Stratal Phonology

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Forthcoming in S.J. Hannahs & Anna R. K. Bosch (eds.), *The Routledge handbook of phonological theory*. Abingdon: Routledge.

Abstract

The purpose of this paper is threefold: to survey current work in Stratal Phonology, to respond to recent arguments against cyclic phonological derivations, and to explore the morphological implications of the theory.

Section 2 lays out the basic principles of Stratal Phonology: cyclicity and stratification. These make major empirical predictions, including Cyclic Containment, the Russian Doll Theorem, and Chung's Generalization. The exposition highlights the fact that Stratal Phonology differs from other cyclic frameworks, such as Cophonology Theory, in positing relatively fewer cycles. Recent proposals are reviewed which look to independent facts in an effort to derive long-standing generalizations about cyclic domain structures: notably, the noncyclic status of roots and the recursiveness of stem-level domains.

Section 3 addresses the contest between cyclicity and output-output correspondence, focusing on Steriade's (1999) claim that English dual-level affixes like *-able* challenge Cyclic Containment. I argue that, whilst Steriade's argument draws force from important empirical facts, containment-compliant analyses centred on lexical acquisition not only describe the phenomena accurately, but also generate correct empirical predictions that are not matched by accounts relying on output-output correspondence.

Section 4 assesses Stratal Phonology by evaluating the plausibility of its implications for morphology. I show, first, that the theory can derive the relative ordering of phonological strata without recourse to the Affix Ordering Generalization, and that it can handle bracketing paradoxes without recourse to rebracketing operations. At the same time, Stratal Phonology presupposes that morphology and phonology are distinct grammatical modules, and for this reason it favours concatenativist approaches to putative instances of process morphology, in line with Generalized Nonlinear Affixation.

Keywords

Affix order, bracketing paradox, Cophonology Theory, cyclicity, dual-level affix, English, German, Indonesian, interfaces of phonology, lexical conservatism, Lexical Phonology and Morphology, modularity, nonconcatenative exponence, opacity, output-output correspondence, Stratal Optimality Theory, stratification.

Contents

1. Introduction

Stratal Phonology is a theory of how phonology interacts with other components of grammar. Its basic principles are simple: phonology applies cyclically over domains defined by certain constituents in the morphosyntactic structure of linguistic expressions, and domains associated with constituents of different rank—stems, words, and utterances—obey different phonological generalizations. In current versions of the framework (e.g. Kiparsky 2000, 2015b; Bermúdez-Otero 2010), these hypotheses are combined with constraint-based models of phonological computation, like Optimality Theory ('OT': Prince & Smolensky 1993; Iosad, this volume; Krämer, this volume).

The hypotheses of cyclicity and stratification are laid out in §2. The assumption of cyclic application predates the rise of Stratal Phonology and provides some common ground with several other approaches to phonology's upper interfaces: notably, Cophonology Theory (Orgun 1996; Inkelas 1998, 2012) and various phonological applications of Chomsky's (2001) Phase Theory (e.g. Embick 2014; D'Alessandro & Scheer 2015; Newell, this volume). Stratal Phonology differs from these in positing relatively fewer cycles. The theory also diverges in important ways from its most immediate precursor: rule-based Lexical Phonology (Pesetsky 1979; Kiparsky 1982a,b; Mohanan 1982). First, Stratal Phonology rejects the claims of Strict Cyclicity and Structure Preservation, which sought to constrain the application of rewrite rules at the stem level. Secondly, Lexical Phonology simply stipulated a number of important generalizations about cyclic domain structures, such as the fact that roots do not define cyclic domains and that stem-level domains are recursive; in contrast, recent work in Stratal Phonology seeks to derive these observations from independent facts. Throughout §2 I emphasize the major empirical predictions of Stratal Phonology, which include Cyclic Containment, the Russian Doll Theorem, and Chung's Generalization.

Cyclic Containment[1] holds that, in cases of morphosyntactically induced phonological opacity, a linguistic expression inherits its opaque phonological properties from a constituent that defines an immediate cyclic subdomain. In recent years, the proponents of output-output correspondence (henceforth 'OO-correspondence') have adduced a number of putative counterexamples to this prediction. The theory of OO-correspondence asserts, instead, that the phonological computation may directly refer to a surface base that does not match a constituent of the opaque expression (e.g. Kenstowicz 1996, Burzio 1996, Steriade 1999). In §3 I address this debate, highlighting the divergent empirical predictions of the cycle and OO-correspondence. As a test case, I pay particular attention to Steriade's (1999: §2-§3) discussion of English affixes with dual-level behaviour, notably *-able*. Steriade's analysis uncovers genuine and previously underappreciated empirical facts, in which the paradigmatic relationships highlighted by transderivational approaches do play a key role. I shall argue, however, that this

[1] This term is due to Steriade (2013, forthcoming).

role should be regarded as taking effect during lexical and morphological acquisition, rather than in the phonological derivation.[2] This account, when implemented within the framework of Stratal Phonology, predicts certain empirical observations that are not captured by OO-correspondence, such as the fact that stress-affecting instances of *-able* suffixation like *re.mé.dǐ.a.ble* (cf. *rémedy*) exhibit the same metrical pattern as forms based on bound roots (e.g. *in.dó.mǐ.ta.ble*). From this and other considerations I conclude that cyclicity retains an empirical advantage over OO-correspondence.

Finally, section 4 asks whether Stratal Phonology permits a graceful integration with other components of grammar, particularly morphology. The theory would be in trouble if it made demonstrably false assumptions about morphology, or if it crucially relied on excessively powerful exponence mechanisms that robbed morphological theory of its empirical content. In this connection, I show, first, that the serial precedence of the stem-level phonology over the word-level phonology does not depend on level ordering, understood as the requirement that all stem-level affixes should occur inside all word-level affixes (cf. Kiparsky 1982a: 131ff). Similarly, Stratal Phonology need not resort to rebracketing operations to deal with so-called 'bracketing paradoxes' (cf. Kiparsky 1983: §5). More fundamentally, however, Stratal Phonology does presuppose that it is possible to demarcate morphosyntax from phonology, for it claims that the morphosyntactic operations in a language can be sorted into a small number of classes (called 'levels' or 'strata') according to the phonological processes for which they define cyclic domains. In opposition to other cyclic frameworks like Amorphous Morphology (Anderson 1992) and Cophonology Theory, I suggest that the best way of delimiting the roles of morphology and phonology in exponence is by adopting a strictly modular stance, in which morphology can select and insert morphs, but cannot alter their phonological content. This, in turn, favours approaches to apparently nonconcatenative exponence along the lines of Generalized Nonlinear Affixation (Bermúdez-Otero 2012: 53).

The implications for morphology reviewed in §4 do not exhaust the predictions of Stratal Phonology. The theory has importance consequences for many other domains of enquiry. A selection of references is included in the further reading suggestions at the end of this chapter.

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[2] See Archangeli & Pulleyblank (this volume) for related ideas.

2. Basic principles of Stratal Phonology

> The change seems small. [...] This was all; and this was enough.
>
> Macaulay, 'Peculiar character of the English Revolution', *History of England*, ch. X.

2.1. Demarcating the framework

The main ideas behind Stratal Phonology have a long and complex intellectual history. According to Kiparsky (1983: 3), the distinction between stem-level and word-level affixation can be traced back to Pāṇini by way of Bloomfield's (1933: 209ff; 1939: §6-§9) 'primary' and 'secondary' affixes. Similarly, Booij (1997: 264) observes that the distinction between 'lexical' and 'postlexical' phonology was already codified in the Praguian terms *phonologie du mot* and *phonologie de la phrase* (CLP 1931: 321, Jakobson 1931: 165). The phonological cycle, in turn, is as old as generative phonology itself (Chomsky, Halle, and Lukoff 1956: 75). The closest ancestor of current stratal work is to be found in rule-based Lexical Phonology and Morphology. As noted in §1, however, research in Lexical Phonology paid a great deal of attention to principles like Strict Cyclicity and Structure Preservation, which governed rule application at the stem level; these hypotheses have since been abandoned (Bermúdez-Otero 2013b). Nonetheless, rule-based stratal theories descending from Halle & Vergnaud (1987) remain in use, particularly in work associated with Distributed Morphology ('DM': Halle & Marantz 1993, 1994): see e.g. Embick (2014) and Newell (this volume)

In this chapter, therefore, the term 'Stratal Phonology' is strictly reserved for work that combines a stratal phonological architecture with contemporary constraint-based parallelist approaches to phonological mappings. This includes not only Stratal OT, but also frameworks where phonological generalizations are expressed by means of Harmonic Grammar (Pater 2009) or Maximum Entropy ('MaxEnt') modelling (Hayes & Wilson 2008): see e.g. Pater and Nazarov (2013) for a stratal MaxEnt study in the acquisition of opacity. In contrast, the requirement of parallelism excludes a potential combination of stratification either with Harmonic Serialism (McCarthy 2010) or with OT with Candidate Chains (McCarthy 2007). This exclusion is motivated by the fact that the hypothesis of cyclic derivation, which is absolutely central to Stratal Phonology, loses much of its empirical content in frameworks that adopt a serialist approach to phonological mappings: see Bermúdez-Otero (2013a: 90-1) for an example. Similarly, current constraint-based parallelist theories are happily unable to express invalid claims like Strict Cyclicity or Structure Preservation, whereas statements like Chung's Generalization (§2.3.3) are derived as theorems.

2.2. The cycle

The key principles of Stratal Phonology are cyclicity and stratification.[3] For the purposes of elucidating the concept of the phonological cycle, let us think of morphology as establishing relationships of exponence between nodes in a syntactic structure and phonological pieces in an underlying representation (for specific proposals, see Bermúdez-Otero 2012: 46-48, 50-53). Phonology, in turn, maps the assembly of exponents built by the morphology onto a surface representation. In a cyclic framework, this mapping is in fact specified by a composite function. Following Kaye (1995: 302), we can conceive of phonological theory as defining a set of $\mathcal{P}$-functions mapping any given phonological input representation *i* onto a corresponding output *o*.[4] In OT, for example, the phonological function $\mathcal{P}_r(i) = o$ consists of an application of $\mathcal{G}_{en}$ followed by an application of $\mathcal{E}_{val_r}$, where r is a ranking of the constraint set CON:

(1) $$\mathcal{P}_r(i) = \mathcal{E}_{val_r}(\mathcal{G}_{en}(i)) = o$$

Now certain nodes in the syntactic structure of a complex linguistic expression can be designated as 'cyclic', in the sense that the assembly of exponents associated with a cyclic node provides the argument for the application of a $\mathcal{P}$-function. Crucially, $\mathcal{P}$-functions triggered by higher cyclic nodes apply to the results of $\mathcal{P}$-functions triggered by lower cyclic nodes, so that the surface representation of the whole expression is obtained by function composition.

In (2), for example, morphology has associated the syntactic structure of the English singular noun *accommodationlessness* (2,a) with the underlying phonological representation in (2,b).[5] The relationships of exponence thus established are indicated by double-headed arrows. Cyclic nodes are highlighted with the superscript $^{\copyright}$, and the corresponding cyclic domains in the underlying representation (2,b) are demarcated with hollow square brackets ⟦ ⟧. The subscripts $_{SL}$ and $_{WL}$ indicate the affiliation of affixes to the stem or word level (discussed in §2.3 below). Given all of the above, the surface representation is determined by the composite function shown in (2,c), with the phonological derivation proceeding as per (2,d).

