

English phonology and morphology

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1 Introduction

The title of this chapter poses a daunting challenge, since the morphophonology of present-day English is one of the most intensively studied areas in the whole of morphology and phonology. Indeed, as key innovations in phonological and morphological theory have been introduced, they have frequently been illustrated by means of case-studies from English: this is true not only for classical rule-based generative phonology (Chomsky & Halle, 1968; henceforth *SPE*), but more recently for connectionist and dual-route approaches to inflection (Rumelhart & McClelland, 1986; Pinker & Prince, 1988) and for output-output correspondence within Optimality Theory (OT) (Benua, 1995, 1997). It follows that we must define our aims somewhat narrowly.

First, then, this chapter focuses on interactions between phonology and morphology in present-day English and their implications for the shape of the morphology-phonology interface in natural language. Perforce, we disregard phonology-syntax interactions, although clearly some key facts and concepts in morphophonology have close phonosyntactic analogues. Our data are drawn from both British and American dialects, standard and vernacular, though obviously no variety is exhaustively described. We focus on facts that have figured prominently in the wider theoretical debate, but also pay some attention to phenomena that seem peculiar to English. Even the latter, however, underscore points of general relevance: as we shall see in section 3.5, for example, some of the idiosyncrasies of present-day English morphophonology are the product of historical contingencies; this illustrates how, when contending with the effects of diachrony, morphophonological theory routinely encounters historically conditioned facts that it can note but not explain.

From a theoretical viewpoint, we concentrate on major conceptions of the morphology-phonology interface, abstracting away from other dimensions of variation between theories. Wherever possible, therefore, our presentation is neutral between rule-based and constraint-based systems, with ‘rule’ simply meaning ‘symbolic generalization’ unless otherwise stated or required by context. We accordingly ignore the differences between rule-based Lexical

Phonology and Morphology (LPM: e.g. Kaisse & Shaw, 1985; Kiparsky, 1982b, 1985) and Stratal OT (Bermúdez-Otero, 1999, forthcoming; Kiparsky, 1998, 2000; Orgun, 1996), except where the choice of model has affected the demarcation of phonology, morphology, and the lexicon (section 2) or the application of concepts such as cyclicity and level segregation (section 3). The general aim of the chapter is to sift through the intricate debate (often highly esoteric and theory-internal) that surrounds English morphophonology and to identify key concepts and issues that deserve our continued attention, regardless of major shifts in the theoretical landscape.

2. The division of labour between phonology, morphology, and the lexicon

2.1 The problem

We have thus far identified our main concern as being the interaction of morphology and phonology in present-day English, but the problem can only be formulated if we can first distinguish between (i) computations performed in the phonology, (ii) computations performed in the morphology, and (iii) lexical storage.

Here, however, the spectrum of opinion is extraordinarily wide. *SPE* did not countenance an independent morphological module and envisaged lexical storage as maximally economical, with all alternations derived via phonological rules. On the other hand, in connectionist and so-called cognitive approaches (Rumelhart & McClelland, 1986; Bybee, 1995, 2001) the lexicon is highly concrete and massively redundant: all grammatical knowledge, whether phonological or morphological, is taken to inhere in the network of associations between items stored in long-term memory, so that, in effect, the lexicon *is* the grammar.

2.2 Testing the boundaries

Most practitioners would assume intermediate positions between these two extremes; but, again, this raises the difficulty of formulating explicit criteria for drawing boundaries between the phonology, morphology, and lexicon. The typical approach here has been to propose tests to identify genuine phonological rules. Below we review a number of these tests, although our list is not exhaustive.

- *SPE* allowed unlimited phonological opacity: such restrictions as it imposed emerged during acquisition from (relatively ill-defined) provisions in the evaluation measure. In contrast, [Bybee-]Hooper's (1976) True Generalization Condition requires genuine phonological rules to be *transparent*, and therefore not to be contradicted by surface evidence.

Although this work has been influential, the proposal seems too strong: more recent research usually acknowledges that phonological rules may be opaque, but proposes grammatical architectures that impose severe formal restrictions upon the complexity of phonological opacity effects, over and above learnability considerations (see e.g. Bermúdez-Otero, 2003, §2).

- Phonological *naturalness* has often been seen as a hallmark of genuine phonological rules, although ‘naturalness’ has variously been defined formally (e.g. genuine phonological rules operate over features, which define natural classes of segments, rather than random segment lists), or functionally (e.g. genuine phonological rules are phonetically grounded), or typologically. In OT, whether mono- or poly-stratal, naturalness is a key criterion, as every genuine phonological process must be the best solution to the problem posed by a given ranking of phonological markedness and faithfulness constraints. Definitions overlap here, since the notion of markedness in OT is intrinsically typological, but can be given both formal and functional readings, as in the recent controversy over the grounding of constraints (Bermúdez-Otero & Börjars, forthcoming; Hale & Reiss, 2000; Hayes, 1999a; Hayes *et al.*, 2004).
- In Kiparsky’s (1994, p.16) reading, Ford & Singh (1983) and Spencer (1991, §4.4) claim that all rules subject to *morphological conditioning* are morphological. A more nuanced version of this approach is advanced by Anderson (1992), who asserts that genuine phonological rules (as opposed to ‘word-formation’, i.e. morphological, rules) can be circumscribed to a morphologically defined domain, but cannot refer to specific morphemes or morphological/syntactic features. This claim is explicitly endorsed in Stratal OT by Orgun (1996) and, *modulo* alignment constraints, by Bermúdez-Otero (forthcoming, ch. 2). The cost of this strategy may be a proliferation of cophonologies, but see section 4 for some interesting applications of the concept of cophonology. Monostratal OT, in contrast, tacitly reverts to the *SPE* position that all morphological information is available to the phonology (see Bermúdez-Otero, forthcoming, ch. 2; Orgun & Inkelas, 2002, p. 116).
- Kiparsky (1994) asserts that morphological rules can be distinguished from phonological rules (both lexical and postlexical) by the cluster of *formal properties* in (1):

(1)

a. Phonological rules	b. Morphological rules
general manipulate single phonological units observe phonological locality conditions follow all morphological rules in the same cycle	item-specific manipulate phonologically arbitrary strings observe morphological locality conditions precede all phonological rules in the same cycle

The properties in (1a) are clearly related to the criteria of transparency and naturalness: any transparent phonological rule will *ipso facto* be general and follow all morphological operations in the same cycle, while any natural phonological rule will *ipso facto* manipulate nonarbitrary phonological constituents and observe phonological locality conditions. However, it should be clear that (1a) falls far short of requiring absolute transparency or naturalness. In consequence, Kiparsky's (1994) proposal can easily be adopted in post-*SPE* rule-based frameworks, where opacity is formally unlimited and naturalness criteria are defined formally rather than functionally; but it will not work in theories with strong transparency and naturalness requirements—including, interestingly, Kiparsky's own (1998, 2000) stratal version of OT.

