5 Lexical Phonology

In this chapter we will look at generative research into the relation between phonology and morphology. We will begin with evidence that phonological rules fall into two broad classes: one sensitive to the morphological and lexical environment and the other not. We will then note another criterion of lexical rules – sensitivity to derived contexts – and examine attempts to subsume this property under the notion of strict cyclicity. After a review of early work in generative morphology, we will see how phonology and morphology are integrated in Kiparsky's (1982a) Lexical Phonology model – the received generative interpretation of the relation between phonology and morphology. We will examine the model's basic concepts and claims and in the final sections turn to current issues and problems that confront the model.

5.1 Introduction

Since the inception of the scientific study of phonology, linguists have noted that phonological alternations and the rules that underlie them tend to fall into two broad classes. These classes are distinguished by several properties, which are listed in (1).

(1) a. relevance of lexical information
    b. distinctive nature of alternating sounds
    c. phonetic motivation for alternation

As illustration, let us compare two rules of English phonology: the flapping rule that converts intervocalic dental stops to a sonorant [D] (IPA [ɾ]) and the so-called trisyllabic laxing rule (TSL) that shortens a vowel when followed by two syllables. These rules differ with respect to each of the features listed in (1). First, the context in which the flapping rule applies can be stated in purely phonological terms as V́___V. The rule converts an intervocalic dental stop to a sonorant essentially without exception. It applies both morpheme-internally (2a) and when the V́___V context is interrupted by a morpheme boundary (2b). Flapping also applies at the phrasal level, where the following vowel is contributed by another word (2c).

(2)	a.	a[D]om	cf. atom-ic
	b.	mee[D]-ing	cf. meet
	c.	wha[D] is wrong?	cf. what

The flapping rule exhibits the two other features of (1) that often accompany such purely phonologically conditioned rules. The [D] that is the output of the rule is not a member of the underlying inventory of contrasting phonological segments in English. This sound arises only as a product of the flapping rule. For this reason English speakers are typically unaware of the sound substitution introduced by this rule. It takes phonetic training to realize that the [t]'s in *atom* and *atomic* are in fact different sounds. Finally, the sonorization of an intervocalic stop is a natural phonological process that is widely distributed through the languages of the world and can be viewed as an assimilation of the sonority of the adjacent vowels.

The TSL rule differs in each of these respects. Before developing this point, we need to assemble some background on this rule, which has played a prominent role in generative phonology. TSL is responsible for many of the vocalic alternations running through the phonology of English. Its precise statement is still a matter of some controversy. For purposes of discussion here, we will accept the formulation given by Kiparsky (1982a), listed in (3a); see section 10.9 for further discussion. This rule shortens a long vowel when followed by two syllables, the first of which is unaccented. (The latter restriction prevents application of the rule in *tītán-ic, Hēbrá-ic, Plātón-ic,* etc.) After TSL has applied, another rule known as Vowel Shift transforms the vowels that have escaped shortening in the manner indicated in (3b).

(3) a. $\bar{V} \rightarrow \check{V} / \_\_\_\_ C\ V_1\ C\ V_2$
(where V_1 is not stressed)

b. ī → aj
ē → ij
ǣ → ej

The rules in (3a,b) jointly account for the vowel alternations exemplified in (4a). (In dialects where long vowels are not diphthongized, the alternations take the form [ē] → [ī] and [ǣ] → [ē]; also, short [i] and [e] are realized as [−ATR] lax vowels [ɪ] and [ɛ].)

(4) a.

divīne	[aj]	divĭn-ity	[i]
serēne	[ij]	serĕn-ity	[e]
profǣne	[ej]	profæ̆n-ity	[æ]

b.

div[ī]ne	div[ī]n + ity	UR
inappl.	[i]	TSL
[aj]	inappl.	Vowel Shift

We will follow the analysis of these alternations developed in *SPE,* which assumes the underlying long vowels reflected in the orthography. The pair *divine-divinity* receives the derivations in (4b).

Additional suffixes whose attachment to a stem invokes TSL are listed in (5).

(5)			
	[-ify]	vīle	vĭl-ify
		clēar	clăr-ify
	[-ual]	rīte	rĭt-ual
		grāde	grăd-ual
	[-ize]	tȳrant	tȳrann-ize
		pēnal	pĕnal-ize
	[-ous]	tȳrant	tȳrann-ous
		fāble	făbul-ous

With this background, let us now consider the ways in which the TSL rule differs from the flapping rule. First, specification of the context in purely phonological terms as ____CVCV is not sufficient to characterize the precise range of application of the rule. There are a significant number of stems with a long tense vowel followed by two syllables. These V̄CVCV strings show no tendency to shorten the initial vowel (6a). Consequently, the rule is only conditioned by the addition of a suffix. Second, not all suffixes activate the rule. While [-ity] and [-ify] regularly initiate shortening, the suffixes in (6b) systematically fail to do so.

(6) a. nīghtingale, stēvedore, īvory
b. brāv-ery, mīght-ily, pīrat-ing

Finally, within the class of suffixes that trigger TSL, there are still idiosyncratic lexical exceptions: *obēsity* fails to undergo the rule and be pronounced as **obĕsity*. Consequently, precise delimitation of the extension of TSL requires information about the lexical and morphological environment in which the V̄CVCV string is located. By contrast, the domain of the flapping rule can be specified in purely phonological terms.

In addition, TSL differs from flapping in that it relates segments that occur as independent phonemes in English. The [ij]≈[ɛ] alternation of *serēne-serenity* relates phonological segments that contrast in such minimal pairs as *beat* vs. *bet*. English speakers have no difficulty in perceiving the sound substitutions effected by TSL in such pairs as *serene-serenity* even if they are not reflected in the orthography. This [ij] vs. [ɛ] difference is one to which proponents of orthographic reform are likely to appeal in order to justify a change in English spelling. It is noteworthy that the *t*'s in *atom-atomic* differ by just as many features as the *e*'s in *serene-serenity*. But few would argue that *atom* and *atomic* should be distinguished orthographically – precisely because this sound difference is below the threshold of consciousness for most speakers. Finally, given the formulation of TSL as in (3a), the environment of the rule is not a particularly natural one for vowel shortening (closed syllable, unstressed syllable, etc.).

The flapping and TSL rules thus contrast with respect to each of the properties of (1). Other rules often fail to display all three features. But this does not invalidate the classification. Rather, the features of (1) should be thought of as relations that constrain the range of properties any given phonological rule is likely to display. If a rule introduces allophones, then it typically lacks lexical conditioning and tends to be phonetically motivated. If a rule substitutes sounds in a

phonetically irrational way, then the terms of the alternation are usually elements of the underlying phonemic inventory, and the rule will quite likely display or develop lexical restrictions.

Let us consider another example in which the distinction between these two kinds of phonological rules is evident. Recall from section 2.7 the rule of Polish that raises [o] to [u] when followed by a word-final voiced nonnasal consonant (7b). This rule accounts for the alternations in (7a).

(7) a.

bup	bob-u	'bean'
xut	xod-u	'pace'
kot	kot-a	'cat'
vus	voz-u	'cart'
dzvon	dzvon-u	'bell'

b. [o] → [+high] / ___ [+cons, −nasal, +voiced] #

Polish raising displays many of the characteristics of English TSL. First, it has lexical exceptions: for example, *skrop* 'scratch' imper. from underlying [skrob] (cf. 1sg. *skrob'-e*). It also has some morphological conditioning. According to Bethin (1978), the rule applies much more often in feminine and neuter nouns than in masculines. The latter point is shown also by extension of the rule to loanwords: the feminines *doz-a* 'dose', *pagod-a* 'pagoda', *mod-a* 'fashion' show raising in the suffixless genitive plural: [dus], [pagut], [mut]. Bethin reports that there is no tendency to extend the rule to such masculines as [mop] 'mob', [snop] 'snob'. In contrast, the final devoicing rule is completely regular. Its context and extent of application do not require access to any lexical or morphological information. Second, Polish speakers are aware of the sound substitution effected by the raising rule since [o] and [u] are contrastive segments. In fact, this sound change is reflected in the orthography: the [u] derived from raising is spelled *ó*. The voicing change is essentially below the level of consciousness; it is not reflected in the orthography. It happens to be the case that each voiced obstruent phoneme in Polish is matched by a corresponding voiceless one. Consequently, the final devoicing rule has no opportunity to introduce allophones. It should be noted that the discussion here abstracts away from the effects of the phrasal context. When the following word begins with a voiced obstruent, the final obstruent of the preceding word will assimilate in voicing. This process may introduce allophones. For example, the voiceless fricative [x] lacks a voiced counterpart as an independent phoneme. But this gap fails to constrain the change of [x] to [ɣ]: for example, *Lech Wałęsa* is phonetically [. . .ɣ # v. . .]. Thus, when the proper conditions obtain, the rule(s) responsible for the voicing of word-final obstruents in Polish display the range of features predicted by the classification in (1). Finally, while final devoicing is one of the most common kinds of phonological rule, the raising of [o] to [u] before a voiced nonnasal consonant is an arbitrary and phonetically unmotivated sound substitution.