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[3] These principles build on a more general assumption of modularity: for discussion, see Bermúdez-Otero (2012: §2.4, 2015: §22.2) and §4.3 below.

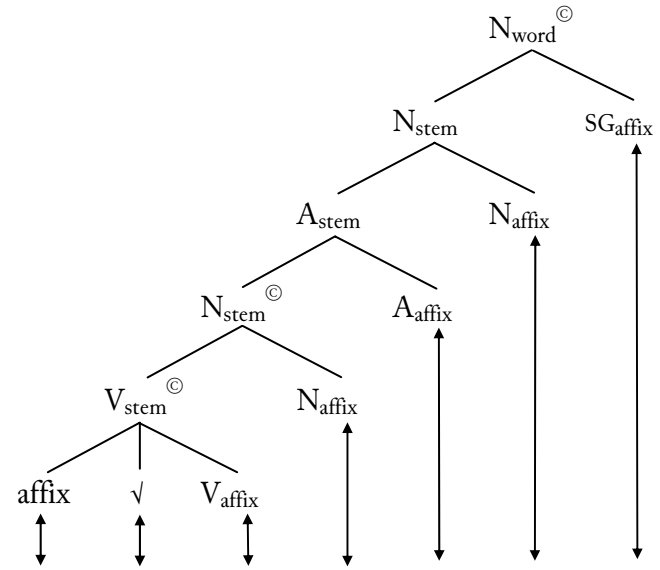
[4] In cases of phonological variation an input is associated with more than one output. If so, phonology specifies relations rather than functions (Smolensky 2006: 535-6; see also Kaye 1995: 330, note 18), and the cycle is more properly described as involving the composition of relations.

[5] Stratal Phonology is compatible with a very broad range of approaches to word syntax. The specifics will not be crucial here. For related remarks, see Bermúdez-Otero (2012: note 38; 2013a: note 36).

The word *accommodationlessness* is naturally attested in a range of broadly compositional senses reflecting the structure in (2,a): for example, it occurs in reference to the medical condition in which the eye lacks the ability to perform the task of accommodating to the distance of visual objects.

The terms *root*, *stem*, and *word*, as used in (2,a), are defined in (5) below.

(2)



a.

b. ⟦ ⟦ ⟦ a- commod -ate$_{SL}$⟧ -ion$_{SL}$⟧ -less$_{WL}$ -ness$_{WL}$ -∅$_{WL}$⟧

c. $\mathcal{P}_{WL}$($\mathcal{P}_{SL}$($\mathcal{P}_{SL}$(a-, commod-, -ate), -ion), -less, -ness, -∅)

d.

$\mathcal{P}_{SL}$	1st cycle	accómmodàte
	2nd cycle	accòmmodátion
$\mathcal{P}_{WL}$	3rd cycle	accòmmodátionlessness

The order of $\mathcal{P}$-function application is thus intrinsically determined by morphosyntactic constituency: the computation of the phonological form of the parts precedes and feeds the computation of the phonological form of the whole. Stratal Phonology derives a great deal of its empirical content from this simple notion. Notably, like all cyclic frameworks, stratal theories predict that morphosyntactically induced opacity is subject to Cyclic Containment:

(3) *Cyclic Containment*

In cases of morphosyntactically induced phonological opacity, a linguistic expression inherits its opaque phonological properties from a constituent defining an immediate cyclic subdomain.

The stress profile of the English word *accòmmodátionlessness*, for example, is doubly opaque: first, the word exhibits prefenestral primary stress (i.e. primary stress outside the final trisyllabic window); secondly, pretonic secondary stress fails to fall on the initial syllable (cf. monomorphemic items like *àbracadábra*). As shown in (2), this is because *accòmmodátionlessness* inherits the metrical contour of the noun stem *accòmmodátion-*, which defines an immediate cyclic subdomain: *accòmmodátion-* is a cyclic constituent, and there is no other cyclic node between *accòmmodátion-* and *accòmmodátionlessness*. In turn, *accòmmodátion-* inherits the foot-

head on its second syllable from its own base, the verb stem *accómmodàte-*, which defines an immediate cyclic subdomain. This accounts for the ungrammaticality of **àccommodátion*. Observe that neither the adjective stem *accòmmodátionless-* nor the verb stem *accómmodàte-* defines an immediate cyclic subdomain within *accòmmodátionlessness*. The adjective stem is not a cyclic constituent (for reasons discussed in §2.3.2 below). The verb stem, though cyclic, is a remote or nonlocal base, rather than a proximate or local one; there is another cyclic node, the noun stem *accòmmodátion-*, closer to *accòmmodátionlessness*. The fact that *accòmmodátionlessness* is in an immediate cyclic relationship with *accòmmodátion-*, but not with *accómmodàte-*, explains the ungrammaticality of **accómmodàtionlessness*.

As we saw in §1, however, recent work on OO-correspondence has called Cyclic Containment into question: I examine and reject the putative counterevidence in §3 below.

Another entailment of cyclic theory is the Russian Doll Theorem:

(4) *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.

In the English derived adjective [[*long*]*ish*] [lɒŋɪʃ], for example, postnasal /g/-deletion overapplies before the initial vowel of the suffix *-ish* [ɪʃ] because its cyclic domain is the adjective stem *long-* [lɒŋ], which is contained within *longish*.[6] The Russian Doll Theorem correctly predicts that postnasal /g/-deletion will also overapply when a vowel follows across a word boundary, as in the phrase *long effect* [lɒŋɪfɛkt]: by simple transitivity, if opacity arises when a word contains a prevocalic token of the stem *long-,* it will also arise when a phrase contains a word that itself contains a prevocalic token of the stem *long-*. In noncyclic frameworks assuming OO-correspondence, in contrast, the Russian Doll Theorem holds only by stipulation (Bermúdez-Otero 2011: 2043).

2.3. Stratification

2.3.1. Key generalizations

The preceding characterization of the phonological cycle generalizes to a wide range of cyclic frameworks. Stratal Phonology, however, adds two other important claims. First, cyclic domain

[6] For our current purposes it does not matter whether the underlying representation of the adjective *long* has been restructured and no longer contains a final /g/. The crucial point is that stem-final [ŋg] cannot occur before suffixes like *-ish* and that this phonotactic restriction on word-level derivatives is opaque (Bermúdez-Otero 2011: 2020, footnote 2).

structure is sparse: relatively few morphosyntactic constituents trigger phonological cycles. Secondly, there are different $\mathcal{P}$-functions for cyclic nodes of different rank.

These ideas are developed in the theory of stratification. The latter makes crucial reference to the concepts of 'root', 'stem', and 'word'. For our current purposes, these may be defined as follows:

(5) a. A **root** (√) is a minimal acategorial lexical item.

b. A **stem** is a lexical item specified for syntactic category (N, V, A, etc). In certain cases it is necessary to distinguish further between **derivational stems** and **inflectional stems**, where a derivational stem belongs to a syntactic category but must undergo some further morphosyntactic operation before it becomes inflectable.

c. A **word** is a syntactically autonomous lexical item bearing the full set of inflectional features required by its category.

In (2), for example, the verb stem *a-ccommod-ate-* derives from the root *commod-*, which by itself has no lexical category and is *a fortiori* uninflectable; cf. the adjective *commod-ious* and the noun *commod-ity*. The topmost node in the structure constitutes a word: namely, a noun covertly inflected for singular number (cf. *weakness-*∅ ~ *weakness-es*). All the nodes intervening between the root and the word are stems: they are specified for lexical category but they are not inflectionally complete. For more extensive discussion of these concepts, see e.g. Kiparsky (2003a) and Bermúdez-Otero (2013a).

We can now formulate four key generalizations (cf. Bermúdez-Otero 2006: 283), to be slightly revised in (23):

(6) a. Roots do not define cyclic domains.
b. Some stems define cyclic domains for the stem-level phonology ($\mathcal{P}_{\mathrm{SL}}$).
c. Words define cyclic domains for the word-level phonology ($\mathcal{P}_{\mathrm{WL}}$).
d. Utterances define cyclic domains for the phrase-level phonology ($\mathcal{P}_{\mathrm{PL}}$).

Most theories in the stratal tradition subscribe to these statements: for example, stem-level, word-level, and phrase-level phonological constraints as defined here correspond roughly to the cyclic, postcyclic, and postlexical phonological rules of Booij and Rubach (1987).[7]

[7] These correspondences are only approximate, however. In Lexical Phonology, cyclic rules were assumed to abide by Strict Cyclicity and Structure Preservation (see §2.1 above), and these hypotheses were often maintained in the face of disconfirming evidence by assigning a rule to the postcyclic stratum even though it applied in domains smaller than the word (Bermúdez-Otero 2013b: §23–§29).

Why the generalizations in (6) should hold is an interesting topic of research. Take, for example, the phonological inertness of roots (Kiparsky 1982a: 144-5, 1982b: 32-3; Inkelas 1989: §3.5.). In an investigation of Spanish morphology, Bermúdez-Otero (2013a) adduces empirical evidence, both internal (the underlying distribution of theme vowels, locality effects in allomorph selection) and external (response latencies in lexical recognition), to show that stems are the minimal units of lexical storage and that all productive morphology is either stem-based or word-based. If these propositions are correct, they automatically explain why (6,a) holds true for Spanish (on Portuguese, see Matzenauer & Bisol 2016). Intriguingly, this approach leaves open the possibility that different stratification régimes may hold in languages that provide learners with better cues for root extraction, if such exist (Bermúdez-Otero 2013a: 53-4).

2.3.2. The nonrecursiveness of word-level and phrase-level domains

Cyclic domain structures conforming to the generalizations in (6) are relatively sparse. The phrase-level phonology, for instance, applies once across the board over the entire utterance; phrasal categories smaller than the utterance (e.g. DPs, IPs, etc) do not trigger phonological cycles. This means that no phonological process applies in a cyclic domain smaller than the utterance but larger than the maximal grammatical word; domains appearing to satisfy this description are prosodic, not cyclic (for the difference, see Bermúdez-Otero & Luís 2009, Bermúdez-Otero 2011: §4). Similarly, a word-level domain will rarely be found embedded within another word-level domain: this is because stems, when cyclic, undergo the stem-level phonology, whilst the grammatical word as defined in (5,c) rarely behaves as a recursive category.[8] In line with (6), therefore, only stem-level domains are ordinarily found nested within domains of the same type. We saw an example of this in (2). The noun stem *accommodation-* contains the verb stem *accommodate-*, and both trigger stem-level cycles: this is shown by the fact that the foot-head erected over the second syllable of *accómmodàte-* during the first cycle prevents the assignment of dactylic secondary stress to *accòmmodátion-* in the second cycle (compare again **àccommodátion* with *àbracadábra*). The word-level phonology, in contrast, applies just once to the whole word.

While English only provides merely negative evidence, German affords a clear positive argument to show that the word-level phonology does not apply in cyclic domains smaller than the fully inflected grammatical word. In German, word-final consonants occupy the syllable coda at the word level, but resyllabify into the onset at the phrase level before enclitics beginning with a vowel: e.g. *spiel* [.ʃpiːl.] 'play' ~ *spiel es* [.ʃpiː.ləs.] 'play it' (Wiese 1996: 251,

[8] Word recursion only arises in the intended sense when a fully inflected grammatical word acts as the base for the derivation of a new stem, which is then itself inflected. This is not impossible: see Rainer (1996) and Bermúdez-Otero (2013a: 26) for examples.