- More recent work in Stratal OT seeks to derive the typical life-cycle of phonological rules (Harris, 1989; McMahon, 2000) from properties of the phonological learning algorithm. From this viewpoint, Bermúdez-Otero (2003, forthcoming) suggests that phonological alternations triggered by an *independent phonotactic requirement* are easier to acquire, and therefore more resistant to morphologization and lexicalization, than phonological alternations lacking in phonotactic motivation. The evidence of Berko's (1958) classic *wug* test supports this claim: Berko found that, by age five, children acquiring English know that the plural noun suffix is an alveolar fricative, i.e. /-S/; however, when selecting among its surface allomorphs, i.e. [-z ~ -s ~ -IZ], children perform best when the choice is phonotactically determined (e.g. [wʌg-z], [bɪk-s]), slightly worse when the choice requires knowledge of the underlying voice specification of the suffix (e.g. [lʌn-z], though *[lʌn-s] is phonotactically fine), and worst of all when there is competition between several potential repair strategies (e.g. [tæs-IZ] with epenthesis vs *[tæs] with coalescence).
- Finally, in their *dual-route approach to morphology* Pinker & Prince (1988) have produced detailed and fairly explicit criteria for distinguishing between lexical storage and morphological computation, at least for inflection. These criteria turn out to be relevant to the distinction between lexicon and phonology, although their applicability is limited. First, if a morphological item is (or can be) constructed online, the logic of the theory requires that all phonological alternations associated with that construction

should also be computable online. Thus, since the past tense and past participle suffix /-d/ is added to verb stems by a genuine morphological rule, it follows that the [-d ~ -t ~ -ɪd] alternation must also be generated by a (phonological) rule. As it happens, this rule is independently required to capture robust word-level phonotactic constraints, which provide further evidence for it. However, this argument does not work in the opposite direction: a phonological pattern may be enforced by a discrete symbolic generalization represented in the grammar even if it does not trigger alternations associated with regular morphological processes. An extreme case would be that of productive phonotactic patterns in isolating languages, which do not cause alternations but are shown to be grammatically active in, for instance, the nativization of loans (Yip, 1993, 1996).

2.3 Do the criteria converge?

If the theory of grammar is to have nontrivial empirical content, one should aim to draw the boundaries between phonology, morphology, and the lexicon by means of a set of logically independent but empirically convergent criteria. As we have seen, however, some of the criteria reviewed in the previous section are mutually incompatible: for example, if phonological rules must be typologically or phonetically natural, then the scope of phonological computation will be considerably narrower than if the status of an alternation depends only on its form and locality properties, as suggested by Kiparsky (1994). Finding a set of convergent criteria has in fact proved to be rather hard. In this section we shall illustrate these difficulties by considering the possible involvement of a phonological process of vowel shift in the alternations found in strong verbs (e.g. *eat~ate*) and in irregular weak verbs (e.g. *keep~kept*).

As is well-known, present-day English has a number of vowel alternations triggered by morphologically sensitive processes of shortening and lengthening (see e.g. *SPE*, pp. 178ff.; Myers, 1987). Their morphological conditioning is discussed in section 3 below.

- In stressed antepenultimate syllables followed by a stressless penult, long vowels are subject to so-called ‘trissyllabic shortening’: e.g. *sāne~sǎnity*, *serēne~serēnity*. This should be regarded as the result of trochaic shortening under final syllable extrametricality: i.e. (*sǎni*)<ty>, *se(rēni)*<ty> (Hayes, 1995, §6.1.5). Trochaic shortening also applies in penultimate syllables before the suffix *-ic*: e.g. *cyclōne~cyclōnic*, *Hellēne~Hellēnic* (see section 4 below).
- Long vowels undergo shortening in closed syllables, assuming word-final consonants to be extrasyllabic: e.g. *dēe*<p>~*děp*<th>, *fī*<ve>~*fifty*.

- Finally, short vowels undergo lengthening when immediately followed by CiV sequences: e.g. *comēdy~comēdian*, *harmōny~harmōnious*.

In *SPE*, the qualitative aspect of these alternations is handled by means of a rule of long vowel shift, which largely recapitulates traditional accounts of the diachronic evolution of long vowels in Early Modern English:

(2) <i>Long vowel shift in SPE</i>			
a.		<i>sane</i>	<i>sanity</i>
	UR	/æ:/	/æ:/
	Trisyllabic shortening	—	æ
	Long vowel shift	e:	—
b.		<i>cyclone</i>	<i>cyclonic</i>
	UR	/ɔ:/	/ɔ:/
	Trochaic shortening	—	ɔ
	Long vowel shift	o:	—
c.		<i>deep</i>	<i>depth</i>
	UR	/e:/	/e:/
	Closed syllable shortening	—	e
	Long vowel shift	i:	—
d.		<i>comedy</i>	<i>comedian</i>
	UR	/e/	/e/
	CiV lengthening	—	e:
	Long vowel shift	—	i:

Consider now the vowel alternations found in strong verbs such as *eat~ate*, *dig~dug*, and *fly~few*, extensively discussed in Halle & Mohanan (1985). Halle & Mohanan's analysis is ostensibly within LPM, but wears the restrictions inherent in the architecture of that model very lightly; in fact, it approximates in abstractness the *SPE* description on which it is based (see McMahon, 2000). Following the programmatic assumptions of *SPE*, Halle & Mohanan seek to derive these vowel alternations by rule, whilst positing the smallest possible number of rules and maximizing the application of each rule (i.e. its 'functional yield'). To achieve this end, Halle & Mohanan formulate a number of (essentially morphological) processes of ablaut, and allow their output to take a free ride on long vowel shift. The alternations are thus factored out into a morphological and a phonological component.

(3) *Strong verb alternations in Halle & Mohanan (1985)*

	<i>eat</i>	<i>ate</i>
UR	/e:/	/e:/
Lowering ablaut	—	æ:
Long vowel shift	i:	e:

Assume, however, that strong past tense and past participle forms are irregular and therefore stored in long-term memory, as convincingly argued in Pinker & Prince (1988) and related work. If so, it becomes unnecessary to divide vowel alternations such as *eat~ate* into a morphological and a phonological component. In consequence, even if one countenances a synchronic phonological rule of vowel shift (and this is a big ‘if’, on which see below), vowel shift will not need to be involved in strong verb morphology. Taking advantage of this result, McMahon (1990, 2000) replaces Halle & Mohanan’s single word-level rule of long vowel shift by two stem-level rules of long vowel shift and short vowel shift; these two rules apply only in derived environments created by the previous application of a shortening or lengthening rule (on the blocking of stem-level rules in nonderived environments, see section 3.3 below).

