics interface, and the balance between synchronic and diachronic explanation.

Theory	Representational effects	Procedural effects	Sample reference
SPE	boundary symbols (+, #)	the cycle	Chomsky and Halle (1968)
Lexical Phonology	prosodic units (built by rules)	the cycle (with levels)	Booij and Rubach (1984)
Stratal OT	prosodic units (controlled by ALIGN)	the cycle (with levels)	Bermúdez-Otero and Luís (2009)
Classical OT	prosodic units (controlled by ALIGN)	OO-correspondence	Raffelsiefen (2005)
Lateral Phonology	empty CV units	the cycle (phases)	Scheer (2008)

Table 1. *Two types of morphosyntactic conditioning acknowledged throughout the history of generative phonology.*

2. Two cases of cyclic misapplication in English: postnasal plosive deletion and Belfast dentalization

Let us begin with a well-known instance of morphologically induced overapplication. Present-day English tolerates homorganic consonant clusters consisting of a nasal followed by a noncoronal voiced plosive (i.e. [b] or [g]) only if the latter is syllabified in onset position; if the plosive would otherwise surface in the coda, it undergoes deletion (Borowsky 1993: 202).[2]

(1) a.   b.

     bomb   [bɒm]   *bombard*_V   [ˌbɒm.ˈbɑːd]

     thumb [θʌm]   *thimble*   [ˈθɪm.**b**l̩]

     crumb [kɹʌm]   *crumble*   [ˈkɹʌm.**b**l̩]

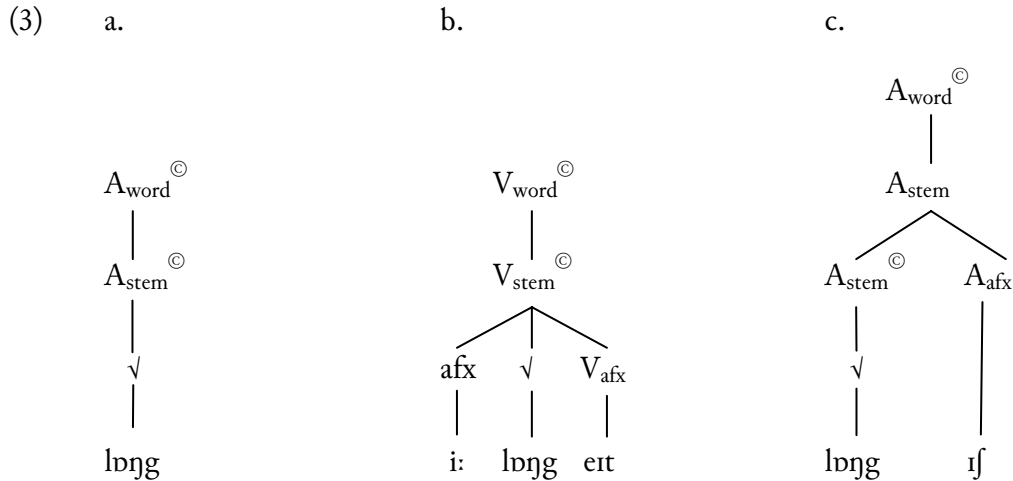   *long*   [lɒŋ]   *elongate*_V   [ˈiː.lɒŋ.ˌ**g**eɪt]

The forms in (1a) and (1b) display normal application and normal nonapplication of deletion, respectively. In (2a), however, the process overapplies: the plosives [b] and [g] fail to surface stem-finally, even though in that position they would be syllabified as onsets; cf (2b).[3]

(2) a.

     bomb-ing [ˈbɒ.mɪŋ]   b.   *[ˈbɒm.**b**ɪŋ]

     thumb-ing [ˈθʌ.mɪŋ]   *[ˈθʌm.**b**ɪŋ]

     crumb-y   [ˈkɹʌ.mɪ]   *[ˈkɹʌm.**b**ɪ]

     long-ish   [ˈlɒ.ŋɪʃ]   *[ˈlɒŋ.**g**ɪʃ]

According to the theory of the phonological cycle, first formulated by Chomsky, Halle, and Lukoff (1956: 75), the key to such instances of morphosyntactically induced misapplication is to be found in part-whole relationships within the grammatical constituent structure of the relevant linguistic expressions. Consider, for example, the morphological structure of the adjective *long*, the verb *elongate*, and the derived adjective *longish*:

---

[2]   All varieties of English exhibit postnasal [b]-deletion; [g]-deletion varies across dialects.

[3]   *Thumb*_N and *thimble* are highly unlikely to be synchronically related, and so native speakers probably have no reason to derive the noun *thumb*_N or the converted verb *thumb*_V from a root /√θʌmb/. If so, the gerund *thumb-ing* [ˈθʌ.mɪŋ] is in fact transparent. This does not affect our argument, however: the key point is that the grammar of English systematically disallows transparent alternations between infinitives ending in [...Vm] and gerunds ending in [...Vm.bɪŋ].

(3) a.   b.   c.

$$
\begin{array}{lll}
 & & A_{word}^{\,©} \\
 & & | \\
A_{word}^{\,©} & V_{word}^{\,©} & A_{stem} \\
| & | & \diagup\diagdown \\
A_{stem}^{\,©} & V_{stem}^{\,©} & A_{stem}^{\,©}\quad A_{afx} \\
| & \diagup\,|\,\diagdown & |\qquad| \\
\sqrt{} & \text{afx}\ \ \sqrt{}\ \ V_{afx} & \sqrt{}\qquad| \\
| & |\ \ \ \ |\ \ \ \ | & |\qquad| \\
\text{lɒŋg} & \text{iː}\ \ \text{lɒŋg}\ \ \text{eɪt} & \text{lɒŋg}\quad\text{ɪʃ}
\end{array}
$$

Let us suppose that some of the morphosyntactic constituents shown in (3) define domains for phonological computation; I shall henceforth refer to these as 'cyclic nodes'. Assume, at a minimum, that the set of cyclic nodes in (3) includes every stem immediately derived from a root, as well as every fully inflected, syntactically free grammatical word; these have been flagged with a superscript ©. Given these premises, one obtains the following nested domain structures:

(4)   a. [[lɒŋg]]   b. [[iː-lɒŋg-eɪt]]   c. [[lɒŋg] ɪʃ]
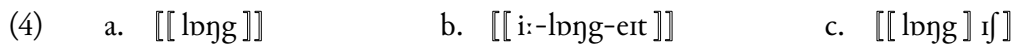
Now suppose that phonological computation proceeds iteratively, starting with the domains defined by the smallest, most deeply embedded cyclic nodes, and then moving to larger, less deeply embedded cyclic nodes: in other words, suppose that the the computation of the phonological form of the parts precedes and feeds the computation of the phonological form of the whole.

(5)   a. [[lɒŋg]]   b. [[iː-lɒŋg-eɪt]]   c. [[lɒŋg] ɪʃ]

	a.	b.	c.
inner cycle	lɒŋ	iː.lɒŋ.geɪt	lɒŋ
outer cycle	—	—	lɒ.ŋɪʃ
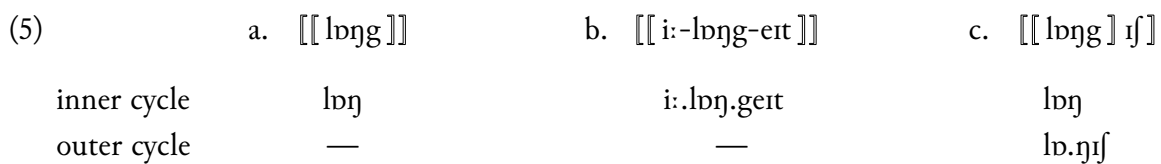
According to this cyclic analysis, postnasal plosive deletion overapplies in *long-ish* because its conditions are met within a morphosyntactic subconstituent, the stem *long-*, which defines a cyclic domain by itself. The environment for deletion disappears in the outer cycle, as the vowel of the suffix *-ish* projects a syllable with an onset capable of sheltering the underlying /g/; but deletion has already applied in the inner cycle. The result is a counterbleeding interaction.

Observe that not all morphosyntactic constituents trigger phonological cycles. In (3b) and (4b), for example, it is absolutely crucial that roots (as opposed to stems) should not count as cyclic nodes (Kiparsky 1982: 32-33, Inkelas 1989: §3.5.5); otherwise, postnasal plosive

deletion would incorrectly overapply in *e-lon**g**-ate*.[4] A fully articulated theory of the cycle must of course specify criteria for designating particular morphosyntactic nodes as cyclic or noncyclic. Scholars working in the tradition of Lexical Phonology (e.g. Kiparsky 1982, Hargus and Kaisse 1993) and Stratal OT (e.g. Kiparsky 2000; Bermúdez-Otero 1999, 2003) have reached a broad consensus on a number of points, sometimes strikingly at variance with phase theory in minimalist syntax (Chomsky 2001): e.g. there appear to be no cyclic nodes between the grammatical word (X°) and the utterance (see further Scheer 2008: §740ff). Many other issues remain open: e.g. whether or not certain affixes should be allowed to define cyclic domains by themselves (Baker 2005; see also Mohanan 1982, and cf. McCarthy 2007: 133-34).

To account for morphologically induced underapplication, the theory of the cycle needs to supplemented with the concept of level or stratum.[5] Consider, for example, the process of dentalization found in certain varieties of English spoken in and around Belfast: the coronal noncontinuants /t, d, n, l/ have alveolar realizations unless immediately followed by /(ə)ɹ/, in which case they become dental (John Harris 1985: 58, 211ff).

(6) a. *train* [t̪ɹ̪ɪən]   *drain* [d̪ɹ̪ɪən]
        true   [t̪ɹ̪ʉ̊ː]   *drew*   [d̪ɹ̪ʉː]

     b. *Peter* [ˈpit̪ə˞]   *ladder* [ˈlad̪ə˞]   *dinner* [ˈdɛn̪ə˞]   *pillar* [ˈpɛl̪ə˞]
        matter [ˈmat̪ə˞]   *rudder* [ˈɹɔd̪ə˞]   *spanner* [ˈspän̪ə˞]

Dentalization underapplies when its environment is created by adding a suffix like agentive *-er* (7a) or comparative *-er* (7b) to a free stem, although it does apply normally when comparative *-er* is suffixed to a suppletive bound root (7c).

(7) a. *hea*[t]*er*   *loa*[d]*er*   *di*[n]*er* 'diner'   *ki*[l]*er*
        wai[t]*er*   *ru*[n]*er*
        shou[t]*er*

     b. *fa*[t]*er*   *lou*[d]*er*   *fi*[n]*er*   *coo*[l]*er*
        la[t]*er*

     c.   *better* [ˈbæt̪ə˞]   'good.CMPR'
        cf. *better* [ˈbætə˞]   'one who bets'

Applying the same principles as in (4), we obtain cyclic domain structures like the following:

---

[4]   For the root-based status of this form, compare verbs like *e-dulcor-ate*, *e-mancip-ate*, *e-viscer-ate*, etc, which are manifestly derived from uninflectable bound bases.

[5]   Some scholars pursue an alternative approach based on Chomsky's (2001) Phase Impenetrability Condition: e.g. Marvin (2002), Scheer (2008).

(8) a. [[*train*]]
   b. [[*Peter*]]
   c. [[*heat*] *er*]
   d. [[*fat*] *er*]
   e. [[*bett-er*]]   'good.CMPR'
   f. [[*bet*] *er*]   'one who bets'

However, it becomes immediately apparent that, if dentalization applies in every cycle, then cyclic derivation will just fail to produce the desired underapplication in (8c,d,f): dentalization will simply take place in the outer cycle.

Many cyclic frameworks solve this problem by asserting that phonological domains associated with morphosyntactic constituents of different kinds may be subject to different phonological generalizations: in common usage, such morphosyntactic constituents are said to 'belong to different phonological levels'. Theories differ as to the number of phonological levels that may be distinguished within the grammar of a single language. Lexical Phonology and Stratal OT typically assume that each grammar specifies precisely three levels: the stem, word, and phrase levels. In affixal constructions, the ascription of the construction to the stem-level or word-level phonology is deemed to depend on properties both of the base (Giegerich 1999) and of the affix: the attachment of an affix to a root necessarily produces a stem-level category; the attachment of an affix to a stem may produce a stem-level or word-level category depending on the idiosyncratic affiliation of the affix (e.g. Bermúdez-Otero 2007a: 283). In constrast, full grammatical words trigger word-level cycles and complete utterances trigger phrase-level cycles.

In the case of Belfast English, one must assume that dentalization applies only within stem-level domains, and that agentive *-er* and comparative *-er* are word-level suffixes unless attached to bound roots. This yields the appropriate counterfeeding relationship between stem-level dentalization and word-level suffixation.