Hall 1999: 119). German coda devoicing must therefore be a word-level phonological process, since it overapplies to word-final consonants resyllabified before enclitics: e.g. *le*/g/ *es weg* [leː.kəs.vɛk] 'put it away'. In this light, consider how the word-level adjectival suffix *-ig* (Wiese 1996: 121) behaves with respect to devoicing. When *-ig* is the last overt suffix in the word, its final consonant is syllabified in the coda at the word level and so devoices in the normal way: e.g. *fett-ig* [fɛ.tɪç] 'fat-y'. In contrast, when *-ig* is followed by another word-level suffix beginning with a vowel, its final consonant undergoes resyllabification into the onset and, crucially, escapes devoicing: e.g. *fett-ig-es* [fɛ.tɪ.gəs] 'fat-y-N.NOM/ACC.SG'. This proves that the word-level phonology applies only once to *fett-ig-es*, even though this item contains two word-level suffixes (7,a). If *-ig* triggered a word-level cycle over the adjective stem, excluding the inflectional marker *-es*, devoicing would overapply (7,b).

(7)

		a. *correct domain structure*	b. *incorrect domain structure*
		⟦WL *fett-ig-es*⟧	⟦WL ⟦WL *fett-ig*⟧ *es*⟧
$\mathcal{P}_{WL}$	1st cycle	fɛ.tɪ.gəs	fɛ.tɪç
	2nd cycle	—	*fɛ.tɪ.çəs

The nonrecursiveness of word-level domains also provides the key to a famous puzzle in Indonesian stress assignment.[9] In this language, suffixes are incorporated into the same prosodic word as the stem, whereas prefixes are prosodically adjoined (Cohn 1989: 200ff):

(8)

(ω **bicára**)	'speak'
(ω′ məm (ω **bicará-kan**))	'speak about'
(ω′ məm (ω **bicàra-kán-ña**))	'speak about it'

Of interest here is the location of stress in polysyllabic sequences housed within the same prosodic word: in (8), these are highlighted in bold. When such sequences belong to a monomorphemic item, primary stress falls on the penult, and secondary prominence is assigned to every second syllable to its left. However, an odd-parity polysyllabic pretonic sequence, as in *xàtulistíwa*, will begin with a dactyl because the *ω*-initial syllable is required to bear stress and clash within *ω* is forbidden.

[9] My Indonesian data come from Cohn (1989) and Cohn & McCarthy (1998). I avoid examples containing schwa, which Cohn (1989: 174) describes as metrically invisible. Goedemans & van Zanten (2007) have recently argued that, in fact, Indonesian has no word stress at all. The case may be similar to that of Spanish secondary stress: there is no direct acoustic manifestation of its existence, but Hualde & Nadeu (2014) find subtle indirect evidence that supports the footing pattern implicit in traditional reports.

(9)	bicára	*bìcára	'speak'
	màʃarákat		'society'
	xàtulistíwa	*xàtùlistíwa, *xatùlistíwa, *xatulistíwa	'equator'
	èrodìnamíka		'aerodynamics'

As shown in (10), a stem formed with the suffix -(*n*)*isasi* '-ization' (< Dutch *-is-atie*) undergoes normal application of regular stress assignment, completely overwriting the metrical contour of its base. Note that the proparoxytonic contour of *amérika* is a lexical exception (Wallace 1976: 59).

(10)	amérika		'America'
	àmerikà-nisási	*amèrika-nisási	'Americanization'

Crucially, -(*n*)*isasi* resembles the stem-level Latinate affixes of English: it entered Indonesian in words borrowed whole from Dutch, but it has since became an autonomous morpheme capable of attaching to new bases, including native stems. In such novel, productively derived forms, the allomorph *-isasi* is predictably selected when the base ends in a consonant, whereas *-nisasi* appears after vowels (De Vries 1984: 484-7, Mueller 2007: 1220-1).[10]

(11)	a.	kompor	'stove'
		kompor-isasi	'the introduction of furnaces in brickyards'
	b.	pompa	'pump'
		pompa-nisasi	'the introduction of pumping systems'

This confirms that the synchronically correct morphemic segmentation of *àmerikànisási* is as shown in (10).

In contrast with -(*n*)*isasi*, native suffixes like valency-changing *-kan* and 3SG.ACC *-ña* cause misapplication of secondary stress assignment.

(12)	(ω **bicára**)		'speak'
	(ω′ məm (ω **bicará-kan**))	*(ω′ məm (ω **bìcará-kan**))	'speak about'

In the derived applicative verb *məm-**bicará-kan***, primary stress falls on the penult, as normal. The preceding syllable, which heads a foot in the base ***bicára***, undergoes destressing to avoid clash: this too constitutes normal application. But the metrical profile of *məm-**bicará-kan*** is opaque because the first syllable of the stem (which is *ω*-initial) fails to receive secondary

[10] There is some variation: the allomorph *-nisasi* can occur after /r/, and bases ending in /i/ sometimes take *-sasi*.

prominence, even though stressing it would not result in a clash. The reason is that the stem-initial syllable is unstressed in the base ***bicára***, and pretonic stress in words containing *-kan* and *-ña* is faithful to the cyclic base, save for the avoidance of clash. The same pattern can be observed in the derived causative verb *məŋ-**àmerikà-nisasí-kan*** (Cohn & McCarthy 1998: 66):

(13)	(ѡ **amérika**)		'America'
	(ѡ **àmerikà-nisási**)		'Americanization'
	(ѡ′ məŋ (ѡ **àmerikà-nisasí-kan**))	*(ѡ′ məŋ (ѡ **àmerìka-nìsasí-kan**)) *(ѡ′ məŋ (ѡ **amèrika-nisasí-kan**))	'Americanize'

In this case, the derived verb bears secondary stress exactly on the same syllables as its proximate base ***àmerikà-nisási***; the only difference is that the foot-head on the penultimate syllable of the proximate base disappears in the derived verb in order to avoid clash. As one would expect, moreover, *məŋ-**àmerikà-nisasí-kan*** is metrically faithful to its proximate base ***àmerikà-nisási***, rather than to its remote base ***amérika***.

We now come to the key puzzle: if a word contains a sequence of two native suffixes like *-kan* and *-ña*, it exhibits opaque stress too, but it is metrically faithful to its remote base, rather than to the proximate one.

(14)	(ѡ **bicára**)		'speak'
	(ѡ′ məm (ѡ **bicará-kan**))		'speak about'
	(ѡ′ məm (ѡ **bicàra-kán-ña**))	*(ѡ′ məm (ѡ **bìcara-kán-ña**)) *(ѡ′ məm (ѡ **bicara-kán-ña**))	'speak about it'

In *məm-**bicàra-kán-ña***, primary stress falls on the penultimate syllable, as normal. The antepenult cannot bear secondary prominence, even though it corresponds to the tonic syllable of the proximate base *məm-**bicará-kan***, because this would create an illegal clash. Unexpectedly, however, pretonic stress in *məm-**bicàra-kán-ña*** falls on the second syllable of the stem. This metrical profile is unfaithful to the proximate base *məm-**bicará-kan***, where the second syllable of the stem is unstressed. It is also an opaque contour, in that the normal application of stress assignment would generate a stem-initial dactyl with prominence on the first syllable of the stem. The only explanation is that pretonic stress in *məm-**bicàra-kán-ña*** must reflect cyclic inheritance from the remote base ***bicára***. How can this be?

Stratal Phonology provides a simple solution to this classic puzzle: *-(n)isasi* is a stem-level suffix, but *-kan* and *-ña* are word-level. At the stem level, iterative stress assignment reapplies normally to each new cyclic domain, overwriting the metrical structure created in previous cycles. At the word level, in contrast, a single new foot is built noniteratively at the right edge, causing the penultimate syllable to receive primary stress; the antepenult is destressed if necessary to avoid clash, but otherwise the pretonic string remains undisturbed. Now, any form containing just one word-level suffix, like *məŋ-**àmerikà-nisasí***$_{SL}$*-**kan***$_{WL}$ in (13),

is predicted to be metrically faithful to its proximate base, as the latter defines an immediate cyclic subdomain: see (15,a). But forms containing two word-level suffixes in a row will behave differently: since the word-level phonology applies just once to the whole word, the first word-level suffix fails to trigger a cycle. Thus, an item like *məm-**bicàra-kán***$_{\text{WL}}$*-**ña***$_{\text{WL}}$ in (14) ends up being metrically faithful to its remote base because the proximate base does not constitute a cyclic node; in this case, only the remote base defines an immediate cyclic subdomain, as shown in (15,b).

(15) a. ⟦$_{\text{WL}}$ məN ⟦$_{\text{SL}}$ ⟦$_{\text{SL}}$ amérika⟧ (n)isasi⟧ kan⟧ b. ⟦$_{\text{WL}}$ məN ⟦$_{\text{SL}}$ bicara⟧ kan-ña⟧

SL: pre-*σ́* overwriting	(ω amérika) (ω àmerikànisási)	(ω bicára)
WL: pre-*σ́* faithfulness	(ω′ məŋ (ω àmerikànisasíkan))	(ω′ məm (ω bicàrakánña))

Nothing else is needed to handle more complex cases like *məŋ-**àmerikà-nisàsi***$_{\text{SL}}$*-**kán***$_{\text{WL}}$*-**ña***$_{\text{WL}}$ ‘Americanize it’ (Cohn & McCarthy 1998: 72), with one stem-level suffix followed by two word-level suffixes:

(16) ⟦$_{\text{WL}}$ məN ⟦$_{\text{SL}}$ ⟦$_{\text{SL}}$ amérika⟧ (n)isasi⟧ kan-ña⟧

SL: pre-*σ́* overwriting	(ω amérika) (ω àmerikànisási)
WL: pre-*σ́* faithfulness	(ω′ məŋ (ω àmerikànisàsikánña))

This item is faithful neither to its proximate base *məŋ-**àmerikà-nisasí-kan*** (where /sa/ is unstressed) nor to the most deeply embedded base ***amérika*** (which bears prominence on the second syllable). Rather, pretonic faithfulness targets the input to the word level: the noun stem ***àmerikà-nisási***. The result happens to exhibit the same metrical contour as a hypothetical transparently-stressed nine-syllable form, but a comparison with opaque word-level forms like (15) shows this outcome to be coincidental.

The stratal approach reveals a profound similarity between cyclic stress assignment in English and Indonesian. The English form *orígin-àt*$_{\text{SL}}$*-ing*$_{\text{WL}}$, with a stem-level suffix followed by a word-level one, is metrically faithful to its proximate base *orígin-àte*, and not to the remote base *órigin*. In contrast, *defénce-less*$_{\text{WL}}$*-ness*$_{\text{WL}}$, with its two word-level suffixes, inherits its metrical contour from its remote base *defénce*. Indonesian *məm-**bicàra-kán***$_{\text{WL}}$*-**ña***$_{\text{WL}}$ reveals this shared pattern more clearly because, in this case, word-level noniterative refooting at the right edge forces the proximate base *məm-**bicará-kan*** to be less faithful to the remote base ***bicára***.