(4) *Vowel alternations in McMahon (1990)*

a.		<i>eat</i>	<i>ate</i>
	UR	/i:/	/e:/
	Long vowel shift	blocked	blocked
b.		<i>sane</i>	<i>sanity</i>
	UR	/e:/	/e:/
	Trisyllabic shortening	—	e
	Short vowel shift	—	æ
	Long vowel shift	blocked	—
c.		<i>comedy</i>	<i>comedian</i>
	UR	/e/	/e/
	CiV lengthening	—	e:
	Short vowel shift	blocked	—
	Long vowel shift	—	i:

By doing away with problematic free rides, McMahon’s analysis represents a clear improvement on Halle & Mohanan’s in terms of concreteness and learnability. Admittedly, Pinker & Prince’s approach to strong verb morphology does not necessarily prevent one from factoring out alternations such as *eat~ate* into a lexically listed part and a part derived by a free ride through an *SPE*-style word-level rule of long vowel shift; but it is hard to see why this should be a desirable option unless one is wedded to the

notions of maximal lexical economy and maximal rule utilization—in which case one would not accept the premises of Pinker & Prince’s model in the first place. In this example, therefore, a measure of convergence is achieved: applying Pinker & Prince’s dual-route model of morphology results in considerable gains in terms of the generality, transparency, and learnability of phonological rules.

Let us now turn to irregular weak verbs such as *keep~kept*, *sleep~slept*, *bite~bit*, or *light~lit*. As we saw above, the vowel alternations found in these verbs are not unique, but are replicated in many other constructions; in this sense, they fulfil Kiparsky’s generality criterion for genuine phonological processes (see (1)). By Pinker & Prince’s criteria, however, they are always associated with irregular (nondefault) morphology: e.g. *-t* against default *-d*, *-th* against default *-ness*. Therefore, if Pinker & Prince are right, then both *keep* and *kept* will have to be stored in long-term memory; the question is whether *kept* will be listed as /ki:p-t/ or as /kep-t/.

In the light of section 2.2, there are good *prima facie* arguments for handling the length component of the *keep~kept* alternation by means of a phonological rule of closed syllable shortening: this process is natural (and indeed phonetically grounded), largely transparent, and blind to morphology within its domain (on the notion of domain, see section 3.2 below). Closed syllable shortening is also required independently to handle robust phonotactic constraints on morphologically underived items. In turn, the qualitative dimension of the alternation could be analysed using McMahon’s (1990, 2000) stem-level rule of short vowel shift. In contrast with closed syllable shortening, however, short vowel shift is still somewhat problematic: e.g. it has no independent phonotactic motivation, involves Greek-letter variables (or, in OT terms, contrived versions of faithfulness), and has a messy penumbra of (un)gliding and (un)rounding rules.

In the case of the irregular weak verbs, therefore, we are confronted with an instance of nonconvergence between demarcation criteria. If the naturalness of closed syllable shortening persuades us to derive the alternating vowels from a single underlier, then we are also committed to computing the far less natural qualitative component of the alternation. But, paradoxically, this would imply that naturalness and transparency (which led us to consider closed syllable shortening as a plausible phonological rule in the first place) are not reliable criteria for distinguishing between lexicalized patterns and genuine phonological generalizations after all.

2.4 Cutting the Gordian knot

How, then, can one solve this impasse? There seem to be two possibilities.

First, we might propose that, at least at the highest grammatical level, phonological generalizations are not constrained by naturalness: they may be pure inductive generalizations, and therefore less markedness-driven than history-driven (in the sense that they simply encapsulate the synchronic

particular, the setup of the morphology-phonology interface must explain how morphological structures can cause phonological generalizations to misapply. Present-day English abounds in instances of such misapplication.

Underapplication is said to occur when a phonological process ρ fails to apply even though a morphological (or syntactic) construction m , or a phonological process triggered by m , creates the conditioning environment of ρ . In certain varieties of Northern Irish English, for example, the coronal noncontinuants /t, d, n, l/, usually realized as alveolar, become dental when followed by [r] or [ə:r] (Harris, 1989, p. 40). This process of dentalization applies normally when its structural description is met within a single morpheme (6a) or within a form derived by class-I suffixation (6b), but it fails when its conditioning environment is created by class-II suffixation (6c), compounding (6d), or syntactic concatenation (6e). For the terms ‘class I’ and ‘class II’, see Siegel (1974) and much subsequent work.

(6) *Dentalization (Northern Irish dialects)*

- a. [t̪]rain, [d̪]rain, ma[t̪]er, la[d̪]er, spa[n̪]er, pi[l̪]ar
- b. sani[t̪]ary, eleme[n̪t]ary
- c. shou[t]er, ru[n]er (agentive -er)
la[t]er, fi[n]er (comparative -er)
- d. foo[t]rest, su[n]roof
- e. goo[d] riddance, ca[l] Rose

The absence of dentalization in (6d) and (6e) can conceivably be explained in purely phonological terms; the process may simply be blocked by prosodic word boundaries: e.g. [ω[ωfoot][ωrest]], [φ[ωgood][ωriddance]]. In (6c), however, the cause of underapplication is clearly morphological.

Other phonological processes that underapply in the presence of class-II suffixes include trochaic shortening and closed syllable shortening, discussed in section 2.3: e.g. prov[əʊ]ke, prov[ɒ]c-ative, but prov[əʊ]k-ing-ness; d[i:]p, d[e]p-th, but d[i:]p-ness. However, Northern Irish dentalization is special in that it is a purely allophonic process, as the alveolar and dental realizations of the coronal noncontinuants are in complementary distribution; see section 3.3 for the theoretical implications of this fact.

In cases of overapplication, a phonological process ρ applies even though its conditioning environment is destroyed by a morphological (or syntactic) construction m , or by another phonological process triggered by m . In Canadian English, for example, the diphthongs /aɪ/ and /aʊ/ undergo raising to [əi] and [ʌʊ] when immediately followed within the same prosodic word by a voiceless obstruent that does not belong to a syllable with stronger stress (Chambers, 1973). Like Northern Irish dentalization, this process is allophonic, in that the surface distribution of the raised and unraised diphthongs is entirely predictable. As observed in Bermúdez-Otero (2003,

§5.1), however, Canadian raising underapplies in the presence of class-II suffixes: e.g. [aɪfʊl] *eyeful*; cf. [aɪfəl] *Eiffel (Tower)*, [nəɪtreɪt] *nitrate*. More famously, raising overapplies before a /t/ that becomes voiced through flapping (Joos, 1942):

- (7) *Canadian raising*
- | normal application | overapplication |
|------------------------|----------------------------------|
| a. [rəɪt] <i>write</i> | b. [rəɪrər] <i>writer</i> |
| | c. [rəɪr ɔudz] <i>write odes</i> |

In (7b) and (7c), the phonological environment created by, respectively, class-II suffixation and syntactic concatenation triggers flapping. By causing /t/ to become voiced, however, flapping removes the conditions for diphthong raising, which nonetheless applies; cf. (7a).