Thus, the Polish raising and devoicing rules classify with respect to the properties in (1) in essentially the same way as the English TSL and flapping rules do. However, the Polish data bring out an additional point. Recall that the raising rule must precede the devoicing rule. This ordering reflects the generalization

that lexically restricted rules typically precede rules of the second type. This is another important difference between the two rule classes that must be explained. Anticipating later discussion, we will refer to rules whose application is sensitive to the morphological or lexical context of the phonological string as *lexical* rules. The second class of rules is termed *postlexical*.

Let us continue developing the distinction between lexical and postlexical rules by looking at another example from Polish. Here we will rely on the discussion of Rubach (1984). Polish has a general rule palatalizing dental consonants such as [t,d,s,n,] to [ć,ʒ́,ś,ń] before suffixes beginning with front vowels, such as the loc.sg. [-e]. The data in (8a) illustrate.

(8) a.

nom.sg.	loc.sg.	
brat	bra[ć]e	'brother'
cud	cu[ʒ́]e	'miracle'
pas	pa[ś]e	'belt'
dzwon	dzwo[ń]e	'bell'

b. wtedy 'then', deptać 'tread', sejm 'parliament'

c. [ć]eń 'shade', [ʒ́]eń 'day', [ś]eń 'hallway', [ń]e 'no'

Polish also has a significant number of root morphemes containing substrings composed of a dental plus front vowel (8b). Rubach reports that there is no tendency to generalize the palatalization rule to these morpheme-internal strings. However, Polish also has a significantly larger number of stems containing a palatal plus front vowel sequence (8c).

The data in (8) pose a significant theoretical problem. Two analyses are possible. The morphemes in (8c) can be assigned underlying representations composed of a dental plus front vowel: [ten], [sen], and so on. If the palatalization rule is permitted to apply morpheme-internally as well as across a morpheme boundary, then these morphemes will be assigned surface representations with a palatal. On this analysis, the items in (8b) are treated as idiosyncratic exceptions to the palatalization rule. Alternatively, an analysis might be proposed in which the palatalization rule is restricted to *heteromorphemic* contexts: the focus of the rule (the dental consonants) is contributed by one morpheme, while the triggering context (front vowel) is contributed by a different morpheme. On this alternative analysis, the items in (8b) are not idiosyncratic exceptions. They are systematically excluded by virtue of the fact that their dental + front vowel substrings do not span a morpheme boundary. An important corollary of this alternative analysis is that the palatal consonants in (8c) must be part of the underlying representations. They cannot be derived by the palatalization rule, which is restricted to apply at the morpheme boundary.

The table in (9) summarizes the opposing analyses.

(9) analysis A

a. domain of palatalization rule is unrestricted

b. [ć]*eń* derives from underlying [t]*eń*

c. *wtedy* is an idiosyncratic exception to the palatalization rule

analysis B
a. domain of palatalization is restricted to heteromorphemic contexts
b. [ć]*eń* derives from underlying [ć]*eń*
c. *wtedy* is not an idiosyncratic exception to the palatalization rule

English TSL poses a similar analytic indeterminancy. If the rule is allowed to apply morpheme-internally, then words such as *elephant* and *pyramid* could be derived from underlying representations with a long vowel: [ēlephant], [pȳramid]. Forms such as *īvory* and *stēvedore* would have to be marked as lexical exceptions. But if TSL is restricted to heteromorphemic environments, then *elephant* must be derived from an underlying short vowel and *īvory* is not a lexical exception. In general, any lexical phonological rule allows these alternative analyses. An adequate theory of phonology will resolve the indeterminacy by imposing a consistent choice between the alternatives.

Rubach (1984) shows that the adaptation of loanwords in Polish strongly supports the second analysis, which restricts the rule to heteromorphemic contexts. In etymologically foreign words, a stem-final dental consonant regularly palatalizes before a front vowel suffix. The data in (10) are representative.

(10)				
	Fiat	'Fiat'	Fia[ć]-ik	dimin.
	Ford	'Ford'	For[ʒ́]-e	loc.sg.
	ras-a	'race'	ra[ś]-ista	'racist'
	dżentelmen	'gentleman'	dżentelme[ń]-i	pl.
	serwis	'auto service'	serwi[ś]-e	loc.sg.
	tez-a	'thesis'	te[ź]-e	loc.sg.

The important point is that the palatalization rule just as systematically fails to affect morpheme-internal dental + front vowel sequences. Note the unpalatalized dentals in *dżentelmen, serwis, teza*. This is a striking contrast. Why should the initial [s] in *serwis* fail to palatalize while the final one undergoes the rule? The contrast is exactly what we expect under analysis B of (9), which restricts palatalization to heteromorphemic dental + front vowel strings. It remains unexplained under analysis A, in which the rule applies in unrestricted, across-the-board fashion.

The Polish data suggest that the class of lexical rules is systematically restricted from applying to morpheme-internal strings. This is an additional criterion to distinguish lexical from postlexical rules: the latter apply without regard to the morphemic constituency of the phonological string. In the next section we will see that delimiting the domain of application of the lexical rules is actually a more complex matter than the tautomorphemic/heteromorphemic distinction found in Polish.

5.2 Derived Environment Rules

Kiparsky (1973a) discovered a class of lexical phonological rules whose application is sometimes extended to tautomorphemic strings and sometimes not. Let

us begin with an example from Finnish, which has a rule converting [t] to [s] before suffixal [i] (11a). This rule accounts for the alternation in (11b) but must be prevented from affecting the morpheme-internal [ti] strings in such lexical items as those in (11c).

(11) a. [t] → [s] / ____ [i]
b. halut-a 'to want', halus-i 'wanted'
c. tila 'room', äiti 'mother'

So far this is exactly the behavior we expect of lexical rules. What makes the Finnish example noteworthy is the existence of a class of morpheme-internal [ti] strings that, unlike those in (11c), do undergo the rule – and systematically so. These [ti] strings derive from underlying [te] sequences through another rule of Finnish that raises word-final [e]. This raising rule, which is stated in (12a), accounts for the alternations in (12b). (12c) cites stems that end in [te]. Observe that in the latter case both rules apply.

(12) a. [e] → [i] / ____ #

b.	joki	'river'	joke-na	essive sg.
	äiti	'mother'	äiti-nä	essive sg.
c.	vesi	'water'	vete-nä	essive sg.
	käsi	'hand'	käte-nä	essive sg.

Vesi must therefore be derived as shown in (13a).

(13) a. [vete] b. [äiti] UR
veti inappl. raising
vesi block *t* → *s*

But now there is a serious problem – namely, how to permit the *t* → *s* rule to apply to the [ti] sequence in (12c) but at the same time prevent it from affecting the morpheme-internal [ti] strings of the items in (11c). There is of course a systematic difference in the two classes of tautomorphemic [ti] strings: the ones in *tila* and *äiti* are present in the underlying representation, while the one in [veti] arises from the application of the raising rule to [vete]. The *t* → *s* rule blocks on underlying [ti] sequences but applies to derived ones.

In earlier chapters we have seen that rule ordering may sometimes be used to distinguish between underlying and derived strings. More specifically, ordering of rules is relevant to situations in which a given rule A applies to an underlying string [x] but fails to apply to an identical string [x] derived from another rule B. We simply order A before B. But in the present case rule ordering is of no avail. The *t* → *s* rule must apply to the output of raising and therefore is ordered later. Yet somehow the grammar must be constructed so that this rule applies to derived [ti] strings but blocks on underlying [ti] strings.

After the publication of Kiparsky 1973a, phonologists discovered a number of other cases of rules whose application is restricted to such "derived contexts."

The *ruki* rule of Sanskrit furnishes an additional example. This rule turns [s] to the retroflex [ṣ] after [r], velars, and high vowels. Following Kiparsky's discussion of the phenomenon, we will assume that the feature [+high] adequately characterizes the environment for this rule. The retroflexion rule applies quite regularly across morpheme boundaries. Suffixes beginning with [s] appear with an [ṣ] in the [r,u,k,i] environment.