The behaviour of word-level suffixes, as illustrated by the evidence of German in (7) and of Indonesian in (15), raises difficulties for cyclic frameworks that posit richer domain structures than Stratal Phonology. In Cophonology Theory, for example, every nonterminal

morphosyntactic node triggers a phonological cycle; a string of the form *base-affix*$_1$-*affix*$_2$ cannot define a single phonological cyclic domain unless its morphosyntactic structure is flat, i.e. [*base-affix*$_1$-*affix*$_2$] rather than [[*base-affix*$_1$]*affix*$_2$] (Orgun 1996: ch. 2). To accommodate data like (7), therefore, Cophonology Theory is forced to say that German suffixes like *-ig* are specified for a vacuous cophonology, i.e. $\mathcal{P}_{\text{-ig}}(i) = i$, and that coda devoicing is confined to a cophonology restricted to inflectionally complete grammatical words. For this solution to work more generally, however, it is not enough to ban all phonological unfaithfulness during vacuous cycles; phonologically driven allomorph selection must be suspended too, in order to permit outwards-sensitive phonologically conditioned allomorphy (e.g. Deal & Wolf forthcoming). Like the proliferation of zero morphs in mainstream DM (Bermúdez-Otero 2016: 392), the proliferation of vacuous cycles in Cophonology Theory does not constitute a direct refutation of the framework, but it could be taken as a signal that a generalization is being missed. Approaches to the interface based on Phase Theory face similar problems over the absence of phonological cyclic domains between the grammatical word and the utterance: Scheer (2011: §786) refers to this as the 'word spell-out mystery'.

2.3.3. The recursiveness of stem-level domains and Chung's Generalization

Rule-based Lexical Phonology used a large measure of brute force to handle the fact that stem-level domains are recursive whereas word-level domains are not (except in the rare cases mentioned in note 8). Affixes were arbitrarily labelled as stem-level or word-level, and it was stipulated that the former were cyclic and the latter were postcyclic or noncyclic (Booij & Rubach 1987, Halle & Vergnaud 1987).[11] This meant that each instance of stem-level affixation triggered a stem-level cycle, whereas only inflectionally complete grammatical words triggered word-level cycles. Whilst such provisions cover a remarkably large amount of empirical ground,[12] they are conceptually unsatisfying; it would be far better if the recursiveness of stem-level domains could, like the phonological inertness of roots, be deduced from independent postulates.

To this end, Bermúdez-Otero (2012: 19-20, 31-40; 2013b), developing intuitions adumbrated by Pesetsky (1979: §5.0) and Borowsky (1993: 219-20), suggests that the richer domain structure that characterizes stem-level constructs as compared with word-level forms

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[11] Affixes can also display dual affiliation, in which case their phonological behaviour correlates with the morphosyntactic status of the base—a point rightly emphasized by Giegerich (1999). The English adjectival suffix *-able*, for example, behaves as word-level when attached to inflectional stems, but as stem-level when attached to roots or derivational stems: see §3.2 below for discussion.

[12] Cole (1995: 95) finds no trace of recursive stem-level domains in Spanish, but her assessment is based on the analysis of a single alternation: diphthongization. Bermúdez-Otero (2013a: 67-71, 2016: 408-13) demonstrates stem-level domain recursion in Spanish with evidence from the syllabification of high vocoids.

emerges from facts about lexical decomposition and storage. His proposals make extensive use of Jackendoff's (1975) theory of lexical redundancy rules, adapted to the framework of OT. In this view, complex stem-level items like *accommodate* and *accommodation* are listed nonanalytically: i.e. as undecomposed wholes with all stem-level phonological properties redundantly specified (17,a). Of course, this in no way implies a denial of the psychological reality of stem-level morphology and phonology; it merely means that stem-level processes work as lexical redundancy rules. In contrast, complex word-level items like *accommodationlessness* may be unlisted or, if entered into the lexicon, are listed analytically as decomposed strings of stem-level pieces (17,b).[13]

(17) *Stem-level nonanalytic listing*

a. ACCOMMODATE ↔ accómmodàte

b. ACCOMMODATION ↔ accòmmodátion

Word-level analytic listing

c. ACCOMMODATIONLESSNESS ↔ ⟦$_{WL}$ accòmmodátion -less -ness -∅⟧

In this system, stem-level domain recursion emerges from morphological blocking. Thus, when the noun *accommodation* was first created, the existence of a lexical entry for the verb *accommodate* (17,a) blocked derivation from the root *commod-*.[14] As this lexical entry already contained a foot-head on the second syllable, initial pretonic secondary stress was blocked too.

(18)

accómmodàte - ion	MAX-Head(Σ)	ALIGN(ω,L;Σ°,L)
àccommodátion	*!	
accòmmodátion ☜		*

Since morphological blocking is affected by factors such as token frequency, this account correctly predicts that those factors will also have an effect on stem-level domain recursion (Collie 2007, 2008): for example, relative token frequency plays a key role in

[13] Bermúdez-Otero (2012: 29, 43; 2013b: §36-§37) motivates the existence of analytic listing with psycholinguistic data and with evidence from phrasal idioms, but Köhnlein (2015: 188ff) shows that analytic listing also provides a solution for a difficult puzzle in the morphophonology of Dutch place names.

[14] The first attestation of the verb *accommodate* in the *OED* dates back to 1531; that of *accommodation*, to 1566. An account of stem-level domain recursion driven by nonanalytic listing and moprhological blocking generalizes to cases in which the synchronically derived item was borrowed before its synchronic base: Bermúdez-Otero (2012: 37-9, 2013b: §42-§45) shows how, in the course of history, the balance between lexical storage and online grammatical derivation determines whether or not a complex stem-level item develops cyclic behaviour.

determining whether derivatives like *importation* and *transportation* cyclically preserve the foot-head on the second syllable of their bases (Bermúdez-Otero 2012: 34-9, 2013b: §21, §42-§45).

(19)

				tokens per million words in spoken section of COCA		
				base		*derivative*
a.	imp[ɔ́]rt	~	ìmp[ɔ]rt-átion	5.15	>	0.62
b.	tràmsp[ɔ́]rt	~	tràmsp[ə]rt-átion	7.23	<	23.54

Like all versions of Stratal OT, this approach to stem-level domain recursion also explains Chung's Generalization (named after Chung 1983: 63). This states that, if a phonological process misapplies within an outer stem-level domain owing to the presence of an inner stem-level domain, then the output of that process must be lexically contrastive. For example, the faithfulness constraint that opaquely preserves second-syllable stress in the derivation of stem-level *accòmmodátion-* from stem-level *accómmodàte-* (18) also preserves the exceptional pretonic contour of monomorphemic *Epàminóndas* (20), which contrasts with that of monomorphemic *àbracadábra* (Kiparsky 2007: 20ff; Bermúdez-Otero 2012: 31-33; Bermúdez-Otero 2013b: §32, §38-§41, and p. 22).

(20)

Epàminóndas	MAX-Head(Σ)	ALIGN(ω,L;Σ°,L)
Èpaminóndas	*!	
Epàminóndas ☜		*

OT with OO-correspondence is unable to explain Chung's Generalization because it uses different constraints to describe phonemic contrast in simple items and cyclic effects in complex items (Kiparsky 2007: 22, Bermúdez-Otero 2012: 40).[15]

2.3.4. Cycles over word-level affixes

Our brief discussion of root inertness (§2.3.1) and of stem-level domain recursion (§2.3.3) has shown that, while the ideas of cyclic derivation and of stratification provide the stratal research tradition with an enduring and stable core, other aspects of the framework continue to be revised and improved, while new empirical predictions are constantly being derived.

[15] Wolf (2011: §4) misdescribes Chung's Generalization and cites empirical evidence that has no bearing on its validity. The generalization forbids the cyclic transmission of purely allophonic properties from a base to a stem-level derivative, but freely allows noncontrastive features to be passed from a base to a word-level derivative. For further clarification of this point with examples from English, see Bermúdez-Otero (2013b: p. 22).

As a further illustration of ongoing work, let me return to the cyclic domain structure of word-level constructs (§2.3.2). In (7) and (15,b) we saw that word-level domains do not embed other word-level domains (except in the circumstances discussed in note 8). Beyond this, however, the stratal tradition affords two competing views of word-level affixes: one such view, represented in (21,a), holds that affixes never define cyclic domains (Kiparsky 1982a,b); the other, exemplified in (21,b), holds that word-level affixes behave just like cyclic stems by defining domains for the stem-level phonology by themselves (Baker 2005: 17, developing ideas in Borowsky 1993).

(21) a. ⟦$_{WL}$ ⟦$_{SL}$ memory⟧ less-ness⟧ b. ⟦$_{WL}$ ⟦$_{SL}$ memory⟧⟦$_{SL}$ less⟧⟦$_{SL}$ ness⟧⟧

Baker's approach predicts that, whilst word-level affixes may *qua* functional morphs escape the prosodic minimality restrictions imposed by the stem-level phonology on lexical items, they will otherwise behave like miniature stems. Recent work supports this prediction with evidence from German and Dutch (Buckler 2009, Buckler & Bermúdez-Otero 2012). In German, for example, stem-level constraints require that an underlying voiceless dorsal fricative should be realized as [ç] in stem-initial position (22,a). Strikingly, the word-level diminutive suffix *-chen* behaves exactly like a stem, in that its initial dorsal fricative is mapped onto [ç] domain-initially at the stem level (22,b).

(22) a. **Ch**ina [çiːna] 'China'

b. ⟦$_{WL}$ ⟦$_{SL}$ Kuh⟧⟦$_{SL}$ **ch**en⟧⟧ [$_{SL}$ kuː-][$_{SL}$ -çən] ⟶ [$_{WL}$ kuːçən] 'cow-DIM'
⟦$_{WL}$ ⟦$_{SL}$ Ku**ch**en⟧⟧ [$_{SL}$ kuːxn̩] ⟶ [$_{WL}$ kuːxn̩] 'cake'

Baker's (2005: 17) hypothesis has further advantages: it naturally accounts for languages like Diyari (Poser 1989: 127-8) and Ngalakgan (Baker 2005: 4ff) in which every productive suffix constitutes a separate stress-assignment domain, and it answers McCarthy's (2007: 133-4) question as to why the phonemic inventory of word-level affixes is never a superset of the phonemic inventory of stems. It has also proved helpful in analyses of nonconcatenative exponence in the framework of Generalized Nonlinear Affixation (§4.3): see e.g. Trommer (2011: 73ff), Zimmermann (2016b: 273). In §4.2 below I shall put it to further use in a solution to bracketing paradoxes of the *ungrammaticality* type, as suggested by Baker (2005: 16-7).

In this light, the stratification generalizations in (6) should be amended as follows:

(23) a. Roots do not define cyclic domains.
b. Some stems and some affixes define cyclic domains for the stem-level phonology ($\mathcal{P}_{SL}$).
c. Words define cyclic domains for the word-level phonology ($\mathcal{P}_{WL}$).
d. Utterances define cyclic domains for the phrase-level phonology ($\mathcal{P}_{PL}$).

3. In defence of Cyclic Containment

> As our Revolution was a vindication of ancient rights, so it was conducted with strict attention to ancient formalities.
>
> Macaulay, *loc. cit.*

3.1. OO-correspondence

Like all cyclic approaches to the morphology-phonology interface, Stratal Phonology currently meets its most serious challenge in the theory of OO-correspondence (e.g. Kenstowicz 1996, Benua 1997). The key idea behind the latter may be summarily stated as follows; cf. (3) above.

(24) In cases of morphosyntactically induced phonological opacity, a linguistic expression copies its opaque phonological properties from the surface representation of a morphosyntactically related expression.