3.2 Domains, cycles, levels

Rule-based LPM and Stratal OT provide derivational (i.e. serial) accounts of morphologically induced misapplication. In both theories the design of the morphology-phonology (and syntax-phonology) interface is based upon three key concepts: domains, cycles, and levels.

Let us use the symbol \mathcal{P} to denote any phonological function associating a phonological input with its corresponding output representation. In rule-based theory, \mathcal{P} is defined by means of a battery of extrinsically ordered transformations; in OT, it consists of a pass through GEN and EVAL, i.e. $\mathcal{R}(x) = \text{EVAL}(\text{GEN}(x))$. A phonological domain can now be defined as the input to any single application of \mathcal{P} . In LPM and Stratal OT, it is assumed that the morphological and syntactic structure of a linguistic expression creates a nested hierarchy of phonological domains. Consequently, a single application of \mathcal{P} may take scope over a unit smaller than the utterance (e.g. a stem or a word). Domain structure, however, is usually taken to be impoverished in relation to morphological and syntactic structure: every phonological domain is associated with some morphological or syntactic construction, but not every morphological or syntactic construction creates a phonological domain (Bermúdez-Otero, forthcoming, ch. 2; though cf. Orgun, 1996). Within this domain structure, the phonological function \mathcal{P} applies cyclically from the smallest, most deeply embedded, to the largest, most inclusive domain. If, for example, an expression e has the domain structure $[[x][[y]z]]$, the claim is that $\mathcal{R}(e) = \mathcal{R}(\mathcal{R}(x), \mathcal{R}(\mathcal{R}(y), z))$.

In LPM and Stratal OT, however, the phonology of a language does not consist of a single function \mathcal{P} , but of a set of distinct functions $\{\mathcal{P}_1, \mathcal{P}_2, \dots, \mathcal{P}_n\}$, conventionally known as ‘levels’ or ‘strata’. Different grammatical

units (e.g. stems, words, phrases) create phonological domains of different types, each calling for the appropriate function (e.g. the stem-level, word-level, or phrase-level function). In present-day English it is generally acknowledged that three levels suffice to describe the relevant morphology-phonology and syntax-phonology interactions (Booij & Rubach, 1987, §5; Borowsky, 1993; but cf. Halle & Mohanan, 1985); we shall henceforth continue to designate these levels with the labels ‘stem level’, ‘word level’, and ‘phrase level’. Within the confines of the grammatical word, morphological operations may idiosyncratically create either stem-level or word-level domains: so-called class-I affixes trigger the application of the stem-level function, whereas class II-affixes invoke the word-level function. *Pace* Siegel (1974), the stem and word levels are not mutually ordered: word-level domains have been argued to occur inside stem-level domains (Aronoff & Sridhar, 1983; Fabb, 1988). In general, though, the classification of English word-formation processes as stem-level or word-level is uncontroversial (though see Giegerich, 1999). In contrast, section 3.3 below shows that the traditional stratal allocation of certain lexical (i.e. word-bound) phonological generalizations is untenable.

Given the grammatical resources just described, one can explain the underapplication of Northern Irish dentalization in (6c) as follows. Consider the phonological domain structure of *finer*, ignoring the phrase level:

$$(8) \quad [\text{word-level } [\text{stem-level } \text{faɪn}] \text{ə}^{\text{r}}]$$

In (8), the conditions for dentalization are not fulfilled within the stem-level domain, but only within the word-level domain created by the class-II comparative suffix *-er*. Suppose now that dentalization is a stem-level phonological process (see section 3.3 for further discussion). If so, it will not apply in the larger domain: in serial terms, the addition of the suffix counterfeeds dentalization.

Interestingly, stratification and cyclicity can account for instances of phonological misapplication that are not directly caused by morphological or syntactic operations. Consider, for example, the derivation of the word *mitre* in Canadian English:

(9)		<i>mitre</i>
	UR	/maɪtər/
	Raising	məɪtər
	Flapping	məɪrər

Here, flapping counterbleeds raising, just as in (7b) and (7c) above, even though the structural description of flapping is met within a single morpheme. Assume, however, that the morpheme MITRE can only occur legally as (part of) a morphologically well-formed word in a syntactically well-formed phrase—even if it is a phrase consisting of a single unaffixed word. If so, expressions

containing MITRE will always have the following phonological domain structure:

$$(10) \quad [\text{phrase-level } (\dots) [\text{word-level } (\dots) [\text{stem-level } \text{maɪtər}] (\dots)] (\dots)]$$

In section 3.1, however, we saw that raising is a stem-level process, since its domain excludes word-level (class-II) suffixes; flapping, in contrast, is phrase-level, as its environment can be created by syntactic concatenation (see (7c)). It therefore follows that /maɪtər/ must undergo raising in the stem cycle, followed by flapping in the phrase cycle. Thus, the stratal account of paradigmatic misapplication in (7b,c) also deals with the nonparadigmatic opacity effect in (9) without further stipulation.

In fact, the proponents of Stratal OT claim that all instances of opacity can be explained in this way: misapplication, they assert, always arises from the serial interaction between cycles (e.g. Bermúdez-Otero, 1999, 2003, forthcoming; Kiparsky, 1998, 2000). In this respect, Stratal OT is more falsifiable and typologically restrictive than rule-based LPM, which allows extrinsic rule ordering within cycles. If borne out by extensive empirical testing, this claim would therefore constitute a genuine explanatory advance. According to Bermúdez-Otero (2003, forthcoming), moreover, using cyclicity and stratification to account for both paradigmatic and nonparadigmatic opacity can enhance learnability. The acquisition procedure he proposes enables learners to use information from alternations in order to recognize departures from input-output identity in nonalternating items and to discover their correct underlying representation. In this view, alternations such as (11a) and (11b) alert English learners to the flapping of input /t/ and /d/ in (11c) and (11d), even though, in the latter, the flap does not alternate:

- (11)
- | | | | |
|----|---|----|---|
| a. | /raɪt ~ raɪt ɒdz/
[rəɪt ~ rəɪr ɒdz]
<i>write ~ write odes</i> | b. | /raɪd ~ raɪd ʌphɪl/
[raɪd ~ raɪr ʌphɪl]
<i>ride ~ ride uphill</i> |
| c. | /maɪtər/
[məɪrər]
<i>mitre</i> | d. | /spɑɪdər/
[spɑɪrər]
<i>spider</i> |

Incidentally, note that psycholinguistic evidence from repetition priming experiments supports the existence of abstract underlying representations such as /maɪtər/ and /spɑɪdər/ (Luce *et al.*, 1999).