(9) | | 'Peter' | 'good.CMPR' | 'one who bets' | 'fatt-er' |
|---|---|---|---|---|
| | [WL [SL *Peter*]] | [WL [SL *bett-er*]] | [WL [SL *bet*] *er*] | [WL [SL *fat*] *er*] |
| SL (dentalization on) | t̪ | t̪ | — | — |
| WL (dentalization off) | — | — | — | — |

3. The Russian Doll Theorem and the life cycle of phonological processes

There is no room in this brief chapter to review all the predictions about morphosyntactically induced misapplication that follow from the theory of the cycle. It will therefore be appropriate to concentrate here on one of the most fundamental:

(10) *The Russian Doll Theorem*

Let there be the nested cyclic domains $[_\gamma \ldots [_\beta \ldots [_\alpha \ldots]\ldots]\ldots]$. If a phonological process ρ is opaque in β because its domain is α, then ρ is opaque in γ.

To my knowledge, this entailment of cyclic theory has not been formally enunciated before, probably because it has been considered so obviously true as to be entirely trivial. Later, however, we shall see that OO-correspondence is easily capable of violating the Russian Doll Theorem and captures its effects only by stipulation (§9).

The Russian Doll Theorem has the following corollary:

(11) If a phonological process exhibits cyclic misapplication within a certain phonological configuration created by affixation, then it must also exhibit cyclic misapplication if the same configuration arises by word concatenation.

This follows logically from elementary facts of morphosyntactic layering: a phonological process can cyclically misapply in the presence of an affix only if that affix is excluded from its cyclic domain, which must therefore correspond to a morphosyntactic category smaller than the grammatical word, i.e. a stem; but, by its very nature, a stem cannot straddle the edges of adjacent words. Postnasal plosive deletion (§2) bears out this prediction: overapplication before word-level suffixes beginning with a vowel, as in *long-ish* [ˈlɒ.ŋɪʃ], entails overapplication in word-final prevocalic environments, as in *long effect* [ˌlɒ.ŋɪ.ˈfɛkt]; cf. *[ˌlɒŋ.gɪ.ˈfɛkt].

Not only does corollary (11) hold true of postnasal plosive deletion in present-day English, but it also captures key facts in the diachronic evolution of the process. For /ŋg/ clusters, in particular, we can reconstruct the four historical stages shown in (12): Stage 0 represents the situation in Early Modern English; Stage 1 is attested in the formal, relatively conservative register of eighteenth-century orthoepist James Elphinston; Stage 2 corresponds to Elphinston's description of his own casual, more innovative register; and Stage 3 is observed in present-day RP (Garrett and Blevins 2009: 527-28).

(12)

	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

In compliance with (11), the diachronic transition from normal application (Stage 1) to word-internal overapplication (Stage 3) is effected through an intermediate phase involving overapplication at word boundaries but normal application word-internally (Stage 2).

More generally, the diachronic pathway shown in (12) provides a clear illustration of the typical life cycle of phonological processes, which stratal-cyclic frameworks capture in a particularly perspicuous way; see e.g. Bermúdez-Otero (1999: 99-103, 239-40; 2007b: 503), McMahon (2000: ch. 4). First, phonetically driven innovations enter the grammar from below as gradient phonetic rules, which later become stabilized as categorical phonological processes applying across the board at the phrase level (Bermúdez-Otero 2007b: 505): in (12), this is the transition from Stage 0 to Stage 1. Subsequently, analogical change causes the new phonological process to climb up to progressively higher levels, concomitantly narrowing down its domain of application (Dressler 1985: 149): in (12) we see deletion climbing up from the phrase level (Stage 1) to the word level (Stage 2), and from the word level (Stage 2) to the stem level (Stage 3). Eventually, senescent processes typically undergo morphologization or lexicalization: see Bermúdez-Otero (2008) for incipient symptoms of this in the case of postnasal plosive deletion.

The overall sequence of events is represented in greater detail in (13).

(13)

level	deletion?	*elongate*	*prolonging ‖*	*prolong it*	*prolong ‖*

a. *Stage 0: Early Modern English*

SL	no	[iː.lɒŋ.geɪt]	[pɹə.lɒŋg] [ɪŋg]	[pɹə.lɒŋg] [ɪt]	[pɹə.lɒŋg]
WL	no	[iː.lɒŋ.geɪt]	[pɹə.lɒŋ.gɪŋg]	[pɹə.lɒŋg] [ɪt]	[pɹə.lɒŋg]
PL	no	[iː.lɒŋ.geɪt]	[pɹə.lɒŋ.gɪŋg]	[pɹə.lɒŋ.gɪt]	[pɹə.lɒŋg]

b. *Stage 1: Elphinston's formal register*

SL	no	[iː.lɒŋ.geɪt]	[pɹə.lɒŋg] [ɪŋg]	[pɹə.lɒŋg] [ɪt]	[pɹə.lɒŋg]
WL	no	[iː.lɒŋ.geɪt]	[pɹə.lɒŋ.gɪŋg]	[pɹə.lɒŋg] [ɪt]	[pɹə.lɒŋg]
PL	yes	[iː.lɒŋ.geɪt]	[pɹə.lɒŋ.gɪŋǥ]	[pɹə.lɒŋ.gɪt]	[pɹə.lɒŋǥ]

c. *Stage 2: Elphinston's casual register*

SL	no	[iː.lɒŋ.geɪt]	[pɹə.lɒŋg] [ɪŋg]	[pɹə.lɒŋg] [ɪt]	[pɹə.lɒŋg]
WL	yes	[iː.lɒŋ.geɪt]	[pɹə.lɒŋ.gɪŋǥ]	[pɹə.lɒŋǥ] [ɪt]	[pɹə.lɒŋǥ]
PL	yes (vacuously)	[iː.lɒŋ.geɪt]	[pɹə.lɒŋ.gɪŋ]	[pɹə.lɒ.ŋɪt]	[pɹə.lɒŋ]

d. *Stage 3: present-day RP*

SL	yes	[iː.lɒŋ.geɪt]	[pɹə.lɒŋǥ] [ɪŋǥ]	[pɹə.lɒŋǥ] [ɪt]	[pɹə.lɒŋǥ]
WL	yes (vacuously)	[iː.lɒŋ.geɪt]	[pɹə.lɒ.ŋɪŋ]	[pɹə.lɒŋ] [ɪt]	[pɹə.lɒŋ]
PL	yes (vacuously)	[iː.lɒŋ.geɪt]	[pɹə.lɒ.ŋɪŋ]	[pɹə.lɒ.ŋɪt]	[pɹə.lɒŋ]

The analogical changes involved in the transitions between Stages 1 and 2 and between Stages 2 and 3 were driven by input restructuring (Bermúdez-Otero 2006: 501ff, Bermúdez-Otero and

Hogg 2003: 105ff). At Stage 1, for example, surface [$_{PL}$ pɹə.lɒŋ‖] was derived unfaithfully from word-level [$_{WL}$ pɹə.lɒŋg] by a phrase-level application of deletion. By Stage 2, however, [$_{PL}$ pɹə.lɒŋ‖] has been reanalysed as derived faithfully from an identical word-level representation [$_{WL}$ pɹə.lɒŋ]. This has the effect of introducing deletion into the word-level phonology, and gives rise to the innovative opaque surface form [$_{PL}$ pɹə.lɒ.ŋɪt], derived from word-level [$_{WL}$ pɹə.lɒŋ] [$_{WL}$ ɪt]. Bermúdez-Otero (1999: 100-3, 239-40; 2003: 4ff) outlines an approach to phonological learning that accounts straightforwardly for such patterns of recurrent input restructuring.

4. Cyclicity vs prosody

In §2 we assumed that the morphosyntactic conditioning effects displayed by postnasal plosive deletion and Belfast dentalization were procedural, not representational (see §1). However, several scholars have proposed that the behaviour of English word-level suffixes should be explained prosodically, rather than cyclically (e.g. Szpyra 1989: 178-200, Hammond 1999: 322-329). In this approach, suffixes like agentive *-er* and adjectival *-ish* are not incorporated into the prosodic word containing the stem, but attach under a second projection of *ω*:

(14) a.   *ω*′   b.   *ω*′

           ω°   σ   *ω*°   σ

          long   *ish*   *fat*   *er*
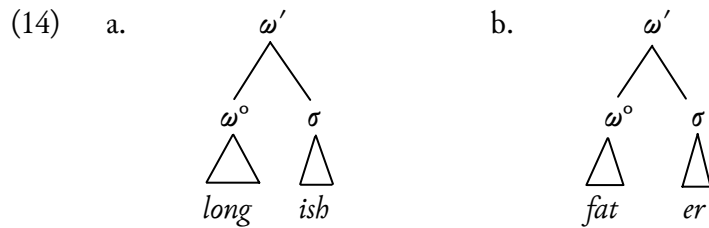
If this were true, then the absence of dentalization in Belfast *fatt-er* [ˈfatəˈ], cf. *[ˈfaʈəˈ] (§2), could be described as a case of transparent nonapplication, rather than as an instance of opaque underapplication: one would just need to stipulate that dentalization does not apply unless its conditions are met within the first projection of *ω*.

$$(15) \quad \begin{bmatrix} \text{coronal} \\ \text{-continuant} \end{bmatrix} \rightarrow [\text{+distributed}] \ / \ [_{ω°} \ \dots \ \_\_(\text{ə})ɹ \ \dots \ ]$$

The uncertainty whether a particular instance of morphosyntactic conditioning in phonology should be analysed procedurally or representationally is in fact one of the most serious and recurrent obstacles faced by empirical research into the morphosyntax-phonology interface. A great deal of extant work fails to make the cut on explicit, consistent, and principled grounds (Raffelsiefen 2005: 214-215). Typically, the question cannot be settled without analysing a very substantial fragment of the phonology of the language in question, including both morphosyntax-phonology and phonology-phonetic interactions (e.g. Bermúdez-Otero and Luís 2009).

In our case, phonological variation and phonetic gradience in English provide strong evidence against the prosodifications shown in (14). Let us first consider variation. Hayes (2000: 98) shows that, in American English, the application frequency of /l/-darkening follows this cline:

(16)   higher frequency of [ɫ]   lower frequency of [ɫ]

        heal ‖   >   *heal it*   >   *heal-ing*   >   *Healey*

On the basis of a comprehensive survey of English function words, however, Selkirk (1996: 204-206) shows that combinations of a verb plus a weak object pronoun like *heal ĭt* undergo affixal cliticization:

(17)

Therefore, if one adopts the approach to English word-level suffixes shown in (14), *heal-ing* will end up being prosodified in the same way as *heal it*, and so prosody will be unable to explain the fact that /l/-darkening applies with greater frequency in the latter than in the former. One would then have to fall back on a procedural (cyclic) explanation: see §9.

The argument from variable /l/-darkening suggests that the prosodification shown in (14) is descriptively insufficient (though cf. Raffelsiefen 2005: 253-256); the evidence of gradient durational effects confirms that it is incorrect. It is a well-known fact that, in English, each of the members of a transparent compound forms a prosodic word by itself:

(18)

Given this fact, the approach to word-level suffixes outlined in (14) predicts that stems in word-level suffixal constructions will display the same patterns of gradient durational adjustment (resistance to polysyllabic shortening, liability to preboundary lengthening) as the first members of transparent compounds, since both occur in the environment [ω′ [ω° __]...]. This prediction proves incorrect. In an experiment with nonce words, Sproat and Fujimura (1993) found no durational effects of stem-level suffixation (e.g. **beel**-*ic*) or word-level

suffixation (e.g. *beel-ing*) when compared with monomorphemic controls (e.g. ***Beelik***), whereas the first members of compounds (e.g. ***beel*** *equator*) were consistently lengthened; see Sproat (1993: 178). A more recent study of Scottish English has detected a very small effect of word-level suffixation: the phonetic realization of the string /ɹeːz/ appears to be slightly shorter in *raisin* [ˈɹeːzn̩] than in *rais-ing* [ˈɹeːzɪŋ] (Sugahara and Turk 2009). Nonetheless, this effect falls far below that of compounding: it is not statistically significant at 'normal' speech rates (Sugahara and Turk 2009: 496); it manifests itself as a 6.6% difference (mean of 23ms) at 'slow' speech rates (p. 496); and it reaches only 9.6% (mean of 42ms) at 'extra-slow' speech rates (p. 499). *Pace* Sugahara and Turkel (2009: 488), these findings are best understood as an effect of footing, rather than of recursive prosodic-word structure:[6]

(19)   a. *raisin*   b. *raise*   c. *rais-ing*

disyllabic foot   but   → monosyllabic foot
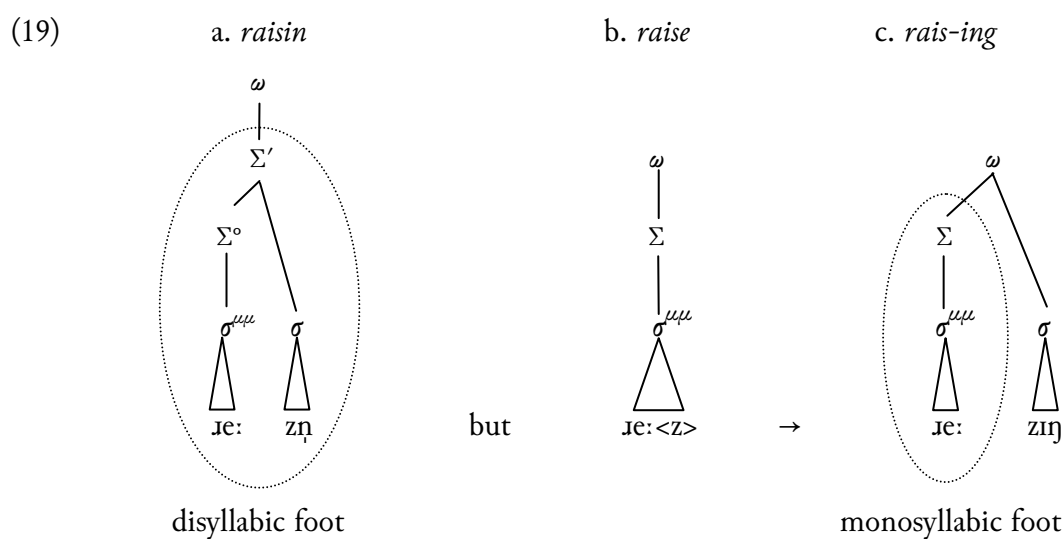
Indeed, the idea that stray syllables affiliated to word-level suffixes attach directly to ω, as in (19c), instead of being footed, makes straightforward sense of the fact that, unless autostressed, word-level suffixes are stress-neutral.