(14)

[-si] 2sg.		[-sya] future	
da-dā-si	'you give'	kram-sya-ti	'he will go'
bi-bhar-ṣi	'you carry'	vak-ṣya-ti	'he will say'
[-s] aorist		**[-su] loc.pl.**	
a-yā-s-am	'I wanted'	senā-su	'armies'
a-bhār-ṣ-am	'I carried'	agni-ṣu	'fires'

There are a substantial number of lexical items with unretroflexed [s] appearing tautomorphemically in the ruki environment: *bisa* 'lotus', *busa* 'mist', *barsa* 'tip'. However, the retroflexion rule cannot be restricted to apply just across morpheme boundaries. When rules of ablaut modify the root vowel so as to create a ruki context morpheme-internally, the rule regularly applies. For example, the root *sās* 'instruct' ablauts to [i] in the participle, triggering retroflexion: *śiṣ-ṭa* 'taught'. Also, *ghas* 'eat' loses its vowel in the reduplicated [ga+ghas+anti], resulting in a [velar+s] cluster that undergoes retroflexion: *ja-kṣ-ati* 3pl. Thus, just as in Finnish, underlying [s] in a tautomorphemic ruki environment must be prevented from undergoing the rule, while derived tautomorphemic strings do undergo it.

Rules that block on underlying tautomorphemic strings but apply either (i) to strings that span a morpheme boundary or (ii) to tautomorphemic strings derived by a previous rule have become known as *derived environment rules*. They pose a serious theoretical problem. Somehow, the underlying [ti] string in Finnish *tila* 'room' and underlying [is] in Sanskrit *bisa* must be prevented from being inputs to the $t \rightarrow s$ and retroflexion rules. But at the same time, the [ti] string derived from Finnish raising and the [is] string derived from Sanskrit ablaut must be inputs to these same rules.

One possible solution to the problem is to allow the application of individual rules to be determined not only by the immediately preceding step in the derivation, but also by information contained in the underlying representation. For example, the Finnish $t \rightarrow s$ rule might be formulated so as to apply to a representation just in case it contains a [ti] string that does not derive from an underlying [ti] string. This *global* condition will block application to *äiti* 'mother' in (13b), since its [ti] string is underlying. But the rule will apply in the derivation of *vesi* 'water' in (13a), because the [ti] string that is input to the rule does not derive from an underlying [ti] string. While this proposal generates the correct outputs, it is theoretically undesirable. If the theory grants any individual rule the power to look back to the underlying representation, then the class of possible grammars is increased significantly. It would be preferable to impose a general condition that predicts when any given rule will block on tautomorphemic underlying strings (i.e., in nonderived contexts). If such a condition can be formulated, then the

class of grammars is not increased at all. In fact, it becomes internally more articulated.

At the time of Kiparsky's discovery and formulation of the problem (1973), many linguists were skeptical about whether such a general condition could be found (see discussion in Kenstowicz and Kisseberth 1977). For there are a significant number of situations in which phonological rules quite clearly do apply in nonderived contexts. Four types are listed in (15).

(15) a. allophonic rules (e.g., English aspiration [t^h]*eam*)
b. cyclic stress (e.g., English *América*)
c. context-free "absolute" neutralization (e.g., Yokuts lowering)
d. contextual neutralization (e.g., Chukchee [ŋ] assimilation)

In view of the fact that the rule types in (15) freely apply in nonderived contexts, the problem reduces to the following two questions. How do the Finnish $t \rightarrow s$ and the Sanskrit retroflexion rules differ from the rules in (15)? Does the purported difference provide a natural explanation for why the former rules block in nonderived contexts, while the latter do not (rather than the other way around, for example)?

Answering these two questions has turned out to be a very difficult problem. An early answer, given by Kiparsky (1973a), noted that the Finnish and Sanskrit rules are neutralization rules. Both [t] and [s] contrast before [i] as well as in many other contexts in Finnish; and both [s] and [ṣ] contrast after [i] as well as in other contexts in Sanskrit. Application of Finnish $t \rightarrow s$ to [tila] would produce **sila*. But since the [ti] string is morpheme-internal, no alternation will be produced and *sila* would naturally tend to be reanalyzed as [sila]. Thus, one might plausibly argue that the $t \rightarrow s$ rule blocks on underlying tautomorphemic [ti] strings, so that a greater range of underlying lexical contrasts surface phonetically. However, while this may be true, the rules in (15c,d) also neutralize underlying contrasts. Why isn't their application blocked morpheme-internally as well? Kiparsky noted that the rules in (15c,d) tend to be automatic rules with no lexical exceptions. Apparently, the Finnish $t \rightarrow s$ and Sanskrit retroflexion rules have exceptions. Thus, the existence of lexical exceptions might permit the two classes of neutralization rules to be distinguished. However, it is hard to see how this purported difference explains why neutralization rules with exceptions block in nonderived contexts while automatic rules do not. Why couldn't the two classes be reversed, so that it is the automatic rules that are restricted to nonderived contexts? As we will see, an answer to this question only emerged much later.

5.3 Strict Cyclicity

The next significant advance on the problem of derived environment rules was made by Mascaró (1976), who discovered reasons to believe that the restriction to derived contexts is a property of *cyclic* rules. Cyclic application refers to a situation in which the derivation proceeds in stages, through the repeated application of the same set of ordered rules to successively larger, more inclusive

strings. The derivation of a big string VWXYZ thus works in successive cycles, from the inside out, rather than in one single run through the rules. Given a string VWXYZ, first an inner substring X is submitted to the cyclic rules. They apply to derive VWX′YZ. The derivation then moves out to a more inclusive substring WX′Y. This substring WX′Y is submitted to the same set of cyclic rules. Their application yields a string X″. The resultant VX″Z is then cycled through the rules again until the outermost cycle comprehending the entire string has been processed. Of course, one assumes that the delimitation of the cyclic domains has some motivation independent of the phonology. A natural proposal is that the cyclic domains mirror the morphological structure of the word, such that each successive level of affixation defines a separate cycle. For example, for the word [origin + al + ity], the stem [origin] would constitute the first cyclic domain, [[origin]al] the second, and the entire word [[[origin]al]ity] the third.

Before considering how cyclic application is connected to the derived environment problem, we might ask if it makes any material difference whether or not phonological rules are applied cyclically. Often the result is the same as under noncyclic application. But there are situations in which the cyclic mode has empirical consequences. Sometimes application of a rule on an earlier cycle supplies information that is crucial to the proper application of another rule on a later cycle. The *SPE* analysis of English provides a classic example. According to *SPE,* some English dialects assign different stress contours to the words *compensation* and *condensation*. The second syllable of *comp*[ə]*nsation* bears no stress and so its vowel is reduced to schwa. But in these dialects, for some reason, vowel reduction blocks on the second syllable of *cond*[ɛ]*nsation*. The pronunciation **cond*[ə]*nsation* with a schwa is unacceptable. If the derivations start with [compensat + ion] and [condens + ation], it will be impossible to explain the contrast in the second syllables, since the words are virtually equivalent. However, the contrast finds a natural explanation in the observation that *cond*[ɛ]*nsation* derives from *condénse* while *comp*[ə]*nsation* derives from *cómpensàte*. If the stress rule is applied cyclically, as in (16), then *condensation* has a stress placed on its second syllable in an earlier cycle. This stress will then block vowel reduction. Since *compensate* assigns no stress to the medial syllable, vowel reduction may apply in this word. Later rules of stress neutralization may leave the medial vowel distinction as the only contrastive feature.

(16)

[condens]ation	[compensat]ion	
		first cycle
[condense]	[compensate]	
condénse	cómpensàte	stress
		second cycle
[condéns]ation	[cómpensàt]ion	
condènsátion	còmpensátion	stress
		later rules
———	còmpənsátion	vowel reduction
còndɛnsátion	———	stress neutralization

In sum, cyclic application of stress provides a natural basis for distinguishing the otherwise equivalent *compensation* and *condensation*.

Cyclic application also solves certain ordering paradoxes in which application of a given rule A must both precede and follow application of another rule B. Such a situation can arise when the rules apply in the order [A,B] on one cycle and then rule A applies over again on a subsequent cycle. To take a simple example, the paradigm for [bɛn] in (17) illustrates two rules of Catalan phonology.

(17) a.

mol	bɛn	3sg.
mol-s	bɛn-s	2sg.
mol-k	bɛŋ	1sg.
mul-íə	bən-íə	3sg. past
'grind'	'sell'	

b.

bint-é	'twentieth'
bin	'twenty'
bim pans	'twenty breads'
biŋ kaps	'twenty heads'

The first rule assimilates the point of articulation of the dental nasal to that of a following consonant. The second deletes a word-final stop after a nasal. In the derivation of [bɛŋ] from [bɛn + k], nasal assimilation clearly must precede cluster simplification. But the phrases *bim pans* and *biŋ kaps* show that nasal assimilation follows cluster simplification as well; for it is only by deletion of the final stop in [bint] 'twenty' that the dental nasal comes to immediately precede the initial stops of the following words.