Under OO-correspondence, therefore, *accòmmodátionlessness* acquires its prefenestral primary stress and its nondactylic secondary stress from the surface representation of the singular form of the noun *accòmmodátion,* rather than from an intermediate representation assigned to the stem *accòmmodátion-* in the course of the derivation; cf. (2) above.[16]

Although in this specific instance both theories produce the same result, their wider predictions diverge dramatically. In particular, OO-correspondence holds that all opaque properties of the derived form must occur transparently in some surface base (Bermúdez-Otero 2011: 2029), and that surface bases need not correspond to morphosyntactic constituents of the derived form.

(25)

	Cyclic frameworks	**OO-correspondence**
a. Need opaque properties surface transparently in the base?	NO	YES
b. Need the base be contained within the derived form?	YES	NO

[16] As we saw in (17), the explanation of stem-level domain recursion proposed by Bermúdez-Otero (2012, 2013b) holds that, upon first encountering the stem *accòmmodátion-*, speakers redundantly store its stem-level representation in the permanent lexicon. In this view, the representation from which *accòmmodátionlessness* inherits its opaque metrical properties occupies an intermediate position in the static network of lexical relations captured by stem-level redundancy rules, but it does not correspond to an intermediate stage of processing in online speech production. This refinement may be set aside in the current context; the key point is that, in the stratal account, *accòmmodátionlessness* is faithful to the stem-level representation of a stem, and not to the surface form of a word.

I shall briefly return to question (25,a) in §3.3 below. In §3.2 I look in depth at one piece of evidence bearing on question (25,b), which in effect asks whether Cyclic Containment (3) is true or not; other data bearing on this issue are discussed in Bermúdez-Otero (forthcoming).

3.2. English dual-level affixes

Steriade (1999: §2-§3) challenges Cyclic Containment (3) with observations from English dual-level affixes like adjectival *-able*. Consider first the adjective *párodiable*, derived from the verb *párody*$_{V}$, itself formed by conversion of the noun *párody*$_{N}$: in this adjective, *-able* behaves as a stress-neutral suffix, creating an extremely long metrical lapse after the tonic syllable. Now suppose that we parse the adjective *remédiable* as derived through the addition of *-able* to the converted verb *rémedy*$_{V}$: in this analysis (to be revised presently), *-able* behaves as a stress-affecting suffix, causing primary stress to shift to the right. If so, what enables the stress shift in *remédiable*, whilst *párodiable* is forced to retain its relatively marked metrical profile? According to Steriade, it is the fact that the pre-existent adjective *remédial* provides a lexical precedent for the stress contour of *remédiable*, whereas there is no such precedent for **paródiable*: cf. $^{\varnothing}$*paródial*.[17] Steriade refers to this as an instance of 'lexical conservatism'.

The putative connection of *remédiable* with *rémedy*$_{V}$ and *remédial* is, however, questionable. In an alternative analysis, Raffelsiefen (2004: 135) regards the metrical profile of *remédiable* as licensed by that of the verb *remédiàte* (whence also *remèdiátion*). Even if the token frequency of *remédiàte* is lower than that of *remédial*, this proposal has the eminent virtue of subsuming the pair *remédiàte~remédiable* under a highly pervasive pattern linking verbs in *-ate* with adjectives in *-able* (Kiparsky 2005: 507). In turn, this pattern is clearly connected to the observation that, when added to stems, *-able* subcategorizes for verbs, not for adjectives. In relation to the ungrammaticality of **paródiable,* moreover, Kiparsky (2005: 507) points out that a lexical precedent for its stress pattern does exist in the adjective *paródic*. Yet, crucially, there is no verb $^{\varnothing}$*paródiàte* (and hence no noun $^{\varnothing}$*paròdiátion*). The corresponding token frequencies, measured in tokens per million words in the BNC, are as follows:

(26)

a.			b.		
	rémedy$_{V}$	5.64		párody$_{V}$	1.04
	remédial	3.39		paródic	0.43
	remédiàte	0.03		$^{\varnothing}$paródiàte	0
	remèdiátion	0.23		$^{\varnothing}$paròdiátion	0
	remédiable	**0.28**		**párodiable**	**0.01**

[17] The superscript $^{\varnothing}$ denotes a lexical gap, i.e. a well-formed but nonexistent lexical item.

The metrical contrast between *remédiable* and *párodiable* thus constitutes a genuine instance of lexical conservatism, but the relevant lexical precedents seem to be *remédiàte* and $^{\varnothing}$*paródiàte*, not *remédial* and $^{\varnothing}$*paródial*.

Raffelsiefen's (2004) richly detailed study of verbs in *-ize* provides a more straightforward case of lexical conservatism in English dual-level affixation. The suffix *-ize* is highly productive in stress-neutral use: e.g. *cónsonant* → *cónsonant-ìze*. Raffelsiefen's data show, however, that *-ize* requires the immediately preceding syllable to be unstressed: e.g. *Clínton-ìze,* but **Búsh-ìze*. Crucially, this requirement can be met through stress shift, but typically only when there already exists another stress-shifted derivative from the same base:

(27)	a.	Japán	**Jàpan**-ése	**Jápan**-ìze	
		Vìetnám	**Viètnam**-ése	**Viétnam**-ìze	
	b.	Tibét	Tibét-an	*Tíbet-ìze	$^{\varnothing}$Tìbet-ése
		Brazíl	Brazíl-ian	*Brázil-ìze	$^{\varnothing}$Bràzil-ése

Evidence of this sort indicates that English dual-level affixes typically abide by the following generalization:

(28) Let *d* be an English derivative of the form *base+affix*.
Let *base* exist as a free form.
Let *affix* have a productive stress-neutral use.
If *d* does not match the stress profile of *base*,
then there exists another derivative *d′* of the form *base+affix′*
such that *d* matches the stress profile of *d′*.

In agreement with Raffelsiefen (2004: 135), I assume that the syntactic selectional restrictions of dual-level affixes constrain the availability of lexical precedents for stress shift under (28): this is shown by the fact that, as we saw in (26), *remédiable* is licensed by *remédiàte* rather than by *remédial*, and *paródic* fails to license **paródiable*. In what follows, however, I set this point aside and discuss Steriade's analysis in its original form: the goal of my argument is to show that, apart from the role of syntactic subcategorization, Steriade's account fails to capture an important phonological constraint on the stress-shifting uses of *-able*.

Steriade interprets generalization (28) as follows. If a lexical item like *remédial* occurs with sufficient frequency, its surface representation is stored in memory. The surface representations stored in memory are monitored by a set of optimality-theoretic LEX constraints. In the case of *remédiable* and *párodiable*, the relevant constraint is LEX-stress: for a candidate *c* containing a realization of a morpheme *m*, LEX-stress is violated if there is no stored surface realization of *m* containing the same sequence of stressed and unstressed syllables as the realization of *m* in *c*. Thus, *remédi-able* satisfies LEX-stress because it contains a surface

realization of the root *remedy*√- whose metrical properties match those of the realization of the root in *remédi-al*; in contrast, **paródiable* enjoys no such support.[18]

(29)

		LEX-stress	*POSTTONIC LAPSE
parody-able *surface support:* párody	(pá.ro.)di.a.ble ☜		**
	pa.(ró.di).a.ble	*!	*
	pà.ro.(dí.a.)ble	*!	
remedy-able *surface support:* rémedy, remédial	(ré.me.)di.a.ble		(*) *!
	re.(mé.di.)a.ble ☜		(*)
	rè.me.(dí.a.)ble	*!	

This analysis directly challenges Cyclic Containment (3): it claims that [ɹi.ˈmiː.di.ə.bl̩] copies its stress contour from the surface representation of a lexical item, *remedial*, that is not contained within *remediable*.

Kiparsky (2005) provides an alternative analysis of (28) in Stratal Phonology. According to his proposal, *-able* and *-ize* are dual-level suffixes, and their stratal affiliation depends on the morphosyntactic status of the base (Giegerich 1999). More specifically, a dual-level suffix like *-able* or *-ize* may occupy two different structural positions: it can attach 'high' to an inflectional stem, or it can attach 'low' to a root or derivational stem.[19] When the affix attaches high, it behaves as word-level and therefore stress-neutral; when it attaches low, it behaves as stem-level and therefore stress-affecting. Crucially, the default mode of attachment is high. Thus, *-able* in productive use normally combines with a verb's inflectional stem in word-level mode (e.g. *párody*V → *párodi-able*); it can be added to a root in stem-level mode (e.g. *remedy*√- → *remédi-able,* cf. *rémedy*V) only when the existence of a derived verb like *remédi-àte*V alerts the learner to the availability of the root for stem-level suffixation. In this view, generalization (28) reflects facts about morphosyntax (the default attachment height for dual-level affixes) and

[18] Steriade claims that stress shift in *remédiable* enables the adjective to satisfy a constraint penalizing word-final strings of three unstressed syllables. This does not quite work, as [ɹi.ˈmiː.djə.bl̩] is only a relaxed variant of the canonical pronunciation [ɹi.ˈmiː.di.ə.bl̩], which has preantepenultimate stress: see Wells (2008: *sub voce*) and note 23 below. In tableau (29), therefore, I substitute a positionally relativized version of Green & Kenstowicz's (1996) foot-based constraint against lapses: this assigns a violation mark for every pair of posttonic unstressed syllables not separated by a foot boundary.

[19] I substitute the term *inflectional stem* for Kiparsky's 'word', and *root* or *derivational stem* for Kiparsky's 'stem', in order to maintain consistency with the definitions in (5).

about lexical acquisition (the learner's failure to extract roots in the absence of positive evidence), not about phonological computation.

The morphological premises of Kiparsky's analysis are strongly supported by crosslinguistic evidence. First, low attachment is known to be strongly correlated with reduced productivity, noncompositional semantics, and arbitrary allomorphy (e.g. Arad 2003). As a special case, De Belder *et al.* (2014) show that low diminutives are far less productive than high diminutives. Secondly, there are languages in which all synchronically productive derivation is based on inflectional stems: examples include Spanish (Bermúdez-Otero 2013a) and Portuguese (Matzenauer & Bisol 2016), where inflectional stems can be formally recognized by the presence of a final theme vowel.[20] In the case of Spanish, Bermúdez-Otero (2013a) adduces internal evidence from local domains for allomorph selection and external evidence from response latencies in lexical recognition to show that Spanish speakers store full inflectional stems in the lexicon. Thus, Spanish speakers' preferences in respect of derivational bases and of lexical decomposition closely match the learner behaviour assumed in Kiparsky's explanation of lexical conservatism in English dual-level affixation.

Kiparsky's analysis is accordingly able to derive observation (28) from independently motivated postulates. Because it assumes a stratal architecture, however, it also makes further empirical predictions. Notably, Kiparsky holds that the stress-shifting uses of dual-level affixes with independently surfacing bases, as in (27,a), reflect the application of the stem-level phonology. Under the stratification generalizations set forth in (23), however, the stem-level phonology applies in all cycles triggered by stems, including those stems created by derivation from a bound root. The stratal account therefore yields the following prediction:

(30) The stress-shifting uses of an English dual-level suffix follow the same pattern of primary stress assignment as items formed by adding the same suffix to a bound root.

This is just a special case of (31).

(31) A form created by adding a stem-level affix to a free stem obeys the same well-formedness conditions as a form created by adding the same suffix to a bound root.