The diagnostics that we have applied so far can be used to demarcate representational morphosyntactic conditioning from procedural morphosyntactic conditioning regardless of one's particular theory of the latter. However, if one commits to a stratal-cyclic analysis of procedural morphosyntactic conditioning, then further demarcation criteria become available. One such criterion is cyclic locality: prosodic structure assigned in an early cycle can persist, and continue to affect the application of phonological processes, throughout later cycles; in contrast, the morphosyntactic structure visible during a phonological cycle ceases to be accessible in the next cycle (by so-called 'Bracket Erasure': see e.g. Orgun and Inkelas 2002: 116). Cyclic locality entails, for example, that the contrast between American English *càpi*[ɾ]*alístic* and *mìli*[t]*arístic*

---

[6]   In (19a), Noun Extrametricality (Hayes 1982: 240) is implemented through the exclusion of the final syllable of the noun stem from the first foot-projection ($\Sigma°$) and through its attachment under a second foot-projection (Σ').

must be mediated by prosody, as /t/-flapping is demonstrably phrase-level (see (36b) below) and so cannot access the internal morphological structure of words: see e.g. Davis (2005), Bermúdez-Otero and McMahon (2006: 403-4); cf. Steriade (2000).

5. Cyclicity vs OO-correspondence

Whilst phonologists generally agree that both representational and procedural morphosyntactic conditioning effects exist, as we saw in §1 and §4, there is currently no consensus on the best way to analyse procedural morphosyntactic conditioning. Within OT, the most popular alternative to the cycle is transderivational correspondence (e.g. Kenstowicz 1996, Benua 1997, Kager 1999, etc). This theory claims that morphosyntactically induced misapplication arises when high-ranking OO-identity constraints cause a transparently derived surface property of a given expression (the 'surface base') to be transmitted to the surface representation of some morphosyntactically related expression, where its presence is opaque. Thus, the underapplication of Belfast dentalization in *fatt-er* [ˈfatəɹ] (§2) would be analysed as follows:

(20)

$$A_{word} \qquad\qquad A_{word}$$

$$A_{stem} \qquad\qquad A_{stem} \quad afx$$

$$\sqrt{} \qquad\qquad\qquad \sqrt{}$$

$$/fat/ \qquad\qquad\qquad /fat/ \qquad /əɹ/$$

IO-FAITH   IO-FAITH

[fat] ←-------- OO-IDENT -------→ [ˈfatəɹ]

transparent nonapplication of dentalization   *underapplication of dentalization*
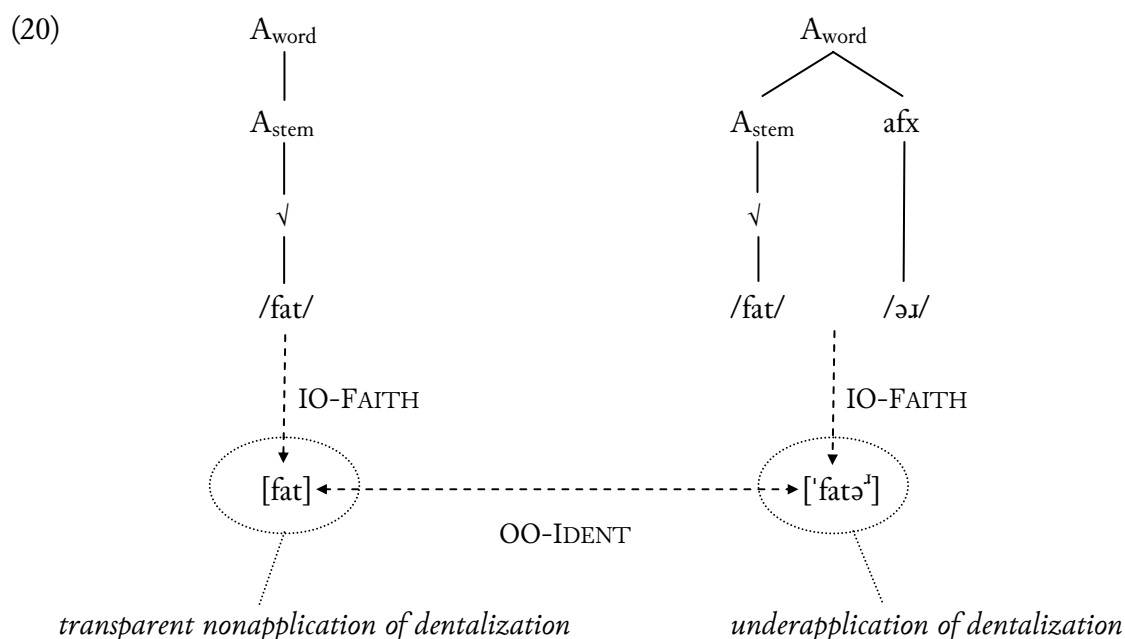
The implementation of this solution poses a number of nontrivial technical challenges, such as motivating the selection of the surface base and preventing the satisfaction of OO-identity by means of overapplication in the base (i.e. transparent /fat-əɹ/→*[ˈfat̪əɹ] leading to opaque /fat/→*[fat̪]); I return to these issues in §9 below.

At this point, however, I should like to compare the core predictions of cyclicity and OO-correspondence. The comparison is in fact easy, because both theories share a fundamental assumption:

(21)   *Ultimate Transparency*

If a phonological generalization p misapplies in the surface representation s of some linguistic expression, then p must apply transparently in some other representation r, with which s is in direct or indirect correspondence.

The theory of the cycle predicts that p will apply transparently in some cyclic domain defined by some morphosyntactic constituent of the expression: the output of this cycle is connected with the surface representation by relationships of input-output faithfulness. In contrast, OO-correspondence predicts that p will apply transparently in the surface representation of some appropriately related linguistic expression; the two surface representations are linked to each other by means of transderivational correspondence. In sections §6 to §8 I adduce empirical evidence supporting the first prediction and challenging the second.

6. Phonologically masked bases (I): Quito Spanish /s/-voicing

Spanish has a voiceless alveolar fricative phoneme /s/. In the dialect spoken in Quito (Robinson 1979, Lipski 1989), /s/ is realized faithfully in the onset (22a), but displays contextual laryngeal allophony in the coda: coda /s/ surfaces as [s] before voiceless segments and utterance-finally (22b), and becomes [z] when followed by a voiced segment either in the same grammatical word or across a word boundary (22c).

(22)   a.   *gasa*   /gasa/   [ˈga.sa]   'gauze'
            ganso   /gaNso/   [ˈgan.so]   'gander'
            da sueño   /da sueɲo/   [ˌd̪a.ˈswe.ɲo]   'makes one sleepy'
            el sueño   /el sueɲo/   [el.ˈswe.ɲo]   'the dream'

       b.   *rasco*   /rasko/   [ˈras.ko]   'I scratch'
            gas caro   /gas kaɾo/   [ˌgas.ˈka.ɾo]   'expensive gas'
            gas ‖   /gas/   [gas‖]   'gas'

       c.   *rasgo*   /rasgo/   [ˈraz.ɰo]   'feature'
            plasma   /plasma/   [ˈplaz.ma]   'plasma'
            gas blanco /gas blaNko/   [ˌgaz.ˈβlaŋ.ko]   'white gas'
            gas noble   /gas noble/   [ˌgaz.ˈno.βle]   'noble gas'

Coda /s/ undergoes voicing not only before voiced obstruents, but also before sonorants: e.g. *plasma* [ˈplaz.ma], *gas noble* [ˌgaz.ˈno.βle]. For our purposes, the crucial fact is that voicing overapplies to word-final prevocalic /s/:

(23) a.   *gas acre*   /gas akɾe/   [ˌga.ˈza.kɾe]   'acrid gas'
     cf. *gasa*   /gasa/   [ˈga.sa]   'gauze'

    b.   *has ido*   /as ido/   [a.ˈzi.ð̞o]   'hast gone'
     cf. *ha sido*   /a sido/   [a.ˈsi.ð̞o]   'hath been'

On the surface, expressions like *gas acre* [ˌga.ˈza.kɾe] fail to meet the conditions for /s/-voicing: in *gas acre*, [z] surfaces in a presonorant environment, but not in the coda, for Spanish has a phrase-level process of resyllabification that moves word-final prevocalic consonants into the onset.[7] In this position, therefore, the transparent realization of /s/ would be voiceless: cf. *gasa* [ˈga.sa].

In a stratal-cyclic framework, the laryngeal allophony of Quito Spanish /s/ submits to the following analysis. First, the stem-level phonology allows output [s], but forbids output [z]: in an optimality-theoretic implementation, therefore, a hypothetical underlying /z/ present in the rich base would be unfaithfully mapped onto [s] in the stem-level output (see Bermúdez-Otero 2007d for an illustration of this strategy). At the word level, in turn, [s] remains unchanged if syllabified in the onset; in the coda, however, [s] loses its laryngeal node, becoming laryngeally unspecified [S]: see (24a). Finally, at the phrase level, input [s] is realized faithfully, whereas delaryngealized [S] acquires voice specifications either by leftward autosegmental spreading from an immediately following obstruent or by default: on the assumption that sonorants are not redundantly specified as [+voice], we can just say that [S] becomes voiced before sonorants in order to satisfy a positional constraint designating [+voice] as the unmarked feature in this particular context, whereas utterance-final [S] is assigned the context-free default specification [-voice]; see (24b).[8] In this analysis, underlying /s/ becomes vulnerable to voicing if it finds itself in the coda in a word-level cycle and so loses its laryngeal node; the generalization is rendered opaque by phrase-level resyllabification.[9]
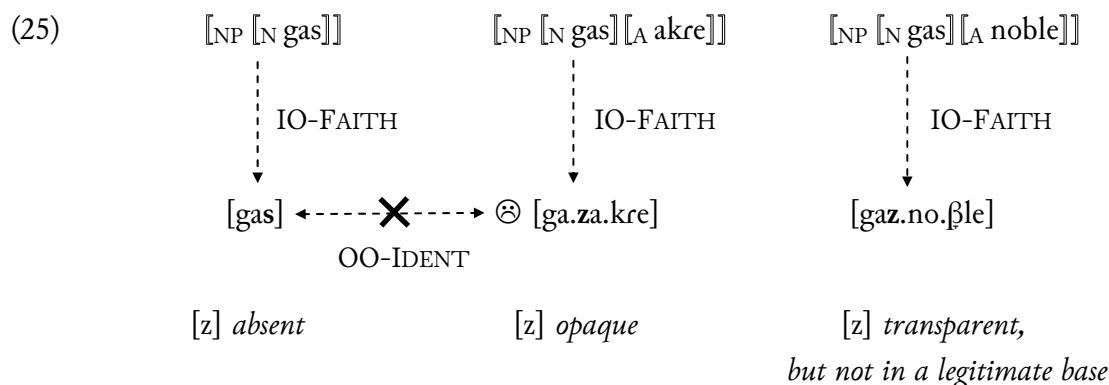
---

[7]   This is confirmed, *inter alia*, by the fact that [ɾ] undergoes optional emphatic trilling in canonical coda positions, but not word-finally before a vowel (James Harris 1983: 70-71): e.g. [maɾ]-[mar] 'sea', [ˌmaɾ.ˈne.ɥɾo]-[ˌmar.ˈne.ɥɾo] 'Black Sea'; but [ˌma.ɾe.ˈxe.o] 'Aegean Sea', not *[ˌma.re.ˈxe.o].