3.3 What level?

In the preceding section we said that Northern Irish dentalization must be a stem-level process because its domain excludes word-level (class-II) affixes. In classical LPM, however, the rule has typically been assigned to the word level (e.g. Borowsky, 1993, pp. 209-10; but cf. Harris, 1989). This counterintuitive move is motivated by a desire to uphold the principle of Structure Preservation. Though the precise formulation of this condition on rule application has been hotly debated, the statement in (12) will suffice for our purposes (see e.g. Kiparsky, 1985, p. 92; Kaisse & Shaw, 1985, §2.4):

(12) *Structure Preservation*

The application of stem-level phonological rules must not violate morpheme structure constraints.

Here, the term ‘morpheme structure constraints’ refers to constraints on underlying representations. Rule-based LPM usually assumes some form of underspecification (typically, radical underspecification: e.g. Kiparsky, 1982a, b; Archangeli, 1988); though cf. McMahon (2000, ch. 5). Accordingly, predictable features are banned from underlying representations. The intent of (12), in this context, is to prevent stem-level phonological rules from generating underlyingly noncontrastive segments. In Northern Irish English, however, [t, d, n, l] and [t̪, d̪, n̪, l̪] are in perfect complementary distribution; as noted in section 3.1, the occurrence of the dental allophones is fully predictable. This means, however, that, if (12) is correct, dentalization cannot apply at the stem level. Thus, LPM faces a contradiction: the domain criterion and Structure Preservation assign Northern Irish dentalization to different levels.

There is good evidence, however, that the fault lies with Structure Preservation. First, the principle has never been successfully defined in formal terms. The statement in (12), for example, conflicts with Kiparsky’s (1982a, pp. 167-8; 1982b, §3.2) own solution of the Duplication Problem (Clayton, 1976), which arises over the fact that stem-level phonological rules often conspire to bring class-I derivatives in line with morpheme structure constraints. Kiparsky (1982a, b) suggested that morpheme structure constraints could be eliminated, since restrictions on nonderived lexical items could be captured by the stem-level rules applying in structure-building mode to radically underspecified underlying representations; but, paradoxically, the formulation of Structure Preservation in (12) seems to make crucial reference to morpheme structure constraints. There has also been disagreement as to whether or not feature spreading may evade Structure Preservation (e.g. MacFarland & Pierrehumbert, 1991; Kaisse & Hargus, 1994).

Secondly, if dentalization is assigned to the word level, then one must find some means of blocking its application before class-II suffixes, but all the expedients available for this purpose weaken the empirical content of LPM in

patently undesirable ways. One possibility would be to stipulate that the rule is blocked by morpheme boundaries (notated in rule-based LPM as ‘]’). As Harris (1989, note 2) observes, however, this solution undermines the principle that phonological generalizations do not refer to morphological information except insofar as their domain may be morphologically defined (see sections 2.2 and 3.2 above). More drastically, Borowsky (1993) prevents *all* word-level rules from applying across morpheme boundaries by ordering word-level phonology *before*, rather than *after*, word-level morphology. Empirically, however, this proposal finds counterexamples both in present-day English and in other languages: see section 3.5 below, though cf. Borowsky (1993, note 15). Theoretically, it subverts the very concept of domain laid out in section 3.2.

The obvious solution, then, is to abandon Structure Preservation and to assign Northern Irish dentalization to the stem level. But the case of dentalization is not unique: Canadian raising violates Structure Preservation in the intended sense too (see sections 3.1 and 3.2). Present-day English has a surprisingly wide array of allophonic processes whose application is restricted to stem-level domains; see Harris (1990) for an extensive list. In section 3.5 we return to this topic, as we reflect on why so much of present-day English phonology is transacted at the stem level.

From a theoretical viewpoint, it is interesting to note that the issue of Structure Preservation does not arise in Stratal OT. In accordance with the optimality-theoretic principle of Richness of the Base (see e.g. McCarthy 2002, §3.1.2), the theory does not permit language-particular restrictions to be directly imposed upon underlying representations. Rather, a phonological feature is underlyingly contrastive if a faithfulness constraint ranked high in the stem-level hierarchy shields it from the neutralizing pressure of markedness; otherwise, it is predictable (allophonic). Accordingly, stem-level rankings control the content of underlying representations (via Lexicon Optimization), and not the other way around (see Bermúdez-Otero, 1999, p. 124; Bermúdez-Otero, forthcoming, ch. 3).

There are clear advantages to relying on the evidence of domains as the sole criterion for assigning phonological generalizations to their respective levels. First, this enables one to maintain the highly restrictive approach to opacity outlined in section 3.2, whereby the relative ordering of phonological processes is entirely determined by the size of their domains. Secondly, a strict correlation between stratal ascription and domain of application aids learnability since, to determine whether a ranking r holds in the constraint hierarchy of level l , the learner need only consider whether r is true (applies normally) in l -domains; the constraint ranking algorithm need not include provisions to deal with morphologically induced misapplication (Bermúdez-Otero, 2003, forthcoming; cf. Hayes, 1999b, §8).

Classical LPM incorporates another principle of rule application that interferes with the establishment of a one-to-one correspondence between levels and domain types: the Strict Cycle Condition. There is a vast literature

on this principle (see e.g. Mascaró, 1976; Kiparsky, 1982a, p. 154), but, again, the statement in (13) will suffice for our purposes:

(13) *Strict Cycle Condition*

Stem-level rules can apply in structure-changing mode only to representations derived in the same cycle.

According to (13), a stem-level rule can change structure (e.g. replace or delete, rather than merely add, features) only in derived environments, i.e. only when the rule's structural description is met by virtue of the previous application of a morphological or phonological process in the same cycle. In other words, blocking in nonderived environments would be a property of stem-level phonological rules. The somewhat opaque label 'Strict Cycle Condition' refers to the classical assumption that the stem level is internally cyclic (for discussion of this idea, see section 3.4 below).

Together with Structure Preservation, the Strict Cycle Condition shaped the standard treatment of vowel shift in rule-based LPM. Vowel shift (*if* countenanced as a synchronic phonological phenomenon at all) should be stem-level, since all the vowel length processes that feed it, such as trochaic shortening and closed syllable shortening, are blind to word-level affixes (see section 2.3). Yet, ignoring the fact that vowel shift alternations are confined to stem-level domains, classical LPM analyses of English morphophonology place the vowel shift rule in the word level (e.g. Halle & Mohanan, 1985). This is motivated by the desire to retain an abstract *SPE*-style approach to the English vowel inventory, which requires nonderived lexical items to take a free ride on long vowel shift: since the Strict Cycle Condition bans free rides on stem-level rules, long vowel shift had to be assigned to the word level. As we saw in section 2.3, McMahon (2000, ch. 3) reconciles the Strict Cycle Condition with the domain criterion by formulating two derived-environment-only stem-level rules of long vowel shift and short vowel shift. Note, however, that Kiparsky (1993) gives up the Strict Cycle Condition on empirical grounds and treats blocking in nonderived environments as a property that may or may not hold for any rule at any level.