Consider the case of *-able*. To test the validity of (30), we need to examine stress assignment in adjectives formed by adding *-able* to bound roots that have no other derivatives; by ensuring that the root does not occur elsewhere, we guarantee that lexical conservatism is not at work. If the stratal analysis is correct, then the phonological generalizations governing stress assignment

[20] In addition, both languages have a very small set of derivational affixes that attach to inflectionally complete grammatical words: see note 8.

in these isolated deradical adjectives should correctly describe the behaviour of primary stress in the stress-affecting uses of *-able* with independently surfacing bases.

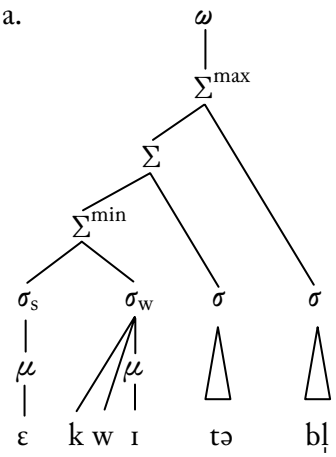
The data in (32) reveal that, when attached to bound roots, the suffix *-able* behaves like a weak retractor: it places primary stress on the immediately preceding syllable, i.e. on the antepenultimate, if heavy (32,a); otherwise, stress goes on the preantepenultimate (32,b).[21] For a survey of stress retraction modes in English, see Kager (1989: 37-63) and references therein.

(32)

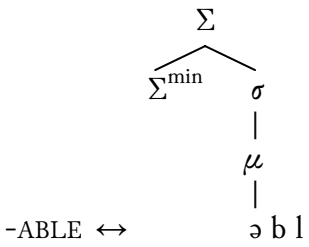
a. *heavy antepenult*	b. *light antepenult*
amḗnable	indómĭtable
coméstible	indúbĭtable
deléctable	inéxŏrable
inelúctable	irréfrăgable

Weak retraction is not the default metrical pattern for disyllabic stem-level suffixes, as indicated by the prefenestral stresses in (32,b): cf. e.g. *-ity*. *Pace* Raffelsiefen (2004) and Zamma (2012), however, it is by no means necessary to set up a separate stem-level cophonology for weak retractors. In fact, doing so would lead to grievous loss of generalization, as repeatedly pointed out in the literature (e.g. Hayes 1982: 243). Rather, since it is independently known that the stem-level phonology of English achieves exhaustive footing by means of adjunction (Bermúdez-Otero 2012: footnote 19 and references therein), a weak retraction structure like (33,a) can be obtained simply by specifying the first syllable of *-able* as sister to a minimal foot projection (Σ° or Σ^{min}; see Ito & Mester 2009: 170) in the underlying representation of the suffix (33,b). Faithfulness to this specification will be enforced by the high-ranking constraint IDENT-$\sigma\frown\Sigma^{\circ}$.

(33) a.



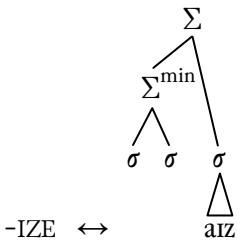
b.



[21] *Amenable* (< Anglo-Norman *amener* < Latin *minārī*) bears no relation to *amenity* (< Latin *amoenitātem*). The *OED* lists the verb *deléctàte*, with an earliest attestation in 1802 (cf. *c*1400 for *delectable*), but describes it as 'rare' and 'affected or humorous'; it has no tokens in the BNC. The rare verb *dúbĭtàte* has a similar status.

Once this mechanism is in place, the same stem-level constraints that build right-aligned bimoric trochees with final syllable adjunction in monomorphemic items like *a*(*gén*)*da* and *A*(*méri*)*ca* will generate weak retraction in *ine*(*lúc*)*table* and *in*(*dómi*)*table.*[22] Strong retractors like *-ize* and *-ate*, which cause stress to skip the immediately preceding syllable regardless of weight (e.g. *réco**g**nìze, dési**g**nàte*), yield to the same analysis, except that the suffix is underlyingly specified as adjoined to a syllabic trochee:

(34)



We can now verify prediction (30). As expected, *remédiable* complies with the pattern of weak retraction found in isolated deradical adjectives in *-able* (32): its canonical pronunciation is [ɹi.ˈmiː.di.ə.bl̩], with preantepenultimate stress before a light antepenult.[23] Similarly, the metrical contour of verbs containing *-ize* in stress-shifting use, like *Jápanìze* and *Viétnamìze* in (27,a), is consistent with the pattern of strong retraction exhibited by deradical items like *récognìze*.

Under the analysis in (29), these facts come as a surprise: LEX-stress predicts that derived adjectives in *-able* will adopt the least marked metrical configuration for which a lexical precedent is available; there is no provision to ensure that this configuration will always be one of weak retraction, nor that it will always match the behaviour of isolated deradical formations like those in (32). This problem goes beyond mere loss of generalization: LEX-stress incorrectly predicts that *-able* will shift primary stress onto a light antepenultimate syllable, in violation of the weak retraction pattern, whenever some established derivative of the same root provides a precedent for antepenultimate stress and none supports preantepenultimate stress.

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[22] This analysis of *-able* provides a straightforward account of the rise of retraction failure in adjectives like *formídable* (cf. earlier *fórmidable*). This can be understood simply as an outcome of univerbation: when an adjective ceases to be parsed as containing the suffix *-able,* it becomes vulnerable to lexically diffusing change towards the general default stress pattern (Bermúdez-Otero 2012: 28). Crucially, this explanation correctly predicts that retraction failure will not occur in novel formations: for an example, see the discussion of **pèriódable* below.

[23] As observed in note 18, the relaxed pronunciation [ɹi.ˈmiː.djə.bl̩] derives from the canonical form by a variable low-level process known as 'compression' (Wells 2008: *sub voce*). Compression is a pervasive phenomenon in present-day English. In addition, the vowel length alternation that opposes *remĕdy* to *remēdial, remēdiate, remēdiation,* and *remēdiable* falls under a general stem-level pattern of CiV-lengthening (Chomsky & Halle 1968: 47, Halle & Mohanan 1985: 78).

Consider, for example, the verb *period*$_{V}$ [ˈpɪə.ɹi.əd], derived by conversion from the homophonous noun. The verb provides the base for the low-frequency novel adjective *period-able*.[24] Since the stress neutral pronunciation *périodable* [ˈpɪə.ɹi.ə.də.bl̩] contains a long final lapse, LEX-stress predicts that a candidate with rightward stress shift will be preferred if supported by some established form containing the root *period*$_{√}$-. There happen to be two such established forms: *pèriódic* and *pèriódical*. In consequence, the grammar in (29) generates **pèriódable*: this candidate has a precedent in established derivatives of *period*$_{√}$- and avoids a long final lapse. Yet native speakers judge **pèriódable* to be completely ungrammatical. On top of the fact that, as adjectives, *periodic* and *periodical* belong to the wrong category in terms of syntactic selection, there is a clear problem on the phonological side too: a stress-shifting use of *-able* must conform with the same pattern of weak stress retraction as found in *-able* derivatives from bound roots (32), but **pèriódable* fails to do so.[25] Kiparsky (2005) runs through several variations of this argument.

Crucially, this empirical problem remains even if the LEX-stress analysis is supplemented with an explicit account of weak retraction in isolated deradical forms like (32). Suppose that, as proposed above, *-able* is underlyingly specified with a metrical marking requiring it to be footed by adjunction (33,b), and that compliance with this specification is monitored by the faithfulness constraint IDENT-σ⁀Σ°. This constraint will need to be ranked above *POSTTONICLAPSE in order for the metrical specifications of *-able* to induce prefenestral stress in isolated deradical items: in tableau (35), this is illustrated with the derivation of preantepenultimate stress in *indómitable*. In a monostratal analysis, however, LEX-stress must dominate IDENT-σ⁀Σ° so as to account for departures from weak retraction in stress-neutral uses of *-able*: in tableau (35), this is the case of *párodiable*. These ranking arguments lead to the hierarchy LEX-stress ≫ IDENT-σ⁀Σ° ≫ *POSTTONICLAPSE, which correctly preserves the original outcome of the analysis for *remédiable*: support from *remédial* allows *remédiable* to satisfy the metrical specifications of *-able*. We have now expanded tableau (29) to handle *indómitable*, while preserving its results for *párodiable* and *remédiable*. As noted in the preceding paragraph, however, the system still selects the wrong candidate for *period-able*: **períodable* loses

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[24] The following are natural occurrences of *periodable* found online (boldface mine):

(i) Franchisees need to pay a fixed **periodable** fee to franchisors [...]
http://wiki.answers.com/Q/How_does_a_franchise_operate

(ii) [...t]he quotation is a complete **periodable** thought.
http://archiver.rootsweb.ancestry.com/th/read/WORDS/2000-01/0947432112

[25] Although [ˈpɪə.ɹi.ə.də.bl̩] clearly reflects stress-neutral word-level suffixation, it also happens to be the pronunciation that would arise by stress retraction: cf. e.g. *amélĭŏrable*. Hayes (1982: §2.6.3) accounts for this fact by assuming that the relevant roots have underlying glides: i.e. *per*/j/*od*$_{√}$-, *-mel*/j/*or*$_{√}$-.

for lack of precedents in other derivatives of *period*, and **pèriódable* wins over *périodable* on low-ranking *POSTTONICLAPSE.[26]

(35)

		LEX-stress	IDENT-σ⌒Σ°	*POSTTONIC LAPSE
indomit- Σ°)able *surface support:* ∅	in.(dó.mi.)ta.ble ☜	(*)		*
	ìn.do.(mí.ta.)ble	(*)	*!	
parody- Σ°)able *surface support:* párody	(pá.ro.)di.a.ble ☜		*	**
	pa.(ró.di).a.ble	*!		*
	pà.ro.(dí.a.)ble	*!	*	
remedy- Σ°)able *surface support:* rémedy, remédial	(ré.me.)di.a.ble		*!	**
	re.(mé.di.)a.ble ☜			*
	rè.me.(dí.a.)ble	*!	*	
period- Σ°)able *surface support:* période, periódic	(pé.ri.)o.da.ble ☹		(*)	**!
	pe.(rí.o.)da.ble	*!		*
	pè.ri.(ó.da.)ble 💣		(*)	

Stratal OT does not incur this problem. At the stem level, IDENT-σ⌒Σ° is ranked above all constraints penalizing stress retraction; at the word level, it is inactive because it is crucially dominated by IDENT-stress. At the stem level, therefore, *-able* can only behave as a retracting suffix, and at the word level it can only be stress-neutral. **Pèriódable*, which follows neither pattern, can win at neither level, regardless of any hypothetical support from *pèriódic*.

In sum, Kiparsky's analysis of English dual-level affixes derives generalization (28) from independently motivated premises, avoids the incorrect predictions of the LEX-stress constraint (e.g. the failure of retraction in **pèriódable*), and explains further facts (e.g. the parallelism between *remédĭable* and deradical *indómĭtable*). I conclude that lexical conservatism in stress-affecting uses of English dual-level affixes is a real and important empirical phenomenon, but one that is perfectly compatible with Cyclic Containment (3). Stratal Phonology explains its

[26] Juliet Stanton (personal communication) notes that *périodable* will win in tableau (35) if IDENT-σ⌒Σ° is replaced with some markedness constraint indexed to *-able* and penalizing stress on light antepenultimate syllables. However, there is no independent motivation for a constraint specifically banning stressed light antepenults. Significantly, *-able* did not historically become a weak retractor through a primary innovation, but rather as an opaque by-product of secondary stress reduction: e.g. (*fórmi*)(*dàble*) > (*fórmi*)*d*[ə]*ble*; cf. also (*míli*)(*tàry*) > (*míli*)*t*[ə]*ry* in British English. An analysis of retraction driven by a faithfulness constraint like IDENT-σ⌒Σ° accords well with this fact: an opaquely derived property has been historically reanalysed as an underlying specification.

fine-grained detail better than OO-correspondence. Bermúdez-Otero (forthcoming) reaches the same conclusion about other instances of lexical conservatism alleged to challenge Cyclic Containment (cf. Steriade 1999, 2008).