[8]   Analysing the presonorant voicing of [S] as driven by a position-sensitive default, rather than by feature spreading from a following sonorant redundantly specified as [+voice], allows for a closer fit between this categorical phonological operation and the gradient phonetic processes of passive voicing on which it is grounded and from which it diachronically emerges (see below): passive voicing in environments such as that occupied by the /s/ in *plasma* involves lengthening of the voicing tail from the preceding vowel, rather than anticipation of glottal pulsing for the following sonorant (Jansen 2004).
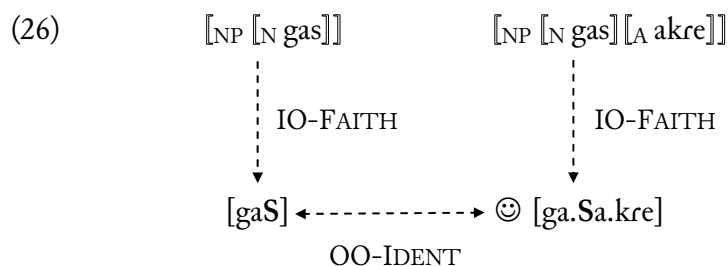
[9]   This cyclic derivation accords partly with Mascaró's (1987) reduction-and-spreading model of laryngeal phenomena, though cf. note 8 above. Bermúdez-Otero (2007d: §31-34) proposes a similar account for the voicing of word-final prevocalic sibilants in Catalan (cf. Wheeler 2005: 162-64). See also Rubach (1996: 72, 82-85) on Cracow voicing, but cf. Strycharczuk (2010).

(24)   [PL [WL gasa]]   [PL [WL gas] [WL akɾe]]   [PL [WL gas]]

a. WL (coda delaryngealization)   [ga.sa]   [gaS] [a.kɾe]   [gaS]

b. PL (defaults)   [ga.sa]   [ga.**za**.kɾe]   [gas]

As stated, the facts of Quito Spanish /s/-voicing pose a challenge to OO-correspondence (Colina 2006). This theory can explain the opaque voicing of onset /s/ in *gas acre* [ˌga.ˈ**za**.kɾe] only by reference to a surface base containing a transparently voiced correspondent [z] in the coda. Many such expressions are found: e.g. *gas blanco* [ˌ**gaz**.ˈβlaŋ.ko], *gas noble* [ˌ**gaz**.ˈno.βle]. The problem, however, is that none of them bears a nonarbitrary morphosyntactic relationship to *gas acre* [ˌga.ˈ**za**.kɾe], and so none can straightforwardly qualify as its base. If surface bases are selected by the containment criterion (Benua 1997: 28-29, Kager 1999: 215ff), the only plausible option is the citation form *gas* [gas], which consists of a subset of the morphs of *gas acre*; but this exhibits [s]. In contrast, *gas noble* [ˌ**gaz**.ˈno.βle], which contains the desired [z], has no better claim to being the base of *gas acre* than, say, *gas caro* [ˌ**gas**.ˈka.ɾo], again showing [s]. Within inflectional paradigms some versions of OO-correspondence allow surface bases to be designated by arbitrary stipulation (e.g. Kenstowicz 1996: 387, 391), but this option is of no avail here, since expressions like *gas*, *gas acre*, and *gas noble* do not belong in an inflectional paradigm; see the discussion of surface base selection in Albright (this volume).

(25)   [NP [N gas]]   [NP [N gas] [A akɾe]]   [NP [N gas] [A noble]]

	IO-FAITH		IO-FAITH		IO-FAITH

[gas] ←----✖----→ ☹ [ga.**za**.kɾe]   [**gaz**.no.βle]

OO-IDENT

[z] *absent*   [z] *opaque*   [z] *transparent, but not in a legitimate base*

However, Colina (2009: 8-10) shows that OO-correspondence can avoid this problem by shifting part of the burden of description onto the phonetics. Colina suggests that, in Quito Spanish, delaryngealized coda [S] does not acquire categorical voice specifications during the phonological derivation either by autosegmental spreading or by default feature insertion; she claims, rather, that expressions like *gas acre* and *gas noble* merely display the effects of gradient passive voicing in phonetic implementation (Keating 1988). If Colina is right, then the surface phonological representation of *gas acre* is [ˌga.ˈ**Sa**.kɾe], with overapplication of delaryngealization in the onset; but this can be analysed without difficulty as involving OO-correspondence with the citation form *ga*[**S**]: cf. (25) and (26).

(26) $[_{NP}\ [_{N}\ gas]]$ $[_{NP}\ [_{N}\ gas]\ [_{A}\ akɾe]]$

                       IO-Faith   IO-Faith

           [gaS] ◄- - - - - - - - - ► ☺ [ga.Sa.kɾe]
                     OO-Ident

Is Colina's reanalysis correct? This question cannot be settled on *a priori* grounds: in particular, the fact that the environment for /s/-voicing in *gas acre* straddles a word boundary does not by itself warrant the conclusion that the process must be gradient rather than categorical. Electropalatographic studies have admittedly shown that many instances of assimilatory external sandhi involve gradient coarticulation (i.e. reduction, overlap, and blending of articulatory gestures), rather than categorical assimilation (i.e. delinking and spreading of discrete phonological features): see e.g. Barry (1985), Wright and Kerswill (1989), Nolan (1992), Hardcastle (1995), and Zsiga (1995). However, there is also compelling evidence for the existence of categorical external sandhi. Holst and Nolan (1995) and Nolan, Holst, and Kühnert (1996) argue persuasively that at least some instances of /s#ʃ/→[ʃ·] sandhi in British English do involve discrete feature delinking and spreading; the likelihood of categorical assimilation increases in the absence of the major prosodic boundary associated with a break between clauses. Ladd and Scobbie (2003) report that, in Sardinian, total anticipatory assimilation between singletons across word boundaries yields long consonants that are phonetically equivalent to underlying geminates. Ellis and Hardcastle (2002) examined inter- and intra-speaker variation in fast-speech /n#k/ sandhi in British English, and found no fewer than four different idiolectal strategies:

     (i)   absence of accommodation between the two segments (in two out of ten subjects);
     (ii)   gradient coarticulation (in two out of ten subjects);
     (iii)   categorical assimilation (in four out of ten subjects);

and   (iv)   variation between categorical assimilation and absence of accommodation, with avoidance of coarticulation (in two out of ten subjects).

Crucially, type-(iv) speakers did not produce residual coronal gestures, but realized the nasal either without any tongue-tip raising at all or with full mid-sagittal linguoalveolar closure; this behaviour is inconsistent with gradient gestural reduction, but reflects the variable application of discrete feature delinking and spreading across word boundaries. Kochetov and Pouplier's (2008: 414) Korean subjects exhibited the same behaviour in /t#p/ and /t#k/ sandhi. These findings clearly indicate that a process of external sandhi may apply gradiently for a speaker in some tokens, and still be categorical for other speakers, or for the same speaker in other tokens. It is therefore unsafe to relegate external sandhi to the phonetics without further argument.

Although instrumental evidence is lacking, Robinson (1979) and Lipski (1989) provide strong indirect evidence that, in many instances, word-final prevocalic /s/ does undergo categorical voicing in Quito Spanish. First, the process applies regularly in all registers

independently of speech rate: it 'may be frequently observed even in slow, disconnected or interrupted speech' (Lipski 1989: 53-54). Secondly, native speakers of the dialect rely on the difference between [s] and [z] to discriminate between minimal pairs like (23b): *ha sido* [a.ˈsi.ðo] 'hath been' vs *has ido* [a.ˈzi.ðo] 'hast gone' (Robinson 1979: 136, 140-1; Lipski 1989: 55). Thirdly, word-final /s/ voicing can be used as a turn-holding device before hesitation pauses (Robinson 1979: 141). Robinson records the following example, where he describes the realization of the /s/ of *es* as 'strongly voiced':

(27)   *es … tres …*
         [ezː ꜛ↘tɾesː]
         'it's … uh … three …'   (Robinson 1979: 141)

It appears that the speaker intentionally produced a sandhi form of *es* to signal the fact that he or she had not reached the end of the utterance. Lipski (1989: 54) adduces further cases. For these reasons, Bradley and Delforge (2006: 39) conclude that the voicing of word-final prevocalic /s/ in Quito Spanish 'reflects a phonological [+voice] specification', as opposed to 'gradient interpolation of glottal activity through the constriction period of phonetically targetless [S]'. This conclusion is incompatible with Colina's (2009) answer to the questions that Quito Spanish /s/-voicing raises for OO-correspondence.

The cyclic derivations proposed in (24) can moreover be seen as the synchronic outcome of a simple series of commonplace diachronic innovations (§3). We may assume that, in an initial round of phonologization and stabilization, the lack of robust phonetic cues for laryngeal features in codas was reinterpreted as phrase-level coda delaryngealization. Analogical change then caused this process of coda delaryngealization to percolate up to the word level. Finally, a second round of phonologization and stabilization caused the gradient passive voicing of delaryngealized sibilants in presonorant contexts to be reanalysed as a categorical phrase-level process of context-specific default feature insertion.

7. Phonologically masked bases (II): English linking and intrusive *r*

Quito Spanish /s/-voicing is not an isolated case: it is not unusual for word-final prevocalic consonants to exhibit properties that are opaque in prevocalic position, but which nonetheless fail to match those of utterance-final consonants in citation forms. Linking and intrusive *r* in nonrhotic dialects of English provides another instance of this phenomenon. Again, a stratal-cyclic approach to the morphosyntax-phonology interface can easily deal with the facts, whereas OO-correspondence must shift some of the descriptive burden to a different component of the grammar: in this case, the theory of representations.

Most nonrhotic dialects of English (Wells 1982: 75-76, 218ff) allow [ɹ] in onset positions, such as word-initially or word-medially before a stressed or unstressed vowel (28a),[10] but forbid [ɹ] in coda positions, such as word-medially or word-finally before a consonant or pause (28b,c).

(28) a. *rack*   [ɹæ̆k]   b. *cart*   [kʰɑːt], *[kʰɑːɹt]
          racoon   [ɹə.ˈkʰuːn]   *car* ‖   [kʰɑː‖], *[kʰɑːɹ‖]
          carouse   [kʰə.ˈɹaːʊz]   *the car came* [ðə.ˌkʰɑːˈkʰeːɪm], *[ðə.ˌkʰɑːɹˈkʰeːɪm]
          caramel   [ˈkʰæ.ɹə.ˌmɛɫ]

      c. *CODA[ɹ]

          * Coda
            |
            |
            ɹ

Crucially, most nonrhotic dialects tolerate [ɹ] word-finally before a vowel, whether the consonant was present etymologically ('linking *r*') or not ('intrusive *r*').

(29) a. *the car is new*   [ðə.ˌkʰɑːɹ.ɪz.ˈnjuː]   linking *r*
      b. *the spa is new*   [ðə.ˌspɑː.ɹɪz.ˈnjuː]   intrusive *r*

The fact that linking and intrusive *r* escapes the phonotactic ban in (28c) indicates that it surfaces in the onset. In English, however, word-final prevocalic *r* (including linking and intrusive *r* in nonrhotic dialects) exhibits lenition in comparison with canonical onset *r*; the transcriptions above reflected this phenomenon by distinguishing between unlenited [ɹ] in (28a) and lenited [ɻ] in (29). Compared with word-initial [ɹ], word-final prevocalic [ɻ] displays the following properties:
   (i)   shorter duration (Cruttenden 2001: 289, Tuinman et al. 2007: 1905-6),
   (ii)   earlier timing of the tongue-root gesture (Campbell et al. 2010: 62),
   (iii) smaller magnitude of the lip gesture (Wells 1990, Campbell et al. 2010: 63-64),
   (iv)   smaller magnitude of the tongue-tip gesture (Gick 1999: 47-49, Campbell et al. 2010: 63-64),
   (v)   greater magnitude of the tongue-root gesture (Campbell et al. 2010: 63-64),
   (vi)   greater intensity (McCarthy 1993: 179, Tuinman et al. 2007: 1905-6),
and (vii) higher F3 (Hay and Maclagan 2010).

---

[10]   John Harris (2006) reports that, in some Southern US dialects, [ɹ] is banned outside foot-initial onsets: e.g. *veɾy, sheɾiff, Càɾolína.*

Thus, dialects with intrusive *r* afford minimal pairs such as the following (McCarthy 1993: 179):

(30) a. *saw eels* [sɔːɹiːɫz]
      b. *saw reels* [sɔːɹiːɫz]

      If, as I have suggested, linking and intrusive [ɹ] escapes the phonotactic restriction in (28c) because it surfaces in onset position, just like word-initial [ɹ], then the reasons why the former undergoes lenition and the latter does not are not apparent on the surface: thus, *r*-lenition overapplies. However, this opaque pattern is easy to describe in stratal-cyclic terms (Kiparsky 1979: 437ff; McCarthy 1991: 203-4). Intrusive *r* is inserted at the word level after ω-final nonhigh vowels in order to satisfy the constraint FINALC, i.e. *V$_\omega$] (McCarthy 1991: 203, 1993: 176), which outranks *CODA[ɹ] at the word level.[11] In the same cycle, the inserted *r* is targeted by coda lenition and undergoes a corresponding featural change: a plausible option, straightforwardly reflecting the early timing and increased magnitude of the tongue-root gesture in the phonetic realization of lenited [ɹ], is to have the Dorsal node replace the Coronal node as the designated primary articulator, notated with an asterisk in (31) below (after Kenstowicz 1994: 149). At the phrase level, however, the relative ranking of FINALC and *CODA[ɹ] is reversed: in consequence, word-final *r* undergoes deletion in preconsonantal and prepausal environments, but in prevocalic position it escapes into the onset, carrying with it the designation of Dorsal as primary articulator.