Thus, nasal assimilation both precedes and follows cluster simplification. Such a state of affairs poses a significant problem for a theory in which the underlying representation is passed through the rules just once. But the paradox is solved if the nasal assimilation process applies on two separation cycles in Catalan: once on the word level and a second time on the phrasal level. The derivations in (18) illustrate the proposed solution.

(18)

[bɛn + k]	[bint] [kap + s]	
		first cycle
bɛŋ + k	bint ———	nasal assimilation
bɛŋ	bin ———	cluster simplification
	[bin] [kaps]	
		second cycle
	biŋ kaps	nasal assimilation

Having seen that cyclic application can sometimes be empirically detected, let us now return to the derived environment problem. Mascaró (1976) demonstrated that certain rules of Catalan are subject to an opacity constraint that can be explained if it is assumed (i) that the rules apply in a cycle and (ii) that they display the property of *strict cyclicity* (Chomsky 1973). He then showed that the derived

environment restriction could be subsumed under the independently needed strict cycle constraint. The rest of this section recapitulates his important result.

Three rules of Catalan phonology are relevant to the discussion. First, although stress falls on one of the last three syllables of the word in Catalan, which particular syllable bears the accent is, in general, unpredictable. Mascaró assumes that the stress is located in the underlying representation. Given this assumption, then a rule destressing a vowel before another stressed vowel is required, since any stem loses its stress whenever it is followed by a stressed affix. In general, only the rightmost underlying accent surfaces phonetically. A rule that removes a stress when followed by another stress accounts for this accentual limitation: Ý → V / ___ . . . Ý. Second, Catalan contrasts the seven vowels [i,u,e,o,ɛ,ɔ,a] in stressed syllables. However, in unstressed syllables [e,ɛ,a] reduce to schwa and [o,ɔ] reduce to [u]. As the forms in (19) show, the stress deletion rule feeds the reduction process. An underlying representation such as [nɔ́bl+ɛ́z+ə] first loses its initial stress to become [nɔbl+ɛ́z+ə], and then reduces to [nubl+ɛ́z+ə].

(19) nɔ́bl-ə 'noble'
nubl-ɛ́z-ə 'nobility'

The final rule relevant to the discussion devocalizes unstressed high vowels after a vowel. This rule is stated informally in (20a). Its application is illustrated in (20b), where the conjunction [i] 'and', the inflectional suffix [-u], and the adjectival suffix [-ik] devocalize postvocalically.

(20) a. [i,u] → [y,w] / V ___ (in unstressed syllable)

b.

sál i pá	'salt and bread'	pá y sál	'bread and salt'
fɛ́r̄-u	'iron'	dé-w	'God'
fɛ́r-ik	'ferrous'	əlžəbrá-yk	'algebraic'

Devocalization must precede destressing, because a postvocalic high vowel does not turn to a glide when it loses its stress. This is clear from the examples *rəim-ét* and *ruin-ós* in (21a).

(21) a.

rəím	'grape'	rəim-ɛ́t	dimin.
ruín-ə	'ruin'	ruin-ós	'ruinous'

b. [[ruín] ós]

	second cycle
inappl.	devocalization
ruin ós	destressing
inappl.	vowel reduction

The derivation of *ruin-ós* must be as shown in (21b). On the first cycle [ruín], no rules are applicable and so we pick up the derivation on the second cycle. If devocalization is ordered first, it (correctly) fails to apply since the postvocalic [i] is stressed. Subsequently, the stress on the stem is deleted by the destressing

rule. Vowel reduction is inapplicable, and *ruinós* is derived. If devocalization applied to the output of destressing, then [ruin]*ós* would incorrectly become disyllabic **ruynós*. We prevent this derivation by ordering devocalization first.

There are, however, some additional cases in Catalan where devocalization does apply to a vowel that has been destressed. The paradigms in (22a) illustrate this situation.

(22)	a.	óbr-ə	'opens'
		ínst-ə	'instates'
	b.	ubr-ír	'to open'
		inst-ár	'to instate'
	c.	à wbrír	'in order to open'
		nò ynstár	'not to instate'

The roots, shown in (22a), are [óbr] and [ínst]. In (22b) the stressed infinitival suffixes trigger loss of stem stress and vowel reduction. In (22c) the infinitives are preceded by *a* 'in order to' and the negative *no,* which devocalize the following vowel. (The vowels in these particles apparently retain some degree of prominence and thus fail to reduce. This is informally recorded with a grave accent: *à, nò*.) The derivations appear in (23).

(23)	[[óbr] ír]	[[ínst] ár]	
			second cycle
	inappl.	inappl.	devocalization
	obr ír	inst ár	destressing
	ubr ír	inappl.	reduction
	à [ubrír]	nò [instár]	
			third cycle
	à wbrír	nò ynstár	devocalization
	inappl.	inappl.	destressing
	inappl.	inappl.	reduction

The important point that emerges from the discussion so far is that devocalization applies to the output of destressing in (23). But this rule interaction fails to obtain in the derivation of *ruinós* in (21b). Here the [i] does not turn to [y] in spite of the fact that it has been destressed and is preceded by a vowel. Mascaró observed that this mysterious contrast finds a natural explanation if the rules are applied cyclically. In *nò* [ynstár], *nò* devocalizes a vowel [i] that has been destressed on a previous cycle. The third cycle thus starts with an unstressed [i]. But in *ruinós* of (21b), the [i] is still stressed at the point when the devocalization rule is reached on the next cycle. Consequently, devocalization cannot apply.

In order to maintain this attractive explanation, however, we must ask what happens to *ruinós* when another affix is added, forcing the [ui] string to go through the rules again. Will devocalization apply to the unstressed [i] at the start of the next cycle? The answer is evident from the superlative form *ruinuz-ízim* 'very

ruinous'. Devocalization does not apply. The disyllabic [ui] string established on the earlier cycle by ordering devocalization before destressing is carried through the subsequent cycles. Thus, devocalization must somehow be prohibited from returning to affect the material of an earlier cycle. Note, however, that the superlative suffix does trigger destressing and vowel reduction on the preceding stem. The derivation consequently must be as shown in (24).

(24) [ruinós] ísim

block	devocalization
ruinosísim	destressing
ruinusísim	reduction
ruinuzízim	other rules

The problem then is that we must block devocalization in (24) but still permit it to apply in derivation (23) of *nò ynstár* from *nò* [instár]. Mascaró pinpointed the relevant difference between the two cases. In the former, the [ui] string is completely contained within the bounds of an earlier cycle. But in the latter, the [òi] string straddles a cyclic boundary. The Catalan data indicate that information drawn exclusively from an earlier cycle constitutes an opaque domain to which rules applying on a later cycle are blind. This, in essence, is the strict cyclicity requirement that Chomsky (1973) argued to hold of the transformational cycle in syntax. The phonological version of the constraint can be formulated as shown in (25). (This formulation departs slightly from that of Mascaró 1976 and follows more closely the statement of the condition in Halle 1978.)

(25) Strict Cycle Condition (SCC)
A cyclic rule may apply to a string x just in case either of the following holds:

a. The rule makes crucial reference to information in the representation that spans the boundary between the current cycle and the preceding one.

b. The rule applies solely within the domain of the previous cycle but crucially refers to information supplied by a rule operating on the current cycle.

In essence, the SCC requires a cyclic rule to refer to a mixture of information – one portion drawn from the earlier cycle and the other contributed by the current cycle.

The SCC succeeds in explaining the intricate pattern of application and blocking of the Catalan devocalization and stress reduction rules. Some important theoretical consequences follow from the assumption that cyclic rules are subject to this condition. To begin with, the first rule to apply on any cycle must apply by case (a), since a rule can apply by case (b) only if some preceding rule has applied on the current cycle. But if the first application on any cycle goes by case (a), then it also follows that no cyclic rule may apply on the innermost cycle of a derivation – for lack of a cyclic boundary. This in turn implies that the underlying

representation of the root morpheme is an opaque domain. No cyclic rule may enter this domain directly, without the assistance of an affix.

It should now be apparent how the SCC draws precisely the same distinction between derived and nonderived contexts that is needed to block improper application of the Finnish $t \rightarrow s$ rule. If we suppose that $t \rightarrow s$ (and thus by implication the raising rule) is cyclic, then just the right patterns of application take place for *halus-i, vesi,* and *tila*. This point is illustrated in (26).

(26)

[halut] i	[vete]	[tila]	
			first cycle
——	——	—	raising
——	——	—	$t \rightarrow s$
			second cycle
——	veti	—	raising
halus i	vesi	—	$t \rightarrow s$

By the SCC, no cyclic rules may apply on the innermost root-level cycle. On the second cycle raising applies to [vete] since, we assume, the triggering word boundary lies outside the root [# [vete] #] and thus becomes visible only on the final word-level cycle. This application takes place in virtue of condition (a). The [+high] introduced by raising will trigger application of $t \rightarrow s$ by condition (b). *halus-i* is derived by condition (a) since it combines information that spans the boundary between the stem and the suffix. But the rule blocks on [tila], which satisfies neither condition of the SCC.