3.4 Is the stem level internally cyclic?

We have just seen that, in classical LPM, the stem level is assumed to be internally cyclic. In essence, this means that stem-level morphological operations generate a particularly rich phonological domain structure: *every* stem-level morphological construction—not just the *outermost*—constitutes a phonological domain.

- (14) *Stem-level phonological domain structure in originality*
- a. *if the stem level is internally noncyclic*
 [stem-level originality]
- b. *if the stem level is internally cyclic*
 [stem-level [stem-level [stem-level origin]al]ity]

In the case of English, this assumption is primarily motivated by stress-related facts, which were already adduced as evidence for the cycle in *SPE*. A good example is the misapplication of pretonic secondary stress assignment in class-I derivatives (see e.g. Hammond, 1989). The monomorphemic items in (15) show that English has ‘polar rhythm’ (van der Hulst, 1984): in a pretonic sequence of light syllables, secondary stress is assigned by building trochees from left to right, not from right to left. In words with three pretonic light syllables, this results in a characteristic dactylic sequence: $\acute{\sigma}\sigma$.

- (15) (**à**bra)ca(dábra)
 (**dè**li)ca(tésse)n
 (**pè**ri)pa(téti)c

In words derived by class-I suffixation, however, polar secondary stress often misapplies:

- (16) *(dìvi)si(bíli)ty di(vìsi)(bíli)ty cf. di(vísi)ble
 *(òri)gi(náli)ty o(rìgi)(náli)ty cf. o(rígi)nal
 *(Èli)za(bé)than E(líza)(bé)than cf. E(líza)beth

If the stem level is cyclic, the facts can be interpreted as showing that the primary stress assigned to the base in the inner cycle is preserved as secondary stress in the derivative during the outer cycle, blocking polar rhythm:

- (17) *domain structure* [[Elizabeth]an]
inner cycle E(líza)beth
outer cycle E(líza)(bé)than

Though apparently well-motivated, however, this postulate of classical LPM again distorts the correlation between levels and domain types. Consider, for example, the English phonotactic constraint that forbids clusters of nasal consonants in the coda. Its precise formulation need not concern us here; let us simply call it ‘nasal cluster simplification’. This constraint must clearly be active at the stem level, since it overapplies before word-level affixes: e.g. [dæmɪŋ] *damn-ing*, not *[dæm.nɪŋ]; cf. [dæm.neɪ.ʃn] *damn-ation*. However, if nasal cluster simplification applies cyclically at the stem level, we have a problem:

(18)

<i>domain structure</i>	[[dæmn]eɪʃn]	
<i>inner cycle</i>	dæm	by nasal cluster simplification
<i>outer cycle</i>	*dæmeɪʃn	

Note that it would do no good, either, to assume that the Strict Cycle Condition blocks nasal cluster simplification in the inner cycle, for in that case input [word-level [stem-level dæmn]ɪŋ] would incorrectly be realized as *[dæm.nɪŋ]. Unsurprisingly, Borowsky (1993, p. 202) assigns nasal cluster simplification to the word level, but at the same high cost as Northern Irish dentalization (see section 3.3). For their part, Halle & Mohanan (1985) set up an extra phonological level (level 2 in their system), which is internally noncyclic but precedes inflectional suffixation.

Interestingly, the problem disappears if one assumes that all stem-level outputs are listed in long-term memory (section 2.4), so that stem-level phonological rules essentially work like ‘lexical redundancy rules’ (Jackendoff, 1975): they express static phonotactic generalizations over stem-level domains, and they capture the relationship between stem-level derivatives and their bases in a purely redundant fashion. Let us assume, on this premise, that there are stored in the English lexicon the following three items: (i) a bound root /_{root} dæmn/, (ii) a free noun stem /_N dæm/, and (iii) a derived noun stem /_N dæmneɪʃn/. The relationship between /_{root} dæmn/ and /_N dæm/ will be redundantly captured by a stem-level morphological process of root-to-stem conversion, plus the stem-level phonological constraint of nasal cluster simplification, which encodes the fact that well-formed stems do not contain clusters of nasal consonants in the coda. Similarly, a stem-level morphological rule of *-ation* suffixation will redundantly express the relationship between /_{root} dæmn/ and /_N dæmneɪʃn/. The following question now arises: what prevents this suffixation rule from applying to the listed stem /_N dæm/, giving */_N dæm-eɪʃn/ → [_N dæmeɪʃn]? The answer is quite simple: blocking, i.e. the independently motivated principle whereby the existence of a listed lexical entry prevents word-formation processes from generating a competing form (see e.g. Aronoff & Anshen, 1998, §1.1). In this view, /_N dæmneɪʃn/ blocks */_N dæm-eɪʃn/ in the same way that *went* blocks **goed*. The absence of */_N dæm-eɪʃn/ is entirely contingent on the presence of /_N dæmneɪʃn/, for */_N dæm-eɪʃn/ violates no grammatical principle or rule other than blocking: the rule of *-ation* suffixation, for example, does not subcategorize for bound roots only (cf. e.g. *sum* ~ *summation*).

As suggested in Borowsky (1993: 220), listing all stem-level outputs provides a viable alternative to stratum-internal cyclicity as the explanation for the misapplication of secondary stress assignment in (16). Assume, first, that English lexical entries are allowed to contain metrical information. This assumption is clearly justified by stress contrasts such as *A(méri)ca* vs

ba(nána). Given Richness of the Base (see section 3.3), a Stratal OT analysis must preserve such underlying oppositions whilst simultaneously excluding impossible stress patterns such as **ci(tý)* or **(cítro)nella*. This could be done by setting up ranking (19) in the stem-level constraint hierarchy:

- (19) FTBIN, *LAPSE » MAX-FootHead » NONFIN
- a. FTBIN
Feet must be binary at some level of analysis (μ , σ).
 - b. *LAPSE
A prosodic word must not contain two adjacent unfooted syllables.
 - c. MAX-FootHead
The output correspondent of an input foot head must be a foot head.
 - d. NONFIN
The final syllable of a prosodic word must not be footed.

Tableau (20) illustrates the operation of this ranking; for the sake of simplicity, we only consider candidates where primary stress is realized on the rightmost foot. As desired, the constraint hierarchy preserves the underlying contrast between *A(méri)ca* and *ba(nána)*, but rules out hypothetical **ci(tý)* or **(cítro)nella*.