---

[11]   The idea that *r*-intrusion is driven by FINALC receives independent support from the absence of intrusive *r* after reduced function words (which do not project an ω-node) in the nonrhotic dialect of Eastern Massachusetts (McCarthy 1991: 200ff, 1993: 173ff). In the case of words ending with high vowels or closing diphthongs, we assume that *r*-intrusion is blocked by the final offglide, which suffices to satisfy FINALC; alternatively, FINALC can be replaced with *V$_{[-hi]\,\omega}$].

     If *r*-intrusion applies ω-finally, then stem-level applications may be needed to generate forms like *draw*[ɹ]*-ing*, for word-level suffixes like *-ing* are incorporated into the prosodic word of the stem, and not adjoined: i.e. [$_\omega$*draw*]→[$_\omega$*drawing*], not [$_\omega$*draw*]→*[$_{\omega'}$[$_\omega$*draw*]*ing*]; see §4 above. If so, we may assume that listed allomorphy preëmpts stem-level *r*-intrusion in cases like *algebr*[ə]*-algebr*[eɪ]*ic* (McCarthy 1991: 196).

(31)　a.　Word Level: FINALC ≫ *CODA[ɹ]

saw

$$\omega$$
$$|$$
$$\Sigma$$
$$|$$
$$\sigma$$

s　ɔ　ɹ

Place

Cor　*Dor

Reece

$$\omega$$
$$|$$
$$\Sigma$$
$$|$$
$$\sigma$$

ɹ　i　s

Place

*Cor　Dor

b.　Phrase Level: *CODA[ɹ] ≫ FINALC

saw seas

$$\omega \qquad \omega$$
$$| \qquad |$$
$$\Sigma \qquad \Sigma$$
$$| \qquad |$$
$$\sigma \qquad \sigma$$

s　ɔ　ɹ　s　i　z

Place

Cor　*Dor

[sɔː.siːz]

saw ease

$$\omega \qquad \omega$$
$$| \qquad |$$
$$\Sigma \qquad \Sigma$$
$$| \qquad |$$
$$\sigma \qquad \sigma$$

s　ɔ　ɹ　i　z

Place

Cor　*Dor

[sɔː.ɹiːz]

saw Reece

$$\omega \qquad \omega$$
$$| \qquad |$$
$$\Sigma \qquad \Sigma$$
$$| \qquad |$$
$$\sigma \qquad \sigma$$

s　ɔ　ɹ　　ɹ　i　s

Place　Place

Cor　*Dor　*Cor　Dor

[sɔː.ɹiːs]
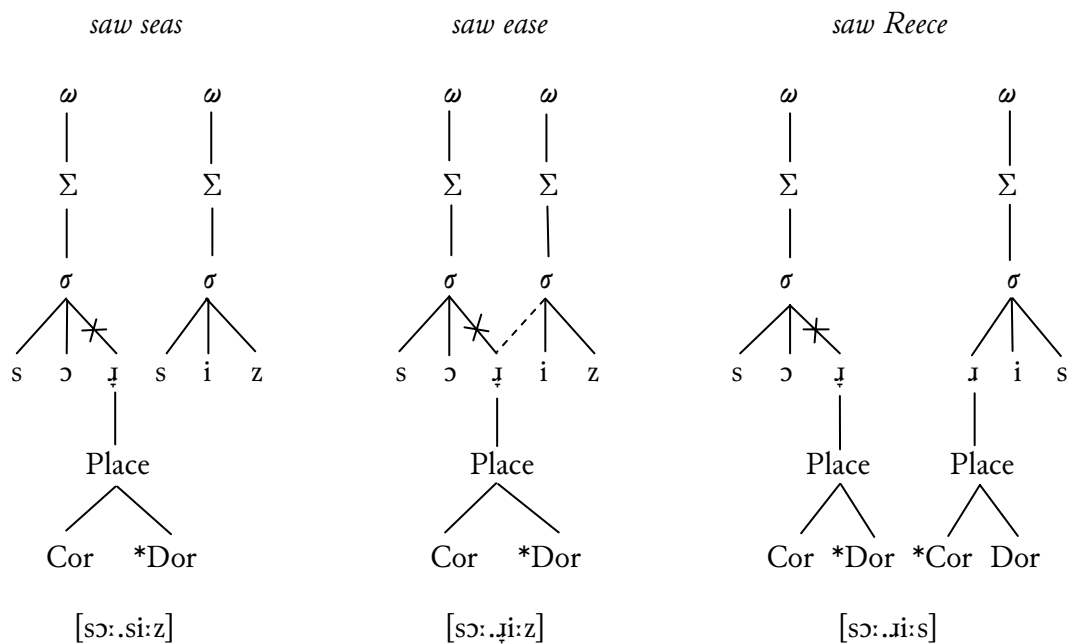
As in the case of Quito Spanish /s/-voicing (§6), this synchronic system can easily be understood as the product of a straightforward series of ordinary phonological changes:

(32) level processes   *manner* *manner is*   *Anna* *Anna is*

    a. *Initial stage.*

       WL   [mæ.nəɹ] [mæ.nəɹ][ɪz]   [æ.nə] [æ.nə][ɪz]
       PL   [mæ.nəɹ] [mæ.nə.ɹɪz]   [æ.nə] [æ.nə.ɪz]

    b. *Phonologization and stabilization (I): lenition of [ɹ] in codas enters the phrase level.*

       WL   [mæ.nəɹ] [mæ.nəɹ][ɪz]   [æ.nə] [æ.nə][ɪz]
       PL   lenition   [mæ.nəɻ̝] [mæ.nə.ɹɪz]   [æ.nə] [æ.nə.ɪz]

    c. *Analogical input restructuring (I): lenition of [ɹ] in codas climbs up to the word level.*

       WL   lenition   [mæ.nəɻ̝] [mæ.nəɻ̝][ɪz]   [æ.nə] [æ.nə][ɪz]
       PL   lenition (vacuous) [mæ.nəɻ̝] [mæ.nə.ɹɪz]   [æ.nə] [æ.nə.ɪz]

    d. *Phonologization and stabilization (II): deletion of [ɻ̝] in codas enters the phrase level.*

       WL   lenition   [mæ.nəɻ̝] [mæ.nəɻ̝][ɪz]   [æ.nə] [æ.nə][ɪz]
       PL   deletion   [mæ.nə]   [mæ.nə.ɹɪz]   [æ.nə] [æ.nə.ɪz]

    e. *Analogical input restructuring (II): analogical extension of word-level final [ɻ̝].*

       WL   insertion, lenition [mæ.nəɻ̝] [mæ.nəɻ̝][ɪz]   [æ.nəɻ̝] [æ.nəɻ̝][ɪz]
       PL   deletion   [mæ.nə]   [mæ.nə.ɹɪz]   [æ.nə] [æ.nə.ɹɪz]

The path for (32e) was smoothed by a general process of schwa apocope in Middle English (Minkova 1991). As a result of this, Early Modern English had relatively few words like *Anna*, with an underlying final /ə/. Thus, the rise of phrase-level *r*-deletion in codas brought about a situation in which most tokens of preconsonantal or prepausal [ə] alternated with prevocalic [əɻ̝]. In these circumstances, learners reanalysed phrase-level representations like [æ.nə‖] as derived by *r*-deletion from word-level [æ.nəɻ̝].[12]

(33) WL   [mæ.nəɻ̝]   [æ.nəɻ̝]

       PL   [mæ.nə‖]   [mæ.nə.ɹɪz]   ➜   [æ.nə‖]   [æ.nə.ɹɪz]
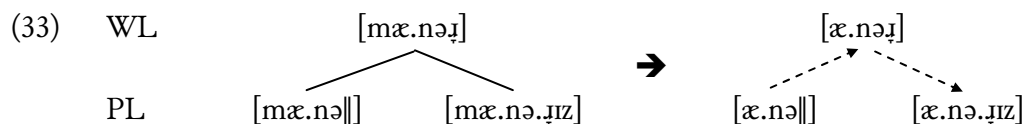
In turn, this analogical extension of final [ɻ̝] across word-level outputs eventually resulted in a word-level ban of *ω*-final [ə], enforced where necessary by [ɻ̝]-insertion.

---

[12] In this view, the analogical extension of final [ɻ̝] across word-level outputs can only have begun after variable *r*-deletion entered the phrase level, but it may well have been in progress before the application rate of *r*-deletion approached 100% (see Hay and Sudbury 2005).
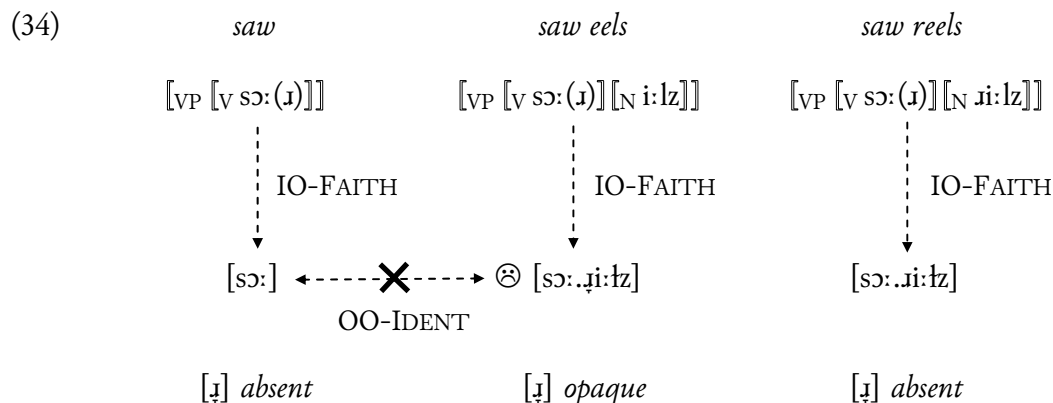
This stratal-cyclic account of the diachronic rise and synchronic operation of *r*-intrusion avoids many of the pitfalls incurred by its best-known competitors. Rule-inversion scenarios resulting in a phrase-level hiatus-breaking rule of [ɹ]-epenthesis in onsets (e.g. Vennemann 1972: 216, McMahon 2000: ch. 6, Bermúdez-Otero and Hogg 2003: 99ff) do not account for the lenited realization of intrusive *r*. In turn, restructuring scenarios in which /ə/ is replaced by /əɹ/ in underlying representations (e.g. Donegan 1993) fail to account for the regular and productive nature of *r*-intrusion (see the references in Heselwood 2009: 86). A regular process of [ɹ]-epenthesis in ω-final position at the word level incurs neither problem.

Furthermore, the diachronic scenario outlined in (32) accords perfectly with the normal life cycle of phonological processes (§3). Both *r*-lenition ([ɹ]→[ɹ̞]) and *r*-deletion ([ɹ̞]→∅) first entered the categorical phonology from below, as phrase-level processes applying across the board (32b,d). The analogical change causing lenition to climb up from the phrase to the word level (32c) proceeds by input restructuring: the lenited [ɹ̞] in surface [PL mæ.nəɹ̞] is reanalysed as already present in the output of the word level.[13] Moreover, *r*-lenition entered the grammar earlier than *r*-deletion (as must be the case, since the former is a precondition for the latter), and so has been exposed to analogical pressures for longer: it is therefore unsurprising that *r*-lenition should be more advanced in its life cycle than *r*-deletion, the former having reached the word level, the latter remaining at the phrase level.

In this light, the synchronic markedness reversal illustrated in (31) can be seen as arising from a clash between disparate diachronic forces: the high ranking of *CODA[ɹ] at the phrase level reflects the phonologization of phonetic effects; in contrast, the high ranking of FINALC at the word level reflects the analogical restructuring of phrase-level inputs. If so, McCarthy's (1993: 181-82) complaint of arbitrariness against his own previous stratal analysis (McCarthy 1991: 203-4) arguably betrays a failure to strike a proper balance between synchronic and diachronic explanation (cf. Bermúdez-Otero 1999: 98-107).

If this account is correct, then English linking and intrusive *r* raises difficulties for OO-correspondence. The segment's lenited realization is opaque because there is no *r*-lenition in onsets. To explain the facts, OO-correspondence would need to find a surface base in which [ɹ̞] occurred transparently, i.e. in the coda. Yet this is impossible, as the defining property of nonrhotic dialects is precisely that they do not allow *r* to surface outside the onset.

---

[13]   This progression from lower to higher levels correctly predicts that, diachronically, word-internal *r*-intrusion, as in *draw-ing* (see note 11), starts later than *r*-intrusion at word boundaries, as in *draw in* (see Hay and Sudbury 2005: 816-18, 820).