To summarize, Mascaró 1976 is an important contribution – for several reasons. The first is theoretical economy. The derived context restriction can be reduced to a condition on rule application (the SCC) that is independently needed for cyclic rules. The theory now admits two classes of rules: cyclic and noncyclic. On the conceptual level, it is natural to try to identify the cyclic-noncyclic classification with the lexical-postlexical distinction developed earlier. In this way, cyclicity becomes another trait of the lexical class of rules. Construing the derived context limitation in terms of strict cyclicity also endows the theory with sharper empirical consequences. We have seen that the cyclicity of a rule is sometimes independently detectable. The implication is that if a rule must be restricted to derived contexts, then it should also display cyclic characteristics; similarly, any cyclic rule will have to apply in derived contexts. In addition, if cyclicity is a function of the lexical-postlexical distinction, then a further prediction is made. The lexical-postlexical distinction traces a line through a language's set of phonological rules. Consequently, any rule A ordered before another rule B that is restricted to derived contexts must also be cyclic. And any rule ordered after a rule that does not respect strict cyclicity will have to be a postcyclic rule.

Tying the derived context problem to strict cyclicity in this way should thus make the validity of the overall theory easier to assess. However, some nagging problems still remain. Most striking is the fact that the English stress rule does not fall into place properly. *SPE* – and later Kiparsky (1979) – showed it to be a paradigm example of a cyclic rule; yet it apparently applies on the root cycle in *América*.

5.4 Morphological Preliminaries

Besides work on the derived environment problem, the other important line of research of the 1970s leading to the development of the Lexical Phonology model took place in morphology. In this section we will review some of the highlights of this research. In its initial stages, generative grammar did not develop a distinct theory of morphology and instead tended to adopt, essentially by default, the assumptions underlying the morphological theory and analysis of the earlier structuralist period – in particular, the conception of the morpheme as a minimal meaningful element.

Aronoff 1976 represents the first serious generative attempt to deal with morphology on its own terms. Two of Aronoff's most significant results relate to the nature of morphemes and to constraints on morpheme concatenation. First, he shows that while the *morpheme* is the minimal unit in word structure, it need not have any constant meaning or indeed any meaning at all. For example, morphological analysis of paradigms such as [permit, remit, commit], [perceive, receive, conceive] isolates the prefixes [per-, re-, con-] and the roots [mit] and [ceive]. Even though no constant semantic value can be assigned to these elements, the grammar nevertheless analyzes them as distinct units. This is evident from various allomorphy rules. For example, the morpheme [mit] has the alternant [mis] before the suffix [-ive]: *permissive, remissive,* and so on. This rule does not apply to just any [mit] string – in fact, it applies only to those that comprise the root [mit] (cf. *vomit, *vomissive*). Consequently, [mit] must be a linguistic unit even if it has no consistent semantic value independent of the particular word in which it occurs.

Aronoff also discusses the notion of *morphological blocking*. In general, lexical items can be located in an abstract morphological space or grid. The same sector is often occupied by items that are the product of distinct *word formation rules* (WFRs). The term "blocking" refers to the fact that the output of a more idiosyncratic, less productive WFR often preempts or blocks application of a more general and productive rule. For example, the regular rule for forming the English past tense suffixes [-ed]: *compute, computed*. The past tense is also formed by less productive rules of ablaut (*sing, sang*) or by suppletion (*be, was*). These less productive formations block the creation of **sing-ed* and **be-ed*. To cite one more example, the productive rule for constructing agentive nouns suffixes [-er]: *compute, computer*. Less productive are the WFRs that add [-ant] (*inhabit, inhabitant*) or that form the agentive directly from the verb by so-called zero derivation (*to guide, a guide*). The less productive rules occupy the lexical building site first, blocking the construction of **inhabiter, *a guider*. (*Guider* is a possible word; but like *cooker,* it is restricted to inanimate denotees.)

Another finding of the early generative morphologists was that the *SPE* distinction between primary and secondary affixes crucial for the proper operation of several phonological rules in English is also crucial to the morphology. English affixes fall into two classes with respect to their effect on stress placement and vowel length. The syllables comprising such primary affixes as [-al] and [-ous] are counted in the computation of antepenultimate position (27a). But secondary affixes such as [-ship, -less] have no effect on the location of the accent (27b). The same distinction also applies to the rule of trisyllabic laxing. Affixes drawn

from the former class may trigger a shortening of the root vowel, but those from the latter class never do (27c,d).

(27)

a.	pýramid	[pyrámid]al
	hómonym	[homónym]ous
b.	pártisan	[pártisan]ship
		*[partísan]ship
c.	nātion	[nătion]al
	ōmen	[ŏmin]ous
d.	sēaman	[sēaman]ship
		*[sĕaman]ship
e.	in[potent]	im[potent]
	un[popular]	*um[popular]
	in[legal]	il[legal]
	un[lawful]	*ul[lawful]

A similar distinction shows up among prefixes (27e). The negative [in-] may, at least sometimes, count for stress while the negative [un-] never does. Correlated with this contrast is the fact that the nasal of [in-] assimilates to a following consonant while that of [un-] does not.

Three generalizations emerging from the study of English word structure also distinguish between primary and secondary affixes. First, primary affixes may be added to bound morphs such as [ept], [ert], [leg]: *in*[ept], *in*[ert], [leg]*al,* [curi]*ous*. But secondary ones may not: **un*[ept], *[leg]*ness,* *[curi]*less*. (There are a few isolated exceptions such as *unkempt*.) Second, as the terms primary and secondary suggest, there appears to be an ordering among the affixes. A secondary affix such as [-ness] can, in general, be added to a base with a primary affix such as [-al]. From [parent]*al* we may form [parental]*ness*. But a primary affix may not be attached to a base that contains a secondary affix. This explains why *[[happy]ness]*al* sounds much worse than [parental]*ness*. Similarly, the secondary prefix [un-] may be added to *ir*[regular] (from *in*[regular]) to form *un*[ir[regular]]. But addition of primary [in-] to a base with a secondary affix yields ungrammatical results – the word *in*[un[regular]] is impossible. Finally, secondary affixes tend to have more coherent semantics. The meaning of *un*[credible] is more or less adequately described as "not capable of being believed." But *in*[credible] means much more, having an added, unpredictable dimension of "amazement."

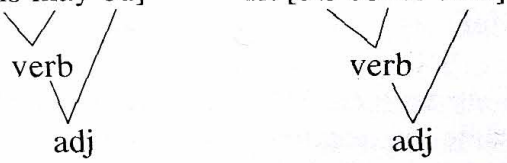
One more result is due to Siegel (1978), who observes that WFRs exhibit an *opacity* property similar to the subjacency property of syntactic transformational rules. Aronoff (1976) had noted that some WFRs are sensitive to lexical properties of the base such as whether or not it is drawn from the Latinate sector of the vocabulary. To take a simple example, [-ity] attaches to Latinate bases. This explains why *[weird]*ity* is odd while [equal]*ity* is not. The word [drink]able is composed of a Latinate affix and a non-Latinate root. Since [-ity] successfully attaches to this base ([drinkabil]*ity*), it appears that when the base contains conflicting [±Latinate] specifications, it is the one added on the preceding cycle that

determines the outcome. In other words, the [−Latinate] feature of the base [drink] is no longer visible when the [-ity] affixation rule applies. To take another example, the prefix [un-] does not in general attach to bases containing the prefix [dis-]; this restriction must be built into the *un*-prefixation rule.

(28) *un[dis[sonant]] *un[dis[tinct]]
*un[dis[loyal]] *un[dis[honest]]

However, it then is mysterious why such words as *undismayed* and *undiscoverable* are completely well formed. As Siegel points out, the mystery vanishes once the internal structure of the bases [dismayed] and [discoverable] is taken into account. They derive from [dismay]*ed* and [discover]*able*. The [dis-] prefix is added on a cycle prior to the one that immediately precedes attachment of [un-].

(29) un[dis may ed] un [dis cover able]



The information that the bases [dis[may]]*ed* and [dis[cover]]*able* contain the prefix [dis-] thus appears to be inaccessible to the *un*-prefixation rule. This result follows if information only from the immediately preceding cycle is available to the WFRs. Then, when the *un*-prefixation rule becomes applicable, it will be able to analyze the adjectives *dismayed* and *discoverable* into just the two immediate constituents [dismay]*ed* and [discover]*able*.