(20)

Stem Level		FTBIN	*LAPSE	MAX-FootHead	NONFIN
/ba(nána)/	(bána)na			*!	
	ba(nána) \rightarrow				*
/A(méri)ca/	(Áme)(ríca)			*!	*
	A(méri)ca \rightarrow				
/(cítro)nella/	(cítro)nella		*!		
	ci(tróne)lla			*!	
	cítro(nélla)		*!	*	*
	(cítro)(nélla) \rightarrow				*
/ci(tý)/	ci(tý)	*!			*
	(cítro) \rightarrow			*	*

There is therefore no obstacle to assuming that the noun *Elizabeth* is specified in its lexical entry as bearing stress on the antepenultimate syllable. Given input $/_{\mathcal{N}}E(líza)beth/$, the stem-level constraint hierarchy simply acts as a static checking device, redundantly expressing the well-formedness of its metrical structure. We can now turn to *Elizabéthan*. Since *ex hypothesi* the base *Elizabeth* is underlyingly stressed on the second syllable, one can just state that the position of the pretonic stress in the derived form is a consequence of faithfulness to input specifications overriding polar rhythm. In our rudimentary Stratal OT analysis we could simply posit the ranking MAX-FootHead » ALIGN($\omega, L; \Sigma, L$), whereby the preservation of underlying foot heads takes precedence over the preference for prosodic words that begin with a foot.

(21)

/E(líza)beth-an/	MAX-FootHead	ALIGN($\omega, L; \Sigma, L$)
(Èli)za(bé)than	*!	
E(líza)(bé)than \rightarrow		*

Of course, the logic of the analysis requires *Elizabéthan* itself to be stored in long-term memory: the stem-level stress rules (as well as the relevant word-formation processes) express its relatedness to *Elizabeth* in a static and redundant fashion. Strikingly, however, the assumption that polar rhythm can be overridden by underlyingly specified foot heads correctly predicts that, when so specified, monomorphemic items may exceptionally fail to show the expected initial dactyl: e.g. *apòtheósis*, *egàlitárian*, *Epàminóndas*, etc. Finally, the proposed account also predicts that stem-level morphological constructions can subcategorize for bases with certain stress profiles: the noun-forming suffix *-al*, for example, only attaches to end-stressed verbs, e.g. *remóv-al* but **depósit-al* (Marchand, 1969, pp. 236-7). This is a classic argument for the interleaving of morphology and phonology in the lexicon (e.g. Kaisse & Shaw, 1985, p. 18; cf. Odden, 1993); in the current approach, however, the stress profile of the base is simply visible in its underlying representation.

At this stage one begins to notice a remarkable consilience of results. Sections 3.2 and 3.3 showed that the falsifiability, restrictiveness, and learnability of stratified grammars improves dramatically when the stratal ascription of phonological processes is determined solely by domain size. In the pursuit of this goal, we were forced in section 3.3 to challenge the LPM principles of Structure Preservation and Strict Cyclicity, which turned out to be problematic for independent reasons. In this section, we have gone on to question the assumption that the stem level is internally cyclic, suggesting instead that stem-level phonological rules behave like lexical redundancy rules in the sense of Jackendoff (1975). In section 2.4, however, we saw that, by assuming stem-level outputs to be lexically listed, it is possible to decouple the quantitative and qualitative aspects of alternations such as *keep~kept*, and

thereby to uphold strong naturalness as a demarcation criterion for genuine phonological rules, as required by Stratal OT. These convergent results indicate that stratification and cyclicity remain fruitful tools for the analysis of the morphology-phonology (and syntax-phonology) interface, and that a more strict understanding of the notion of domain than previously adopted can lend new life to stratal-cyclic theories of grammar.

3.5 Why is the word-level phonology of English so permissive?

Sections 3.3 and 3.4 have shown that, in present-day English, several phonological generalizations traditionally thought to hold at the word level actually belong in the stem level; this includes allophonic rules such as Northern Irish dentalization and Canadian raising, as well as neutralizing processes such as nasal cluster simplification, trochaic shortening, closed syllable shortening, and (if phonological at all) vowel shift. In fact, English phonotactic constraints seem oddly lax at the word level, compared with the stem level. Burzio (2002) couches this observation in terms of output-output correspondence in OT (henceforth, OO-correspondence; see section 3.6 below). Markedness constraints, he observes, appear to be highly ranked for class-I forms, which are as a result forced to alternate with their bases: e.g. *óorigin* ~ *orígin-al*, *k[i:]p* ~ *k[e]p-t*, *eleme[nt]* ~ *eleme[n̩t]-ary*. In contrast, class-II forms seem compelled to violate markedness constraints in order to avoid alternations: there is thus no stress reassignment in *éffort-less-ness* (cf. *éffort*), no closed syllable shortening in *s[i:]p-ed* (cf. *s[i:]p*), no dentalization in *ru[n]-er* (cf. *ru[n]*).

Burzio takes both Stratal OT and standard implementations of OO-correspondence to task for not explaining this fact. Nonetheless, there are reasons to believe that it is not up to Universal Grammar to provide an explanation. First, the word-level phonology of English is not entirely inert: e.g. although the inflectional suffixes /-d/ and /-z/ do not trigger closed syllable shortening, they do undergo alternations driven by constraints against geminates and against clusters of obstruents that disagree in voicing. Secondly, word-level constraints are far more stringent in other languages. In Spanish, for example, there is a neutralizing stem-level process whereby stressed /we/ alternates with unstressed /o/: e.g. *buén-o* ‘good’ ~ *bon-dád* ‘goodness’. In present-day colloquial Spanish, the domain of this neutralization process excludes the superlative suffix *-ísim(o)*, which must therefore attach at the word level: *buén-o* ‘good’ ~ *buen-ísim-o* ‘best’. Unlike English word-level suffixes, however, *-ísim(o)* does affect the location of stress.

In fact, the idiosyncratic permissiveness of English word-level phonology seems to be a historical accident. There is, for example, a good diachronic explanation for the fact that present-day English assigns primary word-stress at the stem level. In OE, primary stress was assigned by aligning a moraic trochee with the *left* edge of the domain; in consequence, the OE

ancestors of present-day class-II suffixes (e.g. *-dom*, *-less*, *-ness*) were neutral with respect to primary stress. In Latin, however, the rules for primary stress targeted the *right* edge of their domain, which included derivational and inflectional material; as a result, the Latin and Romance ancestors of present-day class-I suffixes were stress-affecting. For this reason, when English learners reinterpreted stress assignment as proceeding from right to left, they had to exclude class-II suffixes from its domain; hence, the new stress rule was placed in the stem level with the class-I suffixes.

Similarly, the contrast between the stem-level inflectional ending /-t/, as in *dr[e]m-t*, and word-level /-d/, as in *s[i:]m-ed*, arose through a chronological fluke (see e.g. Lass 1992, pp. 125-30). Both suffixes originate in a Germanic ancestor that attached to the verb root by means of a thematic vowel. Present-day English /-t/ reflects tokens of this Germanic suffix in long-stemmed class-1 weak verbs, where the thematic vowel became subject to syncope already in prehistoric OE; the output of syncope then fed closed syllable shortening in IOE or eME: e.g. Gmc *ke:p-i-ð-a > OE ke:p-t-e > eME kep-t-ə ‘kept’. In contrast, present-day English /-d/ goes back to tokens of the same Gmc suffix in class-2 and short-stemmed class-1 weak verbs, which only lost the thematic vowel in IME, too late to undergo closed syllable shortening.