(34) *saw*   *saw eels*   *saw reels*

$[_{VP}\ [_V\ sɔː(ɹ)]]$ $[_{VP}\ [_V\ sɔː(ɹ)]\ [_N\ iːlz]]$ $[_{VP}\ [_V\ sɔː(ɹ)]\ [_N\ ɹiːlz]]$

⋮ IO-Faith   ⋮ IO-Faith   ⋮ IO-Faith

[sɔː] ◀-----✖-----▶ ☞ [sɔː.ɹ̥iːɫz]   [sɔː.ɹiːɫz]

OO-Ident

[ɹ̥] *absent*   [ɹ̥] *opaque*   [ɹ̥] *absent*

Yet, as in the case of Quito Spanish /s/-voicing, the proponents of OO-correspondence may deflect this argument by putting forward a transparent analysis of linking and intrusive [ɹ̥]. McCarthy (1993: 178-81) does so by invoking ambisyllabicity (Kahn 1976). In this approach, linking and intrusive [ɹ̥] is permitted to surface because it has an onset attachment, but it is lenited because it has a link to the coda too: cf. (31b) and (35).

(35)   *saw ease*   *saw Reece*
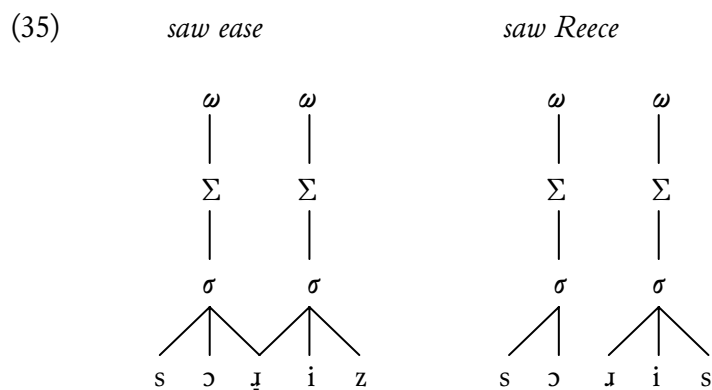
In this sense, ambisyllabicity enables McCarthy (1993: 178-81) to conflate two stages of a cyclic derivation into a single representation—at the cost of a less restrictive theory of syllable structure.

However, ambisyllabicity incurs problems of its own and has been argued to provide an inconsistent account of English segmental allophony (e.g. Kiparsky 1979: 437ff, Jensen 2000, John Harris 2003). Bermúdez-Otero (2007c: §14-§24) notes two ambisyllabicity paradoxes. Since Kahn (1976), the standard diagnostic for ambisyllabification in English is /t/-flapping. In most North American dialects, /t/ undergoes flapping in two environments: foot-medially between a vowel or /ɹ/ and another vowel (36a), and word-finally between a vowel or /ɹ/ and another vowel (36b).

(36) a. $[_\Sigma \ldots \left\{ \begin{matrix} V \\ \text{ɹ} \end{matrix} \right\} \underline{\quad} V \ldots]$ e.g. [ɾ] in *Patty, party, parity*

      b. $\left\{ \begin{matrix} V \\ \text{ɹ} \end{matrix} \right\} \underline{\quad} \text{GWord}] V$ e.g. [ɾ] in *pat it, pat Eve, at it, at ease*

Since the segmental conditions in these two environments are exactly identical, formulating two separate rules of flapping would miss a generalization. Accordingly, Kahn proposed that the two environments could be unified prosodically: in (36a) /t/ becomes ambisyllabic by Coda Capture, and in (36b) /t/ becomes ambisyllabic by Onset Capture.

(37) a. <u>Coda Capture</u>   b. <u>Onset Capture</u>
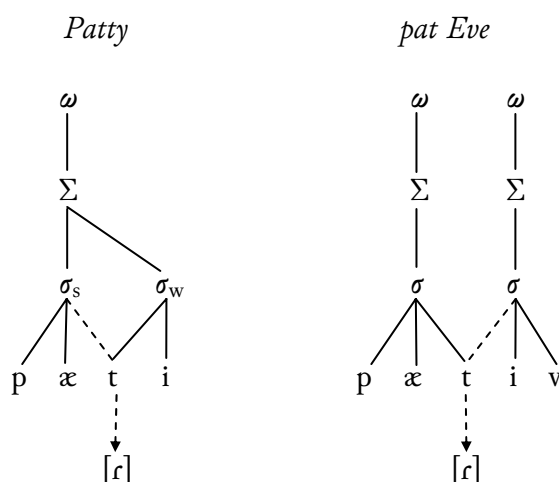
Thus, Kahn's strategy was to use syllabification to channel the allophonic effects of both stress and word-boundaries. Yet this solution does not generalize to other English consonants. Consider, for example, /l/-darkening in the Midwestern American dialect studied by Sproat and Fujimura (1993). This dialect exhibits Kahn's canonical pattern of /t/-flapping. By implication, /l/ too should display the same allophone, either clear [l] or dark [ɫ], in foot-medial intervocalic position (e.g. *Bee*/l/*ik*) and in word-final intervocalic position (e.g. *Bee*/l/ *equates*): /l/ should be ambisyllabic in the former by Coda Capture and in the latter by Onset Capture. As Sproat and Fujimura (1993: 308) themselves note in passing, however, this prediction proves false: X-ray microbeam cinematography revealed that their subjects produced clear [l], with the coronal gesture phased before the dorsal gesture, in *Bee*/l/*ik*, whereas they produced dark [ɫ], with the dorsal gesture phased before the coronal gesture, in *Bee*/l/ *equates*.

(38)

form	/l/ allegedly ambisyllabic by...	/l/ allophone	the coronal gesture...
Beelik	Coda Capture	clear [l]	leads
Beel equates	Onset Capture	dark [ɫ]	lags

In this dialect, therefore, Kahn's ambisyllabification rules work for /t/, but not for /l/. This is Bermúdez-Otero's (2007c) first ambisyllabicity paradox. A second paradox arises from a conflict between /t/-flapping and prefortis clipping (Bermúdez-Otero 2007c: §21-§24); and Kiparsky (1979: 440) observes a third paradox, further discussed by Nespor and Vogel (1986: 93-94). By casting doubt on the existence of ambisyllabicity, these paradoxes challenge McCarthy's (1993) transparent reanalysis of linking and intrusive *r* in (35).

In contrast, the English dialect described by Sproat and Fujimura poses no difficulties for a stratal-cyclic model with onset-maximal stem-level syllabification and resyllabification of prevocalic consonants in word-level and phrase-level cycles (Bermúdez-Otero 2007c: §18-§20). The right results follow from the operation of two word-level processes: one laxes /t/ in non-foot-initial position (Kiparsky 1979: 437ff, Jensen 2000, John Harris 2003); the other darkens /l/ in the coda. A full typology of English dialects supports the need to allow individual allophonic processes to target either weak positions in the syllable (i.e. the coda) or weak positions in the foot (i.e., in a trochaic system, anywhere outside foot-initial onsets). Notably, an innovative pattern of foot-based /l/-darkening (e.g. *ye*[ɫ]*ow, vi*[ɫ]*age*) is attested alongside the conservative syllable-based pattern: see Olive et al. (1993: 366) and Hayes (2000: 95-96) for American dialects, and Carter and Local (2007) for British dialects.[14]

In sum, English linking and intrusive *r* raises the same problem for OO-correspondence as Quito Spanish /s/-voicing: both are patterns of external sandhi in which word-final prevocalic consonants display opaquely derived properties that are absent from citation forms. In both cases, OO-correspondence declines responsibility for the facts and shifts the burden of explanation either to phonetic implementation or to the theory of representations.

8. Nonsurfacing bases in noncanonical paradigms: Albanian stress

In the examples of morphosyntactically induced misapplication discussed in §6 and §7, the surface bases required by OO-correspondence are unavailable for phonological reasons: a phonological process applies normally in a nonfinal cycle $\mathcal{C}$, but the output of $\mathcal{C}$ never surfaces transparently because it is always altered by the operation of subsequent phonological processes in later cycles. However, the output of $\mathcal{C}$ may also fail to surface unchanged for purely morphological reasons. This effect stands out with particular clarity in noncanonical inflectional paradigms, i.e. paradigms exhibiting phenomena such as deponency, defectiveness, suppletion, or heteroclisis (Corbett 2007). In such circumstances, the predictions of cyclicity and OO-correspondence diverge dramatically. Let two words *a* and *b* have identical syntagmatic structures in all relevant respects, but belong in paradigms with different sets of cells: one canonical, the other noncanonical. The theory of the cycle predicts that, in the phonology, *a*

---

[14] Similarly, alongside the conservative pattern of syllable-based *r*-deletion in nonrhotic dialects, an innovative foot-based pattern has been detected in the South of the USA: see note 10 above.

and *b* must exhibit the same effects of procedural morphosyntactic conditioning (§1), since the course of cyclic derivations depends on syntagmatic structure alone (Bobaljik 2008: 32; Bailyn and Nevins 2008: 242). In contrast, OO-correspondence predicts the opposite, as transderivational identity effects depend on the availability of surface bases. On the basis of evidence from Albanian, Trommer (2006, 2009) argues that the first prediction is true, the second false. In this section I briefly summarize Trommer's argument, omitting his detailed motivation of the morphological segmentations underpinning the analysis.

Trommer (2004) found that Albanian polysyllabic words bearing no overt inflection display end-stress in either of two cases:

(i) if the final syllable is headed by a nonmid vowel (i.e. by /i/, /u/, or /a/), as in (39a) and (39b),

or (ii) if the final syllable is both headed by a full vowel (i.e. by a vowel other than /ə/) and closed by a consonant, as in (39b) and (39c);

otherwise, stress falls on the penultima, as in (39d) and (39e).

(39) a. [ɟu.hə.ˈsi]   'linguistics'   d. [ˈho.le]   'swing'
          [a.kə.ˈku]   'here and there'   [ˈba.bo]   'midwife'
          [ɾi.ˈʤa]   'prayer'   [ˈhə.nə]   'moon'

      b. [aɾ.ˈmik]   'enemy'
          [ʧi.ˈfut]   'gipsy'
          [ɾe.zul.ˈtat] 'result'

      c. [a.ˈdet]   'habit'   e. [ˈa.fəɾ]   'near'
          [pa.ˈtok]   'gander'

In wordforms containing overt inflectional markers, however, stress assignment often misapplies. Consider, for example, the present indicative of a verb with a canonical paradigm: *formoj* 'form' (NACT denotes 'nonactive').

(40)

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

According to Trommer, metrical opacity arises in consequence of the fact that the domain of stress assignment is the stem, not the word: stress is assigned transparently in stem-level cycles, but is rendered opaque at the word level by the addition of inflectional suffixes and by regular internal sandhi at the stem-suffix juncture.

(41) a. *Internal sandhi processes*

  (i) nn → n
  (ii) j → ∅ / __h

b. *Sample derivations*

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

Let us now turn to verbs with noncanonical paradigms. The verb *pendohem* 'regret', for example, exhibits deponency: it lacks a voice alternation, and its fixed lexical meaning is expressed by a series of nonactive forms. Crucially, the absence of nonactive forms entails that the location of stress is opaque throughout the present indicative.

(42)

			UR	*SR*	*opaque stress?*
ACT			—	—	—
NACT	SG	1	[GWord [Stem pendo-j] [Affix he-m]]	[pen.ˈdo.hem]	yes: *[pen.do.ˈhem]
		2	[GWord [Stem pendo-j] [Affix he-ʃ]]	[pen.ˈdo.heʃ]	yes: *[pen.do.ˈheʃ]
		3	[GWord [Stem pendo-j] [Affix he-t]]	[pen.ˈdo.het]	yes: *[pen.do.ˈhet]
	PL	1	[GWord [Stem pendo-j] [Affix he-mi]]	[pen.ˈdo.he.mi]	yes: *[pen.do.he.ˈmi]
		2	[GWord [Stem pendo-j] [Affix he-ni]]	[pen.ˈdo.he.ni]	yes: *[pen.do.he.ˈni]
		3	[GWord [Stem pendo-j] [Affix he-n]]	[pen.ˈdo.hen]	yes: *[pen.do.ˈhen]

This fits with the predictions of cyclicity: since the single series of forms of a deponent verb has the same syntagmatic structure as the nonactive series of a canonical verb, both must display the same pattern of metrical opacity; cf. (41b) and (43).
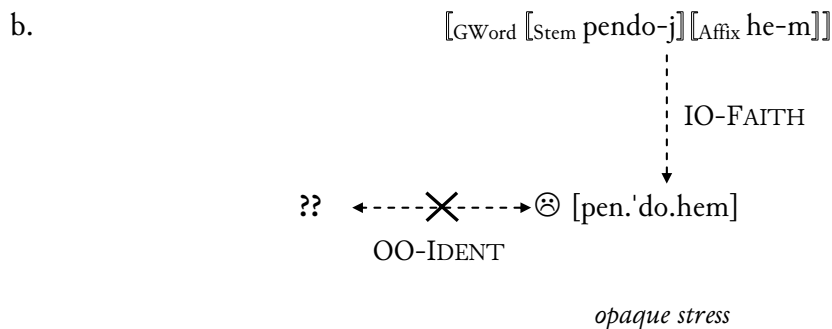
(43)   [WL [SL pendo-j] [SL he-m]]

    SL   (stress assignment)   [pen.ˈdoj] [hem]
    WL   (internal sandhi)   [pen.ˈdo.hem]

                                                'regret.1SG'

In contrast, OO-correspondence seems unable to account for the misapplication of stress assignment in the present indicative forms of Albanian deponent verbs: there are simply no suitable surface bases with transparent stress.