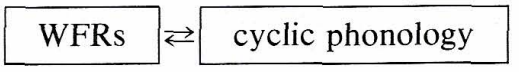
One mechanical way to implement the opacity restriction is to suppress the internal bracketing at the end of a given cycle. To illustrate, *undiscovered* and **undisloyal* would be derived as in (30).

(30) cover → dis[cover] loyal → dis[loyal]
dis[cover] → [dis[cover]]ed dis[loyal] → *un[dis[loyal]]
[discover]ed → un[[discover]ed]

In the transition from the second to the third step, the internal bracketing showing that *discovered* is composed of a complex stem containing a prefix [dis-] and a root [cover] is erased. Consequently, at the point where *un*-prefixation applies, the string [dis] of *discovered* has the same status as the three-phoneme sequence beginning *discotheque*. By contrast, the information that *disloyal* is composed of the prefix [dis-] and the root [loyal] is still accessible to the *un*-prefixation rule because these two morphemes have been concatenated on the immediately preceding cycle.

Pesetsky (1979) noted a serious problem with this *bracket erasure* proposal. The WFRs apply in the lexicon. Nevertheless, a record of the internal bracketing is crucial for the phonology, because it delimits the domains for the cyclic application of the phonological rules. Pesetsky proposed the following bold solution

to the problem: assume that the cyclic phonological rules apply inside the lexicon, after the application of each WFR, as depicted in (31).

(31) 

Several noteworthy consequences ensue from this proposal. First, the cyclicity of the phonological rules no longer has to be stipulated. It now follows from the decision to organize the grammar as depicted in (31). More importantly, we now have a partitioning of the phonological rules into two classes that follows from their location in the overall model of grammar. Kiparsky (1982a) showed that many of the differences between the two classes of rules begin to make sense when the grammar is organized in this fashion. In the next section we turn to this influential work.

5.5 Lexical Phonology

The research on the derived environment problem and the role of morphology in phonology was synthesized by Paul Kiparsky into the theory of Lexical Phonology. In two highly influential papers, Kiparsky (1982a, 1985) developed and articulated Pesetsky's proposal that phonological rules appear at two distinct points in the grammar: in the lexicon and in the postsyntactic, phonological component. Given these two locations, many of the long-noted differences between the two classes of phonological rules begin to make sense. If the lexical phonological rules apply after each WFR, then this class of rules is inherently cyclic. Their cyclic application does not have to be stipulated; it follows from the organization of the grammar. From the work of Mascaró (1976), we know that limitation to derived contexts follows, in turn, from strict cyclicity. Finally, since the lexical rules are interleaved with the WFRs, it is natural for them to have access to the lexical properties of a given word's immediate constituent morphemes. Postlexical rules, on the other hand, apply outside the lexicon to the output of the syntactic component. By virtue of their different location, they can be expected to display different properties. First, since they are postsyntactic, their application may take a word's phrasal environment into account. Lexical rules of course may never do so, since they appear in the presyntactic component. Second, the postlexical rules have no direct access to the lexical properties of the constituent morphemes composing a word. This information is closed off by the bracket erasure convention. This explains why the paradigm postlexical rules – phrasal and allophonic rules – typically are automatic and have no lexical exceptions. Finally, if cyclicity is a function of interleaving with the WFRs, then there is no reason to suppose that the postlexical rules are cyclic. They are consequently free to apply in across-the-board (ATB) fashion and hence are not restricted to derived contexts by strict cyclicity.

Kiparsky's proposal to draw the lexical-postlexical distinction in this way is theoretically very attractive – for several reasons. First, it comes to terms with the intuition, dating back to the beginning of the study of phonological structure,

that there are two different kinds of phonological rules – a distinction that was essentially denied by the earlier generative models. Second, it makes this distinction not by stipulation but rather by a specific proposal about the internal architecture of the grammar; furthermore, this proposal explains, at least in gross terms, why the two classes of rules display the specific properties they do. Third, the lexical-postlexical distinction helps to articulate and individuate the grammar; it thus accords with the modularity thesis that has become a methodological cornerstone of generative grammar. Finally, the Lexical Phonology model makes concrete predictions about how individual languages will have to look under this conception of the grammar. For these reasons, this model has become the focus for most generative research, both of a descriptive and of a theoretical nature, concerned with the relation of phonology to word structure.

In the following sections we will examine the basic concepts and principles of Lexical Phonology. We will also try to distinguish areas where there is basic agreement from those that are more unsettled.

5.5.1 The Model

Lexical Phonology develops the distinction between primary and secondary affixes noted by the early generative morphologists into a level-ordered morphology. The basic proposal is that the word formation rules (WFRs) and the lexical phonological rules can be partitioned into a series of *levels* or *strata*. Figure 5.1 illustrates Kiparsky's (1982a) conception of how the English lexicon is organized. Primary inflection includes the umlaut of *tooth-teeth,* the ablaut of *sing-sang,* and the past tense [-t] of *sleep*-[slep]*t* in addition to the primary derivational affixes in such items as [pyrámid]*al,* [ŏmen]*ous,* [dĕp]*th, im*[potent]. Secondary derivation is illustrated by the affixes in *un*[happy], [loneli]*ness,* [labor]*er*. The remaining inflection includes the regular plural in [cat]*s* and [brush]*es* and the past tense of [leap]*ed* and [pleat]*ed*. In this model, each level has the lexical phonological rules distinctive of that level. The morphological structure of a word is characterized by tracing its development through the paths indicated by the arrows. For example, the structure of *codifiers* is analyzed as follows. The word is composed of the base [cōde], which has been submitted to the lexical phonological rules of level 1 (stress being the only relevant rule to apply). Then the verbalizing WFR affixing *-ify* applies to yield the representation [cōd]*ify*. This representation is submitted to the phonological rules of level 1, where TSL applies to derive [cŏd]*ify*. The latter representation then enters level 2. No phonological rules are applicable, and the agentive suffix is added to give [cŏdifi]*er*. Finally, at level 3 the plural suffix is added to yield [codifier]*s*. It is apparent that this model defines a set of lexical items by a hierarchy of WFRs.

Two additional points should be noted about figure 5.1. First, any derivation proceeds through all the levels even if no relevant morphology applies at that level. Thus, the word *cat* is derived by submitting it to the lexical phonological rules of each of the three levels. Second, the output of each level is a *lexical item.* This is a technical term for Kiparsky; and as we will see, it plays a central role in the theory.

It should be clear that the model straightforwardly accounts for several generalizations about English word structure noted earlier. For example, the contrast

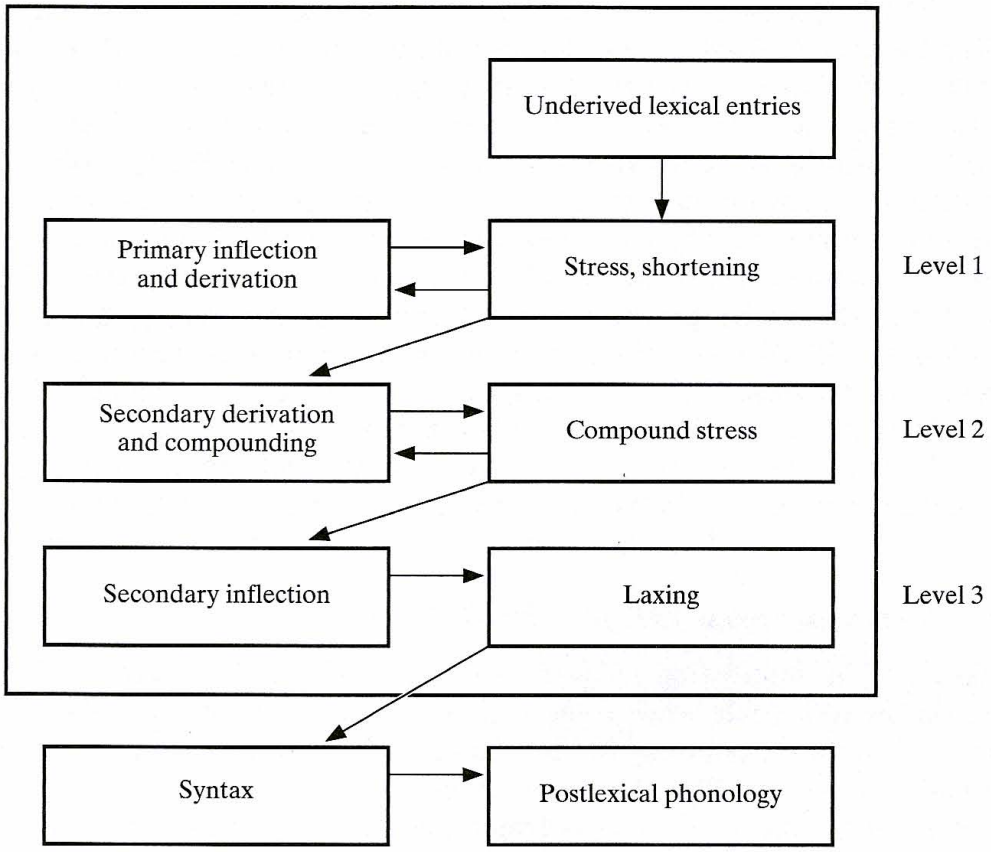


Figure 5.1 Lexical phonology in English.

between the relative well-formedness of *parentalness* and the marked deviance of **inunregular* can now be explained as follows. In the Lexical Phonology model, words are formed by the successive application of the WFRs. Prefixation and suffixation rules thus create successive layers of affixation. *Parentalness* arises from suffixation of *-al* to the base [parent] at level 1, followed by suffixation of *-ness* at level 2. **Inunregular* would have to arise from prefixation of *in-* to the base [unregular]. But the WFR prefixing *in-* applies at level 1, while the base [unregular] only arises at level 2. Since there is no provision to return to an earlier level in the model of figure 5.1, once [unregular] has been formed, the prefix *in-* cannot be attached. In this way, the generalization that primary affixes may not appear outside secondary affixes is captured.