Finally, allophonic processes such as Northern Irish dentalization and Canadian raising have ended up in the stem level through analogical change. This fact is hardly surprising, for in their ordinary life-cycle phonological processes typically climb from lower to higher grammatical strata (e.g. Bermúdez-Otero, 1999, pp. 98-104; Bermúdez-Otero, forthcoming; Harris, 1989; McMahon, 2000, ch. 4).

3.6 OO-correspondence

So far, we have analysed morphologically induced misapplication in present-day English in terms of domains, cycles, and levels. In OT, however, OO-correspondence (Benua, 1997) has lately become an increasingly popular alternative. This theory posits the existence of constraints that require the output representation of a morphologically derived form to be identical with its correspondent in the output representation of the base. Stratal distinctions are handled by indexing OO-correspondence constraints to particular affix classes: in English, for example, class-I and class-II forms would be evaluated by OO_I- and OO_{II}-constraints, respectively.

As an illustration, consider again Northern Irish dentalization. In Benua’s (1997, §5.3.1) analysis, normal applications of dentalization are triggered by the following constraint hierarchy:

$$(22) \quad *ALV-RHOTIC \gg *DENT \gg IO-IDENT[\pm distributed]$$

The context-free constraint *DENT favours alveolar as the unmarked place of articulation for coronal noncontinuants; before rhotics, however, context-sensitive *ALV-RHOTIC requires dentals. To block dentalization in *ru[n]-er*, Benua ranks *ALV-RHOTIC below OO_{II}-IDENT[±distributed], which prevents any segment in a class-II derivative from disagreeing in distributedness with its correspondent in the base: cf. *ru[n]*. In contrast, *ALV-RHOTIC dominates OO_I-IDENT[±distributed], thereby forcing dentalization in class-I *eleme[n̩t]-ary*; cf. *eleme[nt]*.

(23)

		OO _{II} -IDENT[±distributed]	*ALV-RHOTIC	OO _I -IDENT[±distributed]	*DENT
<i>runner</i> base: <i>ru[n]</i>	<i>ru[n̩]er</i>	*!			*
	<i>ru[n]er</i> →		*		
<i>elementary</i> base: <i>eleme[nt]</i>	<i>eleme[n̩t]ary</i> →			*	*
	<i>eleme[nt]ary</i>		*!		

In this approach, the relative phonotactic laxity of the word level compared with the stem level is reflected in the high ranking of OO_{II}-constraints and the low ranking of OO_I-constraints (see section 3.5).

The theory of OO-correspondence has been severely criticized on both empirical and theoretical grounds (Orgun, 1996; Bermúdez-Otero, 1999; Kiparsky, 1998, 2000). Its opponents highlight problems in the selection of surface base-forms and adduce cases where there is no transparent output form that can act as the source of misapplication. In turn, the advocates of OO-correspondence have searched for instances of misapplication that resist analysis in terms of stratification and cyclicity. At first blush, the Withgott effect looks like a good candidate. In American English, flapping appears to overapply in derived forms such as *càpi[r]alistic* (from *cápi[r]al*); cf. words with the same stress profile such as derived *mìli[t]aristic* (from *mìli[t]àry*) and nonderived *Nàvra[t]ilóva* (Withgott, 1982). One could argue that *càpi[r]alistic* gets its flap through OO-correspondence with *cápi[r]al* (Steriade, 2000). For a stratal approach, in contrast, the facts may at first seem problematic: flapping is a phrase-level process and should therefore be blind to morphological

structure (see sections 3.1 and 3.2). As shown in Jensen (2000, pp. 208-11) and Bermúdez-Otero (forthcoming, ch. 2), however, flapping does not really overapply, but is simply sensitive to differences in foot structure: the underlying /t/ in *càpi/t/alístic* surfaces in foot-medial position, whereas it is foot-initial in *míli/t/arístic* and *Nàvra/t/ilóva* (see also Davis, 2005).

(24)	(cápi)l-istic	→	(càpita)(lístic)
			↓
			[ɾ]
cf.			
	(míli)(táry)-istic	→	(míli)(ta(rístic))
			↓
			[t]
	Navrati(lóva)	→	(Nàvra)(ti(lóva))
			↓
			[t]

It is thus foot construction, rather than flapping, that misapplies, but this is entirely expected, as foot construction takes place at the stem level (see sections 3.4 and 3.5).

4 The emergence of morphology

Up to now, we have managed to describe morphology-phonology interactions in present-day English without allowing the phonology access to any morphological information other than domain structure (see section 2.2). This approach, however, faces a severe challenge from instances of phonological nonuniformity among stem-level affixes, particularly in relation to stress assignment (Pater, 2000; Raffelsiefen, 1999; Zamma, 2002). Among class-I adjective-forming suffixes, for example, most render the final syllable extrametrical (25a), but *-ic* triggers mere consonant extrasyllabicity (25b):

- (25) a. (ómi)<nous>, o(rígi)<nal>, (tóle)<rant>
 b. a(tómi)<c>, Ger(máni)<c>, pro(phéti)<c>

One could handle the idiosyncratic behaviour of *-ic* by specifying its underlying representation with some *ad hoc* phonological diacritic, such as an empty vowel: i.e. /-ɪk∅/. However, this strategy for dealing with phonological nonuniformity is unlikely to succeed in the general case. Consider, for example, the opposition between suffixes inducing ‘weak retraction’ (e.g. adjectival *-oid*) and suffixes inducing ‘strong retraction’ (e.g. verbal *-ate*); see Liberman & Prince (1977, pp. 274-6). What underlying phonological property

- (28) *Trochaic shortening*
- | | | | |
|----|------------------------|---|---------------------------|
| a. | <i>In cophology A:</i> | A(měri)<ca>
sin(cěri)<ty>
(nātu)<ral> | cf. sincēre
cf. nāture |
| b. | <i>In cophology B:</i> | de(vělo)<p>
de(crěpi)<t>
cy(clōni)<c> | cf. cyclōne |

This follows automatically if the ranking for trochaic shortening (RHHRM » MAX- μ ; see Prince & Smolensky, 1993, pp. 59-60) is part of the master hierarchy.

5 Conclusion

Close analysis of the relationship between phonology, morphology, and the lexicon in present-day English continues to yield new insights into the nature and organization of grammars. Theories based on stratification and cyclicity dominated the field during the 1980s. Today, the stratal approach faces tough competition, but is still fostering new advances in our understanding of the morphology-phonology interface.

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