(44)   a.   [GWord [Stem formo-j]]   [GWord [Stem formo-j] [Affix he-m]]

                        ⋮ IO-Faith   ⋮ IO-Faith

                [foɾ.ˈmoj] ◄-------------► ☺ [foɾ.ˈmo.hem]
                            OO-Ident

            transparent stress   *opaque stress*

b. ⟦GWord ⟦Stem pendo-j⟧ ⟦Affix he-m⟧⟧

⋮
⋮ IO-Faith
↓

?? ◀----✕----▶ ⊛ [pen.ˈdo.hem]
OO-Ident

opaque stress
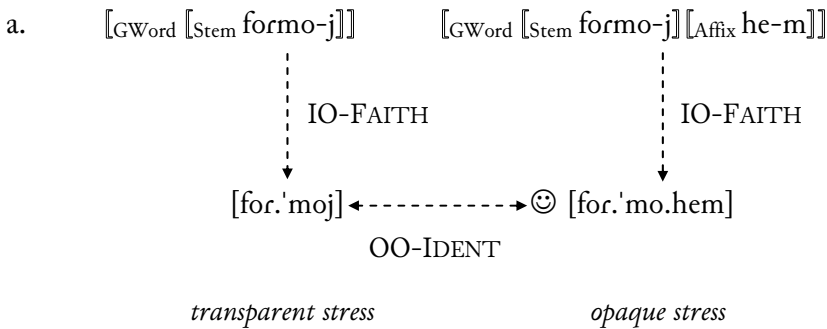
Thus, Trommer's analysis suggests that morphologically induced misapplication depends on syntagmatic structure, not on the contents of paradigms.

In the case of Quito Spanish /s/-voicing, the advocates of OO-correspondence shifted the burden of explanation to phonetics (§6); in the case of English linking and intrusive *r*, to the theory of representations (§7). A similar escape manoeuvre in the case of Albanian stress might conceivably appeal to morphology, e.g. by claiming that stress assignment in Albanian verbs has been partly or wholly morphologized. 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 defective, deponent, suppletive, and heteroclitic paradigms.

## 9. Further challenges to OO-correspondence

The case studies presented in §6, §7, and §8 provide the most direct challenge to the theory of OO-correspondence: in all three cases, the necessary surface bases appear to be unavailable. However, transderivational theories face other questions, briefly noted in §5: what expressions can qualify as surface bases, and how are they selected? should OO-identity be symmetrical, base-prioritizing, or both? (see Albright: this volume). Whilst these problems have attracted a great deal of attention in the literature, the fact that OO-correspondence fails to preserve much of the corroborated empirical content of cyclic theory has generally prompted less discussion. One key instance is the Russian Doll Theorem (§3).

For example, (45) reports the incidence of /l/-darkening in three English dialects where the process has not yet become foot-based (i.e. where /l/ remains light in *village*: see §7).[15] From this evidence one can reliably infer a pattern of diachronic evolution instantiating the Russian Doll Theorem: (45) is a perfect match for (12) and (13).

---

[15] For RP, see Cruttenden (2001: 201). The dialect I have here labelled 'Am1' is the one described by Sproat and Fujimura (1993); see §7 above. For 'Am2', see Olive et al. (1993: 212-15). The implicational relationships implicit in (45) are confirmed by the rates of variation reported by Hayes (2000: 98): see (16) above.

(45)

	RP	Am1	Am2
Healey	l	l	l
heal-ing	l	l	ł
heal it	l	ł	ł
heal ‖	ł	ł	ł
darkening of rhymal /l/ applies at...	PL	WL	SL

conservative   innovative

In a transderivational analysis, however, the inevitability of the Russian-doll pattern disappears. For example, Hayes (2000: 102) proposes two separate OO-identity constraints to capture the facts in (45): Am1 shows an effect of high-ranking OO-IDENT(PHRASAL); Am2 shows effects of both OO-IDENT(PHRASAL) and OO-IDENT(MORPHOLOGICAL).

(46)   a.   hiːł   hiː.łɪt

OO-IDENT(PHRASAL)

   b.   hiːł   hiː.łɪŋ

OO-IDENT(MORPHOLOGICAL)
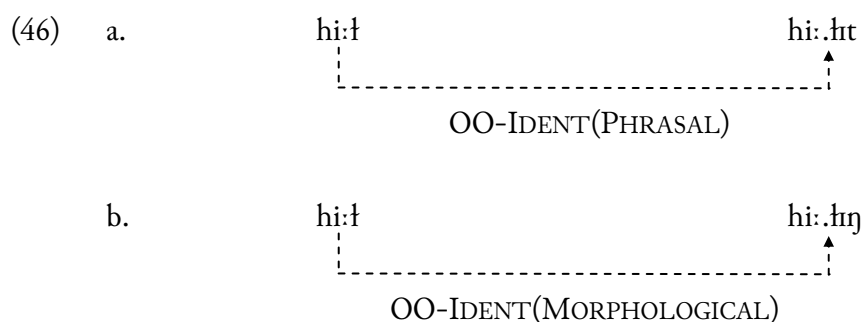
By factorial typology, however, these two constraints can generate an impossible dialect with [hiːł, hiː.łɪŋ, hiː.lɪt], in violation of the Russian Doll Theorem. All that is needed is a constraint hierarchy of the following type:

(47)   *CODA[l] ≫ OO-IDENT(MORPHOLOGICAL) ≫ *[ł] ≫ OO-IDENT(PHRASAL).

To avoid this result, Hayes (2000: 102) resorts to stipulating an innate fixed ranking in Universal Grammar:

(48)   OO-IDENT(PHRASAL) ≫ OO-IDENT(MORPHOLOGICAL).

The explanatory loss is plain to see: whereas (11) was a corollary, (48) is an axiom.

It thus looks as if a great deal of work remains to be done before OO-correspondence can claim to have superseded the cycle.

References

Bailyn, John F. and Andrew Nevins (2008). 'Russian genitive plurals are impostors', in Asaf Bachrach and Andrew Nevins (eds), *Inflectional identity*. Oxford: Oxford University Press, 237-70. Available at http://ling.auf.net/lingBuzz/000364.

Baker, Brett (2005). 'The domain of phonological processes', in Ilana Mushin (ed.), *Proceedings of the 2004 Conference of the Australian Linguistics Society*. Published online at http://hdl.handle.net/2123/112.

Barry, Martin C. (1985). 'A palatographic study of connected speech processes', *Cambridge Papers in Phonetics and Experimental Linguistics* 4: 1-16.

Benua, Laura (1997). *Transderivational identity: phonological relations between words*. Doctoral dissertation, University of Massachusetts, Amherst, MA. Available at ROA-259-0498, Rutgers Optimality Archive, http://roa.rutgers.edu.

Bermúdez-Otero, Ricardo (1999). *Constraint interaction in language change: quantity in English and Germanic [Opacity and globality in phonological change]*. Doctoral dissertation, University of Manchester and Universidad de Santiago de Compostela, Manchester and Santiago de Compostela. Available at http://www.bermudez-otero.com/PhD.pdf.

— (2003). 'The acquisition of phonological opacity', in Jennifer Spenader, Anders Eriksson, and Östen Dahl (eds), *Variation within Optimality Theory: Proceedings of the Stockholm Workshop on 'Variation within Optimality Theory'*. Stockholm: Department of Linguistics, Stockholm University, 25-36. Expanded version (2003) available at ROA-593-0403, Rutgers Optimality Archive, http://roa.rutgers.edu.

— (2006). 'Phonological change in Optimality Theory', in Keith Brown (ed.), *Encyclopedia of language and linguistics* (2 edn, vol. 9). Oxford: Elsevier, 497-505.

— (2007a). 'Morphological structure and phonological domains in Spanish denominal derivation', in Fernando Martínez-Gil and Sonia Colina (eds), *Optimality-theoretic studies in Spanish phonology*. Amsterdam: John Benjamins, 278-311.

— (2007b). 'Diachronic phonology', in Paul de Lacy (ed.), *The Cambridge handbook of phonology*. Cambridge: Cambridge University Press, 497-517.

— (2007c). 'Word-final prevocalic consonants in English: representation vs derivation'. Paper given at the Old World Conference in Phonology 4, Rhodes, 20 January 2007. Handout available at http://www.bermudez-otero.com/OCP4.pdf.

— (2007d). 'Marked phonemes vs marked allophones: segment evaluation in Stratal OT". Paper given at the workshop 'Segment inventories', 30th GLOW Colloquium, Tromsø, 11 April 2007. Available at www.bermudez-otero.com/GLOW2007.pdf.

— (2008). '[ðə swɪ'ŋɒmɪtə 'tɜːnd ə'genst sə 'mɪŋɪs 'kæmbəl] Evidence for Chung's Generalization'. Paper given at the 16th Manchester Phonology Meeting, Manchester, 24 May 2008. Handout available at http://www.bermudez-otero.com/16mfm.pdf.

Bermúdez-Otero, Ricardo and Richard M. Hogg (2003). 'The actuation problem in Optimality Theory: phonologization, rule inversion, and rule loss', in D. Eric Holt (ed.), *Optimality Theory and language change*. Dordrecht: Kluwer, 91-119.

Bermúdez-Otero, Ricardo and April McMahon (2006). 'English phonology and morphology', in Bas Aarts and April McMahon (eds), *The handbook of English linguistics*. Oxford: Blackwell, 382-410.

Bermúdez-Otero, Ricardo and Ana R. Luís (2009). 'Cyclic domains and prosodic spans in the phonology of European Portuguese functional morphs'. Paper given at the Workshop on the Division of Labour between Morphology and Phonology & Fourth Meeting of the Network 'Core Mechanisms of Exponence', Meertens Instituut, Amsterdam 16 January 2009. Available at www.bermudez-otero.com/bermudez-otero&luis.pdf.

Bobaljik, Jonathan David (2008). 'Paradigms (optimal and otherwise): a case for skepticism', in Asaf Bachrach and Andrew Nevins (eds), *Inflectional identity* (Oxford Studies in Theoretical Linguistics 18). Oxford: Oxford University Press, 29-54.

Booij, Geert and Jerzy Rubach (1984). 'Morphological and prosodic domains in Lexical Phonology', *Phonology Yearbook* 1: 1-27.

Borowsky, Toni (1993). 'On the Word level', in Sharon Hargus and Ellen M. Kaisse (eds), *Studies in Lexical Phonology* (Phonetics and Phonology 4). San Diego: Academic Press, 199-234.

Bradley, Travis G. and Ann Marie Delforge (2006). 'Systemic contrast and the diachrony of Spanish sibilant voicing', in Randall S. Gess and Deborah Arteaga (eds), *Historical Romance linguistics: retrospective and perspectives*. Amsterdam: John Benjamins, 19-52.

Campbell, Fiona, Bryan Gick, Ian Wilson, and Eric Vatikiotis-Bateson (2010). 'Spatial and temporal properties of gestures in North American English /r/', *Language and Speech* 53 (1): 49-69.

Carter, Paul and John Local (2007). 'F2 variation in Newcastle and Leeds English liquid systems', *Journal of the International Phonetic Association* 37 (2): 183-99.

Chomsky, Noam (2001). 'Derivation by phase', in Michael Kenstowicz (ed.), *Ken Hale: a life in language*. Cambridge, MA: The MIT Press, 1-52.

Chomsky, Noam and Morris Halle (1968). *The sound pattern of English*. New York: Harper & Row.

Chomsky, Noam, Morris Halle, and Fred Lukoff (1956). 'On accent and juncture in English', in Morris Halle, Horace G. Lunt, Hugh McLean, and Cornelis H. van Schooneveld (eds), *For Roman Jakobson: essays on the occasion of his sixtieth birthday, 11 October 1956*. The Hague: Mouton, 65-80.

Colina, Sonia (2006). 'Voicing assimilation in Ecuadoran Spanish: evidence for Stratal OT'. Paper given at 36th Linguistic Symposium on Romance Languages, Rutgers University, 1 April 2006.

— (2009). 'Sibilant voicing in Ecuadorian Spanish', *Studies in Hispanic and Lusophone Linguistics* 2 (1): 1-18.

Corbett, Greville G. (2007). 'Deponency, syncretism, and what lies between', in Matthew Baerman, Greville G. Corbett, Dunstan Brown, and Andrew Hippisley (eds), *Deponency and morphological mismatches* (Proceedings of the British Academy 145). Oxford: Oxford University Press, 231-69.