3.3. Theory comparison

As the preceding case-study shows, the question whether phonological derivations proceed cyclically is strictly empirical: the answer depends on the validity of generalizations such as (3) and (4). While the debate will no doubt continue in years to come, Stratal Phonology emerges from this challenge as a progressive research programme (Lakatos 1970), in that it responds to tough empirical tests not by weakening its empirical content but by producing results like (30).

The evolution of the theory of OO-correspondence since its birth more than twenty years ago (Benua 1995) looks rather different. From the outset, the practitioners of OO-correspondence have postulated a widening range of transderivational relationships between surface forms. As a result, we can now choose between asymmetrical and symmetrical correspondence, between local and nonlocal relationships, and between reference to free bases only and reference to all paradigmatically related expressions: compare, for example, the proposals of Benua (1997) and Kager (1999) with those of Burzio (1996) and Kenstowicz (1996). By itself, this growth in the number of transderivational correspondence types need not be a worrying sign; after all, one often sees a similar expansion and diversification of applications whenever a new grammatical mechanism of some generality is discovered. The problem lies, rather, in the fact that this trend has not been accompanied by the formulation of criteria defining the situations in which each type of transderivational relationship holds. Insightfully, Kenstowicz (1996: 390-1) identified this as an urgent task for the theory of OO-correspondence. Yet, to date, no such criterion has stood up to scrutiny. For example, McCarthy (2005: 172) proposed that OO-correspondence is asymmetrical and base-prioritizing in derivation, but symmetrical in inflection; but Hall & Scott (2007) and Albright (2008), among others, soon identified counterexamples. The outcome is that, as the generative capacity of the theory has grown in line with the range of its applications, its predictive power has fallen: if one has to predict in order to explain (Hempel & Oppenheim 1948), OO-correspondence describes more and more, but explains less and less.

As the empirical content of the theory of OO-correspondence dwindles, it becomes proportionately more difficult to find direct empirical counterexamples. In (25,a), however, we saw that all forms of transderivational correspondence converge on one prediction: OO-correspondence cannot explain phonological opacity in a linguistic expression unless its opaque phonological properties surface transparently in some morphosyntactically related form. Accordingly, OO-correspondence is directly falsified by all cases of morphosyntactically induced misapplication where no appropriately related surface form is transparent. Recent research has identified no fewer than seven instances of this phenomenon:

(36) a. Schwa epenthesis in Itelmen intransitive verbs (Bobaljik 2008).
b. Voicing of word-final prevocalic /s/ in Ecuadorian Spanish (Bermúdez-Otero 2011: §6; Strycharczuk *et al.* 2014).
c. Lenition of linking and intrusive [ɹ] in nonrhotic English dialects (Bermúdez-Otero 2011: §7).
d. Stress in Albanian deponent verbs and *plurale tantum* nouns (Trommer 2013).
e. Debuccalization of word-final prevocalic /s/ in Northern Chilean dialects of Spanish (Broś 2015: ch. 4).
f. Failure of gliding of stem-final prevocalic /i/ in Bothoa Breton verbs (Iosad 2016: ch. 10).
g. Failure of vowel reduction in Catalan compounds (Mascaró forthcoming).

4. Morphological implications of Stratal Phonology

In §3.2 we saw Stratal Phonology meeting a new observational challenge without loss of empirical content. We must now ask, however, whether the theory achieves its success by placing unreasonable demands on morphology and syntax. Linguistic theory runs a constant risk of delivering illusory advances in the study of one part of grammar by smuggling the analytic costs across the interface with another component.

Recent developments in morphology illustrate this danger. Research within DM has uncovered robust and profound empirical generalizations about locality restrictions on suppletive allomorphy (Bobaljik 2012, Smith *et al.* 2016). However, mainstream versions of DM with vocabulary insertion into single terminals (e.g. Embick 2010) have produced theories of allomorphic locality that are demonstrably too restrictive (Merchant 2015, Bermúdez-Otero 2016). Counterexamples are typically avoided by shifting the burden onto phonology in ways that deprive phonological theory of its empirical content (Bermúdez-Otero 2013a: 87–91, 2016: 404–19).

In this section I argue that Stratal Phonology, in contrast, permits a graceful integration with morphology: it can derive the relative ordering of phonological strata without recourse to the Affix Ordering Generalization (§4.1), it can handle bracketing paradoxes without recourse to rebracketing operations (§4.2), and it favours restrictive approaches to apparently nonconcatenative exponence (§4.3).

4.1. Affix order

Stratal Phonology is often claimed to make untenable assumptions about morphology (e.g. Inkelas 2012: 157, Shwayder 2015: 42–44). The argument runs as follows: in Stratal Phonology, the serial order of phonological levels crucially depends on the Affix Ordering Generalization,

which holds that all stem-level affixes must occur inside all word-level affixes (Selkirk 1982: 91, after Siegel 1974 and Allen 1978); but the Affix Ordering Generalization is false (Aronoff 1976: 85, Aronoff & Sridhar 1983, Fabb 1988, etc), and so Stratal Phonology must be wrong.

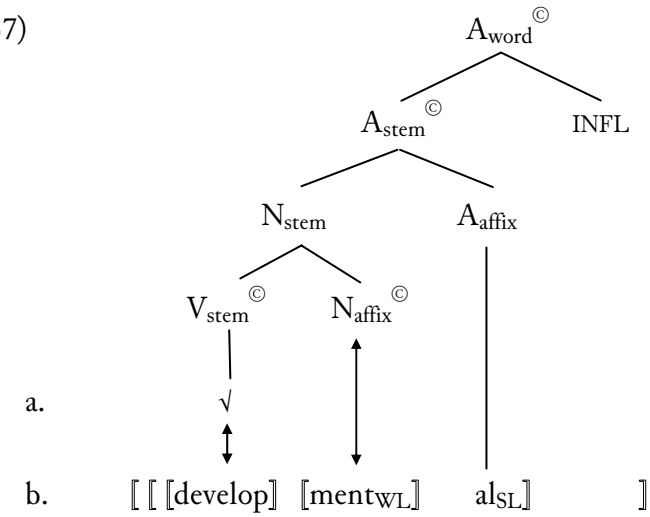
This argument, if correct, would indeed deprive Stratal Phonology of much of its appeal. Notably, one of the major advantages of the theory is its ability to derive phonological opacity effects from the size of the cyclic domains of the phonological processes involved (Kiparsky 2000, 2015b). This result supports a promising approach to the difficult problem of explaining the acquisition of opaque phonological derivations (Bermúdez-Otero 2003; Tesar 2014: 170-1, 399). In general, however, stratal accounts of opaque phonology would be thrown into disarray if violations of the Affix Ordering Generalization could disrupt the serial sequence of phonological levels by causing the word-level phonology to apply before the stem-level phonology.

Worryingly, the minor premise of the argument appears to be true: the Affix Ordering Generalization does appear to be untenable. Kiparsky (1983) rejected some of the putative counterevidence from English by arguing that, in cases like *cànnibalístic*, the nonexistence of $^{\varnothing}$*cánnibalist* indicates that the string *-istic* should be analysed as a fused stem-level suffix, rather than as word-level *-ist* followed by stem-level *-ic*. Kiparsky (1983) also sought to deflect counterexamples like *devèlop-mént*$_{\text{WL}}$*-al*$_{\text{SL}}$ by invoking the dual-level status of *-ment*: he argued that, in fact, *devèlopméntal* has the same structure as *òrna-mént*$_{\text{SL}}$*-al*$_{\text{SL}}$, where *-ment* behaves as a stem-level affix because it attaches to a bound root (see §3.2 above). There is a valuable insight behind this suggestion: Hay (2003) has demonstrated experimentally that the acceptability of a novel item containing *-al* attached to a base ending in *-ment* decreases in direct proportion to the decomposability of the base. Nonetheless, Hay's experiments also show that, when coerced to add *-al* to an unequivocally word-level form ending in *-ment,* native speakers of English have no difficulty computing its phonological form: e.g. *impòverish-mént-al* [ɪmˌpɒvəɹɪʃˈmɛntl̩]. More decisively, the Affix Ordering Generalization appears not to hold in certain languages other than English (Inkelas 2012).

Crucially, however, the major premise of the argument from affix ordering is false: Stratal Phonology need not assume the Affix Ordering Generalization in order to prevent the word-level phonology from applying before the stem-level phonology; the stratification generalizations in (23) suffice to do the job. For the purposes of demonstration, let us assume, *pace* Kiparsky (1983), that *-ment* behaves as a word-level affix in *devèlop-mént*$_{\text{WL}}$*-al*$_{\text{SL}}$. The vital point is that, even if *developmental* has this structure, the suffix *-al* undeniably attaches to a noun stem (5,b), and not to a noun wordform (5,c), since there is no number inflection inside *-al*: plural *development-s* is fine, but word-based **development-s-al* is not (cf. note 8). It follows that, insofar as *development-al* is a stem-based derivative, and only fully inflected grammatical words trigger cycles of the word-level phonology (23,c), there is no word-level cycle before the addition of *-al* in the phonological derivation of *developmental*. Rather, given the syntactic structure in (37,a) and its morphological realization in (37,b), the theory of

stratification summarized in (23) yields the composite phonological function in (37,c).[27] This results in a derivation in which all stem-level cycles precede all word-level cycles.

(37)



c. $\mathcal{P}_{WL}$($\mathcal{P}_{SL}$($\mathcal{P}_{SL}$(develop), $\mathcal{P}_{SL}$(ment), -al))

4.2. Bracketing paradoxes

The term *bracketing paradox* is considerably vague and denotes a disparate collection of phenomena (Spencer 1988: 680-1; Stump 1991: note 38).[28] It is usually applied to problems of morphological analysis arising from a clash between two or more criteria for determining the constituent structure of a linguistic expression, but the conflicting criteria may be of various sorts: e.g. semantic scope, subcategorization requirements, syntactic distribution, etc. In this section I shall consider just one type of paradox exemplified by the English word *ungrammaticality*, which is widely believed to raise particular difficulties for Stratal Phonology; for discussion of *transformational grammarian*, see Bermúdez-Otero (2016: 422-3).

In general, bracketing paradoxes are challenging because, as we saw in (2), Stratal Phonology derives the order of cycles in the phonological derivation from part-whole relationships in morphosyntactic constituent structure. When morphosyntactic constituency and phonological domains seem not to match, a problem arises. Such challenges can always be

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[27] English adjectives only inflect overtly for degree (e.g. *small-∅* ~ *small-er* ~ *small-est*), but *developmental*, if at all gradable, does so periphrastically (e.g. *more developmental*). In (37,a), however, I have added an inflection node to the structure just to highlight the difference between a stem and a word in the sense of (5).