Kiparsky also assumes that the output of each level is a full-fledged lexical item. If this assumption is granted, then we can explain why bound roots such as [ept] only appear with level 1 affixes: compare *in*[ept] with **un*[ept]. The latter can only be constructed by prefixing *un-* at level 2. Because the morphological levels are ordered, the bound morph [ept] must traverse level 1. But this will be impossible if the output of each level must be a full-fledged lexical item.

Another noteworthy feature of the model is that an underived base is passed through the level 1 phonological rules before any WFRs are applied. In many cases this step will be vacuous if application is blocked by the SCC. But recall that at least some rules such as stress assignment must be permitted to operate on the initial cycle. Since, in general, phonological rules may precede the appli-

cation of WFRs, it is possible for the latter to take into account information supplied by a phonological rule. A possible example is furnished by deverbal nominalizations in *-al*. This suffix attaches only to bases whose final syllable is accented: [acquít]*al*, [rebút]*al*, *[devélop]*al*. The requirement that the final syllable of the base be accented forms a clause in the [-al] WFR, thus blocking the construction of deviant items such as **develop-al*. This example is an important one for several reasons. First, it shows that phonological rules (in this case stress assignment) can apply prior to a WFR (*-al* suffixation). Such a state of affairs is impossible in the earlier generative models where all morphology takes place in the lexicon and all phonology in the postsyntactic component. Second, it is crucial that an underived base such as [acquit] be passed through the phonological rules of level 1 before any WFR applies so that it may pick up the stress required by the *-al* affixation rule. Finally, this example shows that the stress rule must be permitted to apply on the initial cycle and so must not be blocked by the SCC.

5.5.2 *Conjunctive versus Disjunctive Ordering*

Kiparsky has an interesting answer to the question of why stress assignment applies on the root cycle while rules such as trisyllabic laxing (TSL) are blocked by the SCC. Before examining his solution to this problem, we must consider an additional concept: the *Elsewhere Condition* (Kiparsky 1973b). It is a proposal to account for *disjunctive* relations between phonological rules. To this point, we have assumed that phonological rules apply *conjunctively*. If rule A applies to derive a representation [x], a subsequently ordered rule B must apply to [x] if [x] satisfies the structural description of rule B. The final output is thus the conjunction of the application of rules A and B. A disjunctive relation holds when either rule A or rule B, but not both, may apply. It typically arises when rule A applies to a certain subset of strings and rule B applies to the remainder as the "elsewhere" case. Let us look at a simplified example adapted from Kiparsky 1973b. In Sanskrit, word-final [s] assimilates the precise point of articulation of a following coronal consonant, becoming retroflex before a retroflex and palatal before a palatal (32a). Elsewhere, it turns to [h] (32b).

(32) a. s#t → st
s#ṣ → ṣṣ
s#ć → ść

b. s#m → hm
s#a → ha
s#pause → h pause

(33) a. $s \rightarrow [\alpha Fs] / \_\_\_\ \#\ \begin{bmatrix} +\text{coron} \\ \alpha Fs \end{bmatrix}$

b. $s \rightarrow h / \_\_\_\ \#\ \{\ \underset{[-\text{coron}]}{C},\ V, \text{pause}\}$

c. $s \rightarrow h / \_\_\_\ \#$

(33a) expresses the assimilation rule (where F is an ad hoc designation of the features for the retroflex and palatal points of articulation). One could express the $s \rightarrow h$ rule by enumerating the precise set of contexts that form the complement of the assimilation rule, as in (33b). However, this is a complex and unnatural rule. It should only be found in a language that also has a rule such as (33a) operating in the complementary set of contexts. There is thus a descriptive generalization about the relation between the rules that (33b) fails to express. The most natural statement of the $s \rightarrow h$ rule appears in (33c). Intuitively, the relation between the assimilation and aspiration rules is that [s] assimilates to a coronal and *elsewhere* turns to [h]. This relation can be expressed if it is the natural rules of (33a) and (33c) that appear in the grammar of Sanskrit. There is one problem with this description, however. The aspiration rule must be prevented from affecting a string that has undergone the assimilation rule – for example, the string *s#t*. In other words, the relation between assimilation and aspiration is disjunctive. Conjunctive application must be prevented, since otherwise underlying [s#t] will be incorrectly converted to [h#t].

The theoretical problem the Sanskrit data raise is to find a general way to predict when a disjunctive relation will be imposed between a pair of rules instead of the normal conjunctive relation under which both rules may apply. Kiparsky's (1982a) proposal is stated as (34), the *Elsewhere Condition*.

(34) Rules A and B in the same component apply disjunctively to a form θ if and only if

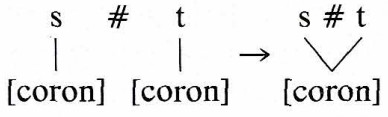
a. The structural description of A (the special rule) properly includes the structural description of B (the general rule).
b. The result of applying A to θ is distinct from the result of applying B to θ.

In that case A is applied first, and if it takes effect, then B is not applied.

A number of technicalities arise in applying this constraint to any given case. We will content ourselves here with understanding its basic intent. In essence, (34) claims that application of rule B will be suspended when the information defining the inputs to rule A subsumes all of the information defining inputs to B. This condition holds in the Sanskrit case. The assimilation rule applies to the class of strings denoted by its structural description [s#coronal consonant]. This expression clearly subsumes the information content of [s#] – the set of strings forming the elsewhere case. In general, the structural description of the elsewhere rule can be derived by cancelling out material from the structural description of the special rule (in our case, [+coronal, αFs]). The requirement that the structural changes of the rules be distinct means that the disjunctive relation will only be imposed when the feature changes of the two rules are contradictory or otherwise incompatible. For example, we would not want to impose disjunctive ordering on rules palatalizing obstruents after [i] and spirantizing obstruents after all vowels. The incompatibility requirement is also satisfied in the Sanskrit case because the aspiration rule defines a point of articulation that is distinct from the one

assigned by the assimilation rule. Thus, with the Elsewhere Condition available, the Sanskrit treatment of final [s] can be analyzed by the natural rules (33a,c).

Note that the Sanskrit data provide a compelling argument for disjunctive ordering only if assimilation is treated as feature changing. If assimilation arises from the spread of a feature (as argued in section 4.3), then an underlying [s#t] string will come to share the same [coronal] specification.

(35)


The aspiration rule can then be made sensitive to this formal property, applying to singly linked coronals and passing over multiply linked ones. Indeed, the failure of aspiration to apply to multiply linked structures may reflect a general constraint on rule application (as argued in section 8.4) and thus have nothing to do with a disjunctive relation between assimilation and aspiration.

Another possible example motivating disjunctive ordering is furnished by the TSL rule of English: *serēne, serĕn-ity; crīme, crĭm-inal.* As argued in section 10.9, we will assume that the rule is restricted to the stressed member of a disyllabic (trochaic) foot (36a).

(36) a. $\bar{V} \rightarrow \breve{V} / \underset{('\sigma}{\_\_\_} \underset{\sigma)}{C_0\ V}$

b.

Jordan	Jordān-ian
colony	colōn-ial
melody	melōd-ious

c. $\breve{V} \rightarrow \bar{V} / \underset{('\sigma}{\_\_\_} \underset{\sigma)}{C\ i\ V}$

A number of rules lengthen vowels in the same metrical context but under more restricted segmental conditions. One accounts for the alternations of (36b), lengthening nonhigh vowels when followed by an [i + V] string. The rule governing this alternation can be formulated as (36c) with the same stressed plus unstressed metrical conditioning. The shortening rule of (36a) represents the elsewhere case, while lengthening is a special rule applying to only a subset of the cases that meet the general metrical condition. A disjunctive relation must obviously be imposed on the rules since the lengthened vowels in (36b) escape shortening by (36a).