Cruttenden, Alan (ed.) (2001). *Gimson's pronunciation of English* (6th edn). London: Arnold.

Davis, Stuart (2005). '*Capitalistic* v. *militaristic*: the paradigm uniformity effect reconsidered', in Laura Downing, T. Alan Hall, and Renate Raffelsiefen (eds), *Paradigms in phonological theory*. Oxford: Oxford University Press, 106-21.

Donegan, Patricia (1993). 'On the phonetic basis of phonological change', in Charles Jones (ed.), *Historical linguistics: problems and perspectives*. London: Longman, 98-130.

Dressler, Wolfgang (1985). *Morphonology: the dynamics of derivation*. Ann Arbor: Karoma.

Ellis, Lucy and William J. Hardcastle (2002). 'Categorical and gradient properties of assimilation in alveolar to velar sequences: evidence from EPG and EMA data', *Journal of Phonetics* 30 (3): 373-96.

Garrett, Andrew and Juliette Blevins (2009). 'Analogical morphophonology', in Kristin Hanson and Sharon Inkelas (eds), *The nature of the word: essays in honor of Paul Kiparsky*. Cambridge, MA: The MIT Press, 527-45.

Gick, Bryan (1999). 'A gesture-based account of intrusive consonants in English', *Phonology* 16 (1): 29-54.

Giegerich, Heinz J. (1999). *Lexical strata in English: morphological causes, phonological effects* (Cambridge Studies in Linguistics 89). Cambridge: Cambridge University Press.

Hammond, Michael (1999). *The phonology of English: a prosodic optimality-theoretic approach* (The Phonology of the World's Languages). Oxford: Oxford University Press.

Hardcastle, William J. (1995). 'Assimilations of alveolar stops and nasals in connected speech', in Jack Windsor Lewis (ed.), *Studies in general and English phonetics: essays in honour of Professor J. D. O'Connor*. London: Routledge, 49–67.

Hargus, Sharon and Ellen M. Kaisse (eds) (1993). *Studies in Lexical Phonology* (Phonetics and Phonology 4). San Diego: Academic Press.

Harris, James W. (1983). *Syllable structure and stress in Spanish: a nonlinear analysis*. Cambridge, MA: MIT Press.

Harris, John (1985). *Phonological variation and change: studies in Hiberno-English*. Cambridge: Cambridge University Press.

— (2003). 'Release the captive coda: the foot as a domain of phonetic interpretation', in John Local, Richard Ogden, and Rosalind Temple (eds), *Phonetic interpretation: papers in laboratory phonology VI*. Cambridge: Cambridge University Press, 103-29.

— (2006). 'Wide-domain *r*-effects in English', *UCL Working Papers in Linguistics* 18. Available at http://www.phon.ucl.ac.uk/publications/WPL/06papers/harris.pdf.

Hay, Jennifer and Andrea Sudbury (2005). 'How rhoticity became /r/-sandhi', *Language* 81 (4): 799-823.

Hay, Jennifer and Margaret Maclagan (2010). 'Social and phonetic conditioners on the frequency and degree of 'intrusive /r/' in New Zealand English', in Dennis R. Preston and Nancy Niedzielski (eds), *A reader in sociophonetics*. Berlin: Mouton de Gruyter, 41-70.

Hayes, Bruce (1982). 'Extrametricality and English stress', *Linguistic Inquiry* 13 (2): 227-76.

— (2000). 'Gradient well-formedness in Optimality Theory', in Joost Dekkers, Frank van der Leeuw, and Jeroen van de Weijer (eds), *Optimality Theory: phonology, syntax, and acquisition*. Oxford: Oxford University Press, 88-120.

Heselwood, Barry (2009). 'R vocalisation, linking R and intrusive R: accounting for final schwa in RP English', *Transactions of the Philological Society* 107 (1): 66-97.

Holst, Tara and Francis Nolan (1995). 'The influence of syntactic structure on [s] to [ʃ] assimilation', in Bruce Connell and Amalia Arvaniti (eds), *Phonology and phonetic evidence: papers in laboratory phonology IV*. Cambridge: Cambridge University Press, 315-33.

Inkelas, Sharon (1989). *Prosodic constituency in the lexicon*. Doctoral dissertation, Stanford University, Stanford, CA. Published (1990), New York: Garland.

Jansen, Wouter (2004). *Laryngeal contrast and phonetic voicing: a laboratory phonology approach to English, Hungarian, and Dutch*. Doctoral dissertation, University of Groningen.

Jensen, John T. (2000). 'Against ambisyllabicity', *Phonology* 17: 187-235.

Kager, René (1999). 'Surface opacity of metrical structure in Optimality Theory', in Ben Hermans and Marc van Oostendorp (eds), *The derivational residue in phonological Optimality Theory*. Amsterdam: John Benjamins, 207-45.

Kahn, Daniel (1976). *Syllable-based generalizations in English phonology*. Doctoral dissertation, MIT, Cambridge, MA.

Keating, Patricia (1988). 'Underspecification in phonetics', *Phonology* 5: 275-92.

Kenstowicz, Michael (1994). *Phonology in generative grammar*. Oxford: Basil Blackwell.

— (1996). 'Base-identity and uniform exponence: alternatives to cyclicity', in Jacques Durand and Bernard Laks (eds), *Currents trends in phonology: models and methods* (vol. 1). Salford: European Studies Research Institute, University of Salford, 363-93.

Kiparsky, Paul (1979). 'Metrical structure assignment is cyclic', *Linguistic Inquiry* 10 (3): 421-41.

— (1982). 'Lexical Morphology and Phonology', in In-Seok Yang for the Linguistic Society of Korea (ed.), *Linguistics in the morning calm: selected papers from SICOL-1981* (vol. 1). Seoul: Hanshin Publishing Company, 3-91.

— (2000). 'Opacity and cyclicity', in Nancy A. Ritter (ed.), *A review of Optimality Theory*. Special issue, *The Linguistic Review* 17 (2-4): 351-67.

Kochetov, Alexei and Marianne Pouplier (2008). 'Phonetic variability and grammatical knowledge: an articulatory study of Korean place assimilation', *Phonology* 25 (3): 399-431.

Ladd, D. Robert and James M. Scobbie (2003). 'External sandhi as gestural overlap? Counter-evidence from Sardinian', in John Local, Richard Ogden, and Rosalind Temple (eds), *Phonetic interpretation: Papers in Laboratory Phonology VI*. Cambridge: Cambridge University Press, 164-82.

Lipski, John (1989). '/s/-voicing in Ecuadoran Spanish: patterns and principles of consonantal modification', *Lingua* 79: 49-71.

Marvin, Tatjana (2002). *Topics in the stress and syntax of words*. PhD dissertation, MIT, Cambridge, MA.

Mascaró, Joan (1987). 'A reduction and spreading theory of voicing and other sound effects'. Ms. Barcelona: Universitat Autònoma de Barcelona. Published (1995) in *Catalan Working Papers in Linguistics*, 4 (2): 267-328.

McCarthy, John J. (1991). 'Synchronic rule inversion', in Laurel Sutton, Christopher Johnson, and Ruth Shields (eds), *Proceedings of the Seventeenth Annual Meeting of the Berkeley Linguistics Society*. Berkeley, CA: Berkeley Linguistics Society, 192-207.

— (1993). 'A case of surface constraint violation', *Canadian Journal of Linguistics* 38 (2): 169-95.

— (2007). *Hidden generalizations: phonological opacity in Optimality Theory*. London: Equinox Publishing.

McMahon, April M. S. (2000). *Lexical phonology and the history of English*. Cambridge: Cambridge University Press.

Minkova, Donka (1991). *The history of final vowels in English: the sound of muting* (Topics in English Linguistics 4). Berlin: Walter de Gruyter.

Mohanan, K. P. (1982). *Lexical Phonology*. Doctoral dissertation, MIT, Cambridge, MA.

Nespor, Marina and Irene Vogel (1986). *Prosodic phonology* (Studies in Generative Grammar 28). Dordrecht: Foris.

Nolan, Francis (1992). 'The descriptive role of segments: evidence from assimilation', in Gerard R. Docherty and D. Robert Ladd (eds), *Papers in laboratory phonology II: gesture, segment, prosody*. Cambridge: Cambridge University Press, 261-80.

Nolan, Francis, Tara Holst, and Barbara Kühnert (1996). 'Modelling [s] to [ʃ] accommodation in English', *Journal of Phonetics* 24 (1): 113-37.

Olive, Joseph P., Alice Greenwood, and John Coleman (1993). *Acoustics of American English speech: a dynamic approach*. New York: Springer Verlag.

Orgun, Cemil Orhan and Sharon Inkelas (2002). 'Reconsidering bracket erasure', in Geert Booij and Jaap van Marle (eds), *Yearbook of morphology 2001*. Dordrecht: Foris, 115-46.

Raffelsiefen, Renate (2005). 'Paradigm uniformity effects versus boundary effects', in Laura J. Downing, T. Alan Hall, and Renate Raffelsiefen (eds), *Paradigms in phonological theory*. Oxford: Oxford University Press, 211-62.

Robinson, Kimball L. (1979). 'On the voicing of intervocalic *s* in the Ecuadorian highlands', *Romance Philology* 33 (1): 137-43.

Rubach, Jerzy (1996). 'Nonsyllabic analysis of voice assimilation in Polish', *Linguistic Inquiry* 27 (1): 69-110.

Scheer, Tobias (2008). *A lateral theory of phonology (vol. 2). How morpho-syntax talks to phonology: a survey of extra-phonological information in phonology since Trubetzkoy's Grenzsignale*. MS (2nd draft). Nice: Université de Nice - Sophia Antipolis.

Selkirk, Elisabeth O. (1996). 'The prosodic structure of function words', in James L. Morgan and Katherine Demuth (eds), *Signal to syntax: bootstrapping from speech to grammar in early acquisition*. Mahwah, NJ: Lawrence Erlbaum Associates, 187-213.

Sproat, Richard (1993). 'Looking into words', in Sharon Hargus and Ellen M. Kaisse (eds), *Studies in Lexical Phonology* (Phonetics and Phonology 4). San Diego: Academic Press, 173-95.

Sproat, Richard and Osamu Fujimura (1993). 'Allophonic variation in English /l/ and its implications for phonetic implementation', *Journal of Phonetics* 21: 291-311.

Steriade, Donca (2000). 'Paradigm uniformity and the phonetics-phonology boundary', in Michael B. Broe and Janet B. Pierrehumbert (eds), *Papers in laboratory phonology V: acquisition and the lexicon*. Cambridge: Cambridge University Press, 313-34.

Strycharczuk, Patrycja (2010). 'What's in a word? Prosody in Polish voicing'. Paper given at the 18th Manchester Phonology Meeting, 20 May 2010. Slides available at http://personalpages.manchester.ac.uk/postgrad/patrycja.strycharczuk/18mfmslides.pdf.

Sugahara, Mariko and Alice Turk (2009). 'Durational correlates of English sublexical constituent structure', *Phonology* 26 (3): 477-524.

Szpyra, Jolanta (1989). *The phonology-morphology interface: cycles, levels and words* (Croom Helm linguistics series). London: Routledge.

Trommer, Jochen (2004). 'Albanian word stress'. Ms. Osnabrück: University of Osnabrück. Forthcoming in *Balkanistica*.

— (2006). 'Stress uniformity in Albanian: morphological arguments for cyclicity'. Paper given at the workshop 'Approaches to phonological opacity', 29th GLOW Colloquium, Barcelona, 5 April 2006.

— (2009). 'Stress uniformity in Albanian: morphological arguments for cyclicity'. Ms. Leipzig: University of Lepzig.

Tuinman, Annelie, Holger Mitterer, and Anne Cutler (2007). 'Speakers differentiate English intrusive and onset /r/, but L2 listeners do not', in Jürgen Trouvain and William J. Barry (eds), *Proceedings of the 16th International Congress of Phonetic Sciences (ICPhS 2007)*. Dudweiler: Pirrot, 1905-08.

Vennemann, Theo (1972). 'Rule inversion', *Lingua* 29: 209-42.

Wells, J. C. (1982). *Accents of English* (3 vols). Cambridge: Cambridge University Press.

— (1990). 'Syllabification and allophony', in Susan Ramsaran (ed.), *Studies in the pronunciation of English: a commemorative volume in honour of A.C. Gimson*. London: Routledge, 76-86.

Wheeler, Max W. (2005). *The phonology of Catalan* (The phonology of the world's languages). Oxford: Oxford University Press.

Wright, Susan and Paul Kerswill (1989). 'Electropalatography in the analysis of connected speech processes', *Clinical Linguistics and Phonetics* 3 (1): 49-57.

Zsiga, Elizabeth C. (1995). 'An acoustic and electropalatographic study of lexical and postlexical palatalization in American English', in Bruce Connell and Amalia Arvaniti (eds), *Phonology and phonetic evidence: papers in laboratory phonology IV*. Cambridge: Cambridge University Press, 282-302.