[28] Sproat (1985: 16) and Cole (1995: 87) trace the discussion of bracketing paradoxes in generative linguistics back to Siegel (1974). Other classic works on this topic include Williams (1981), Kiparsky (1983), Pesetsky (1985), Sproat (1985), Hoeksema (1987), Beard (1991), and the articles by Spencer and Stump cited above.

overcome by brute force, i.e. by resorting to *ad hoc* rebracketing operations (Sproat 1985: 79ff, 468-9); but expedients of this nature cause the theory to haemorrhage empirical content.

Let us therefore consider the case of *ungrammaticality*. The Siegel-Allen theory of affix ordering (which I rejected in §4.1) suggests the morphosyntactic bracketing in (38,a). In contrast, semantic scope favours (38,b), since *ungrammaticality* means 'property of being ungrammatical'.

(38) a. [$_N$ un [$_N$ [$_A$ grammatical] ity]]
b. [$_N$ [$_A$ un [$_A$ grammatical]] ity]

The correct structure is (38,b), as shown by considerations of subcategorization: the prefix *un-* does not attach productively to nouns, at least not with the relevant meaning. Sproat (1985: 25-33) provides a detailed critique of Allen's (1978) and Fabb's (1984) claims that denominal *un-* prefixation is productive. Some apparent exceptions, like the well-established word *unbelief*, could plausibly be analysed as diachronic back-formations from the corresponding adjectives (i.e. *unbelieving*). Other items formed by denominal *un-* prefixation appear to vary in their acceptability: for example, both *unproblem* and *unidiom* are attested on the World Wide Web but fail to occur in controlled corpora such as the BNC. Recently, Horn (2005) has argued that *un-* does in fact productively attach to nouns, but he crucially shows that the lexical semantics and pragmatics of the resulting words can be very different from the usual 'opposite' sense of *un-* in deadjectival items (e.g. *unhappy*) or the usual 'reverse' sense of *un-* in deverbal items (e.g. *unfasten*). In *ungrammaticality*, we do have the normal 'opposite' sense associated with *un-* in deadjectival derivation.

However, if the morphosyntactic constituent structure of *ungrammaticality* is that shown in (38,b), a serious phonological problem arises. The prefix *un-* is in the scope of the stem-level phonological cycle triggered by the suffix *-ity*. If so, what prevents the final consonant of the prefix from undergoing nasal place assimilation in this cycle, yielding *[ˌʌŋgɹəˌmætɪˈkæləɾɪ]? Observe that, at the stem level, nasal+plosive clusters are subject to obligatory assimilation within feet (Kiparsky 1979: 439-40), as shown by their behaviour both in tautomorphemic enviroments (e.g. ***conga*** ['kɒŋgə]) and across the boundary between an affix and a bound root (e.g. ***con-greg-ate*** ['kɒŋgɹɪˌgeɪt]).[29]

Baker's (2005: 16-17) theory of word-level affixation, illustrated in (21,b) above, offers a simple solution, drawing on insights from Aronoff & Sridhar (1983) and Booij & Lieber (1993). Since *un-* is a word-level prefix, it defines a stem-level domain all by itself. But we know independently that every English word-level prefix occupies a prosodic word (*ω*) by itself too (e.g. Booij & Rubach 1984: §4.1). We can therefore infer that this prosodic word is erected

[29] Obligatory stem-level assimilation should not be confused with gradient coarticulation or with the categorical but optional phrase-level process found in some dialects (Bermúdez-Otero & Trousdale 2012: 694-6).

over the prefix during its stem-level cycle. If this reasoning is correct, the phonological derivation of *ungrammaticality* runs as follows:

(39) *ungrammaticality*

domains		⟦WL ⟦SL ⟦SL ʌn⟧⟦SL gɹæmætɪkæl⟧ ɪtɪ⟧⟧
$\mathcal{P}_{SL}$	1st cycle	(ω 'ʌn), (ω gɹæ'mætɪkæl)
	2nd cycle	(ω' (ω ˌʌn)(ω gɹæˌmætɪ'kælɪtɪ))
$\mathcal{P}_{WL}$		(ω' (ω ˌʌn)(ω gɹəˌmætɪ'kælətɪ))

Crucially, the prosodic word erected over *un-* in its affix cycle protects the final consonant of the prefix from place assimilation in the cycle triggered by *-ity*, as /n/ and /g/ occupy different feet.[30]

Interestingly, Stratal Phonology offers an independent check on the validity of this solution. The prosodic word erected over *un-* in its affix cycle can survive in the cycle triggered by *-ity* only if preserved by a high-ranking faithfulness constraint in the stem-level phonology of English. Let us suppose that this constraint is IDENT-Head(***ω***), which requires that, if a foot heads a prosodic word in the input, it should also do so in the output. By the logic of Chung's Generalization, outlined in §2.3.3, this predicts that *ω*-headship must be lexically contrastive in English monomorphemic words. This proves correct: compare the regular prominence relationships in *bàrracúda* and *rèferéndum*, where the second foot heads the prosodic word, with the exceptional metrical pattern of *Ládefòged* and *périwìnkle* (Liberman & Prince 1977: 270, 308).

4.3. The division of labour between morphology and phonology

I conclude with a very small note on a very large topic. In the preceding sections we have seen that Stratal Phonology does not burden morphological theory with untenable assumptions: it can do its appointed job of deriving cyclic domains for phonological processes from morphosyntactic structure without having recourse either to level ordering or to rebracketing operations. More fundamentally, however, Stratal Phonology does presuppose the existence of a

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[30] *Pace* Newell (this volume), the nasal of the prefix *in-* undergoes place assimilation even across *ω*-boundaries (Wennerstrom 1993, Raffelsiefen 1999). This is shown by forms like *impolite* (ω' (ω ˌɪm)(pʰə'laɪt)), where [m] exhibits assimilation but [pʰ] must be foot-initial since it is aspirated; cf. *importune* (ω ˌɪmpə'tjuːn). This idiosyncrasy of *in-* is best analysed as reflecting underspecification: the nasal of /ɪN-/ is thus underlyingly different from that of /ʌn-/. It appears that /ɪN-/ has become a dual-level affix like *-able* (§3.2): it displays the prosodic behaviour of a stem-level prefix in root-based forms like *importune*, whereas it is prosodified in the same way as word-level *un-* in stem-based forms like *impolite*.

determinate boundary between morphology and phonology (Bermúdez-Otero 2012: 72; cf. Inkelas 2012: §4). This is because, in practical terms, to adopt the hypothesis of stratification is to assert that each pattern of exponence observed on the surface can be decomposed into a morphosyntactic and a phonological component (either or both of which may be vacuous). In turn, the morphosyntactic operations identified by such decomposition will fall into a small number of classes (known as 'levels' or 'strata') according to their phonological effects. If the theory of stratification summarized in (23) is correct, there are precisely three such classes.

Practising Stratal Phonology therefore requires robust and principled criteria for demarcating morphology from phonology. The best conceptual motivation for such a demarcation is to be sought in the principle of representational modularity (Jackendoff 1997: §2.6): morphology performs computations over morphs, whereas phonology performs computations over melodic and prosodic units. In this approach, morphology is bound by the Morph Integrity Hypothesis (Bermúdez-Otero 2012: 50): morphological operations may only select and insert exponents without altering their phonological content; 'process morphology' is banned. This conclusion is admittedly controversial: it is notably rejected in much work that otherwise shares key assumptions with Stratal Phonology (e.g. Anderson 1992, Inkelas 2012). Its great advantages, however, lie in its empirical content and heuristic power.

In line with the Morph Integrity Hypothesis, there is a long tradition of research that seeks to reduce apparently nonconcatenative exponence to the insertion of pieces of nonlinear phonological representation whose existence is independently motivated: e.g. floating features or feature-geometric treelets in the case of mutation, fully or partially bare prosodic nodes or prosodic treelets in the case of reduplication and subtraction. The general programme, pioneered by Lieber (1992: ch. 5) and Stonham (1994), is labelled Generalized Nonlinear Affixation in Bermúdez-Otero (2012: 53). Recent contributions to this line of research include Artés (2016), Bye and Svenonius (2012), Gribanova (2015), Iosad (2014), Köhnlein (2016: §5.1), van Oostendorp (2012), Roseano (2015), Saba Kirchner (2010, 2013), Spahr (2016), Trommer (2011, 2014, 2015), Trommer and Zimmermann (2014), Zdziebko (2015), and Zimmermann (2013a,b; 2016a,b), among others.

5. Summary

The roots of Stratal Phonology are ancient (§2.1), and its conceptual core, consisting of the principles of cyclicity (§2.2) and stratification (§2.3), displays remarkable stability; but the theory also continues to grow and develop around this core. A promising line of research seeks to increase the explanatory depth of Stratal Phonology by deducing previously established generalizations, like the noncyclic status of roots and the recursiveness of stem-level domains, from independent facts (§2.3.1, §2.3.3). We have also seen that the theory responds to the challenge of new observations like lexical conservatism (§3.2) not by reducing its empirical content, but by producing predictions like (30). Crucially, Stratal Phonology achieves these results without imposing unreasonable theoretical costs on morphology: it can thrive without

the Affix Ordering Generalization (§4.1) and without rebracketing operations (§4.2), and it has an intrinsic affinity for restrictive approaches to apparently nonconcatenative exponence like Generalized Nonlinear Affixation (§4.3). It is for these reasons that the stratal tradition continues to exert a claim on our attention.

6. Further reading suggestions

The classic exposition of rule-based Lexical Phonology is Kiparsky (1982b). Kaisse & Shaw (1985) provide a very accessible introduction. The relationship of the theory with Prosodic Phonology was elucidated by Booij & Rubach (1984); Bermúdez-Otero & Luís (2009) provide up-to-date discussion of this question. Booij & Rubach (1987) codified the canonical three-level version of the framework. By the early 1990s, however, rule-based Lexical Phonology was in crisis, largely as a results of problems raised by the principles that sought to regulate the application of rewrite rules at the stem level: this situation is documented in Hargus & Kaisse (1993).

The most influential early presentation of Stratal OT, focused on the problem of opacity, is Kiparsky (2000); a more recent review of the *état de la question* may be found in Kiparsky (2015b). Bermúdez-Otero (2010) provides a comprehensive and continuously updated survey of Stratal OT, with reading suggestions and links, but referring only to my own work. Defences of Stratal Phonology against OO-correspondence include Bermúdez-Otero (2011, forthcoming), Trommer (2013), and Kiparsky (forthcoming); see also (36) above. Bermúdez-Otero (2012) presents a stratal perspective on the division of labour between phonology, morphology, and the lexicon.

As noted in §1, Stratal Phonology has consequences for many issues: on nonconcatenative morphology in general, see Bermúdez-Otero (2012: §2.4.2); on mutation morphology in particular, see Trommer (2011); on reduplication in particular, see Kiparsky (2010); on allomorphic locality, see Bermúdez-Otero (2013a: §3, 2016); on the interface with phonetics, see Bermúdez-Otero (2015: §22.2.2, §22.2.4) and Ramsammy (this volume); on phonological acquisition, see Bermúdez-Otero (2003); on phonological variation, see Turton (2016); and on historical change and the life cycle of sound patterns, see Bermúdez-Otero (2015), Kiparsky (2015a), and Ramsammy (2015, this volume).

Analyses of extensive fragments of the phonology of a single language or of closely related languages provide a good way to appreciate the heuristic value and explanatory power of stratal models. Classics in rule-based Lexical Phonology include Rubach (1984, 1993). In Stratal OT, see Kiparsky (2003a,b) and Iosad (2016).

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