Having seen the motivation for the Elsewhere Condition, let us now turn to its role in the Lexical Phonology model. Kiparsky argues that the phenomenon of morphological blocking can be construed as a reflex of the Elsewhere Condition. For example, consider the two rules in (37) marking the English plural.

(37) a. pl → en / [X ___] (where X = ox, child, . . .)
b. pl → es / [X ___]

The structural description of (37a) clearly subsumes that of (37b). The former rule lists a particular set of lexical items. But in (37b) X is a variable standing for any noun and thus designates the elsewhere case. If the Elsewhere Condition applies in this case, then we explain why words with double marking of the plural such as **childrens* and **oxens* are ill formed. Application of the lexically restricted *-en* rule preempts the regular plural rule and thus blocks the construction of such doubly marked words. Kiparsky then observes that inherent plurals such as *people* and *cattle* work the same way as *children* and *oxen* do. These words are peculiar in a couple of respects. First, they are grammatically plural since they impose plural verbal agreement: *The people/cattle *is/are coming*. But they lack any overt morphology (i.e., an affix or an ablaut) and hence are not derived by any WFR from a singular base. They are thus underived lexical items that, unlike most nouns, happen to be plural instead of singular. Since these items are plural, it is now necessary to explain why the regular plural rule (37b) fails to apply and produce **peoples, *cattles*. These items are ill formed and the grammar must prevent their generation. But now there is a problem. We cannot evidently invoke the Elsewhere Condition since *people* and *cattle* are not the product of any WFR. Yet because they are inherent plurals, it seems entirely natural that the rule suffixing [-es] is suspended.

Kiparsky proposes to solve this puzzle by construing each lexical representation as an identity rule mapping the string into itself. To make this proposal more intuitive, one might suppose that a derivation is launched by making a copy of the lexical representation. This cloning thus maps every lexical item into itself.

(38) cattle pl → cattle pl

The "rule" in (38) will now invoke the Elsewhere Condition with respect to the regular plural rule in essentially the same way that the rule forming *ox-en* does. (In the context of this discussion, "rule" is understood as any licensed transition from one representation to the next in the derivation.) The information contained in *cattle* is clearly much richer and subsumes the information content of the plural rule (37b).

5.5.3 Strict Cyclicity and the Elsewhere Condition

Armed with the Elsewhere Condition and the construal of each lexical item as an identity rule, we can now return to the strict cyclicity problem. Kiparsky (1982a) notes that the two clauses defining a derived context (across cyclic boundaries and information derived on the same cycle) do not form a natural class conceptually. Rather, they appear to designate the complement of a more basic notion: the material contained in the underlying representation at the start of each cycle. Somehow, this material prevents the application of rules that would have the effect of altering its information content. But, Kiparsky reasons, this is analogous to the relation between (38) and the plural rule (37b). If each lexical item initiating a cycle is the product of an identity rule such as (38), then the Elsewhere Condition will suspend application of any rule that would change the information

content of the lexical item. In this way, the underlying representation itself prevents application of rules that will alter its content.

Let us see how this works by returning to the Finnish $t \rightarrow s$ rule. The rules are formulated in (39).

(39) a. $\begin{bmatrix} -\text{cons} \\ -\text{back} \end{bmatrix} \rightarrow [+\text{high}] \; / \; \_\_\_\_ \; \#$

b. $\begin{bmatrix} -\text{contin} \\ +\text{coron} \end{bmatrix} \rightarrow [+\text{contin}] \; / \; \_\_\_\_ \begin{bmatrix} -\text{cons} \\ +\text{high} \\ -\text{back} \end{bmatrix}$

c. [tila] → [tila]

First consider [tila]. It defines the identity rule in (39c). The structural description of this rule is much richer and subsumes the partial specification of the [ti] string that forms the structural description of the $t \rightarrow s$ rule (39b). Furthermore, and crucially, the structural changes of the two rules are inconsistent. The latter assigns [+continuant] and the identity rule assigns [−continuant]. Consequently, (39c) and (39b) fall under the Elsewhere Condition. The more specific rule (39c) thus preempts application of the more general $t \rightarrow s$ rule.

Now consider the two cases of derived contexts. Recall that [halut]*i* becomes [halus]*i*. The Elsewhere Condition will not apply in this case because the relevant identity rule [halut] → [halut] does not subsume the [ti] string in [halut]*i*. The suffixal [i] is left out. In general, any combination of information taken from separate cyclic domains will suffice to turn off the Elsewhere Condition, because the relevant identity rule will be unable to cover the material introduced on the current cycle.

Next consider the case of new information derived on the same cycle. Recall that Finnish #[vete]# becomes #[veti]# and then #[vesi]#. The first step involves material spanning the cyclic brackets (assuming that the word boundary # marks a separate domain) and so proceeds essentially just like [halut]*i*. This step assigns the feature [+high] to the final vowel. But this operation suffices to remove the stem from the control of the [vete] → [vete] identity rule. The [−high] feature on the final vowel of [vete] now fails to cover the [+high] assigned by the raising rule. The Elsewhere Condition is thus not invoked and the $t \rightarrow s$ rule may now enter inside the root. In general, any information change introduced by transboundary application drives a wedge into the root through which subsequent phonological rules may enter.

Finally, recall the remark that the output of any phonological cycle is a lexical item. As such, it may serve as the base for a subsequent WFR. Furthermore, being a lexical item, it defines an identity rule. This is crucial for a proper account of the strict cyclicity of Catalan [ruin]*ós*, derived from [ruín]*ós*. Given that [ruin]*ós* is a lexical item, the identity rule [ruin]*ós* → [ruin]*ós* is induced. This rule then blocks application of devocalization to the [ui] substring in [ruinus]*ísim* on the next cycle.

To summarize the discussion, we see that the Strict Cycle Condition is derivable from the Elsewhere Condition – a constraint that is needed anyway to characterize

disjunctive rule application. Finally, Kiparsky argues that if strict cyclicity is viewed as a function of the Elsewhere Condition, then we can make sense of the fact that stress rules may apply on the root cycle in apparent disregard of the Strict Cycle Condition. The stress rule operating in *América* does not alter the feature content of the underlying representation but rather supplements it by erecting a metrical structure. Stress is by and large predictable in English. Since stress is not utilized to encode the English lexicon, it will not trigger the Elsewhere Condition. This in turn permits the stress rule to apply on the initial cycle. But in a language such as Russian, where the accent unpredictably falls on any syllable of the morpheme, stress information must be present in the underlying representation. This in turn activates the Elsewhere Condition and blocks stress rules from applying on the initial cycle (Halle and Vergnaud 1987).

5.6 Structure Preservation

Another basic concept of Lexical Phonology is Structure Preservation. The idea runs as follows. Each grammar stipulates a set of underlying contrastive segments (the phonemic inventory). According to Structure Preservation, representations within the lexicon may only be composed of elements drawn from the phonemic inventory. The phonemic inventory thus constrains the kinds of phonological rules that may apply in the lexicon. If a rule introduces or refers to a noncontrastive segment, then, by Structure Preservation, that rule can only apply postlexically. To take a simple example, we know from chapter 2 that the flap in English is a predictable segment and thus not a phoneme. Structure Preservation requires the flapping rule to be postlexical. In a well-articulated model such as Lexical Phonology, this claim has consequences. For example, it allows us to explain why, although stress is assigned cyclically, we do not find [atóm]*ic* realized as *a*[D]*ómic*. The latter representation could arise if the flapping rule applied on the first cycle, giving *a*[D]*om*. The principle of Structure Preservation prohibits such a derivation because the flapping rule must be postlexical and hence cannot apply at level 1. Structure Preservation can also be argued to confer learnability advantages on the theory of Lexical Phonology. If one assumes that the phonemic inventory can be determined independently of the phonological rules, then it automatically follows that a rule will be postlexical if it either introduces or refers to an element not belonging to the set of contrastive segments. More generally, the Lexical Phonology model curtails (but does not completely eliminate) the need for extrinsic ordering statements; if the various criteria we have outlined distinguish a pair of rules as lexical versus postlexical, then their ordering need not be stipulated but rather follows from the overall architecture of the grammar.

Let us illustrate these points further by some material from Spanish (Harris 1983, Wong-opasi 1986). Within the vowel system of Spanish, there is a contrast between the mid vowels [e,o] and the diphthongs [ie,ue]. There is also a well-known alternation between diphthongs in accented syllables and corresponding mid vowels in unaccented syllables. We will follow Harris (1985b) in assuming that the diphthongs underlie this alternation and that they simplify by the rule in

(40b). (For the point to be made here, we could also derive the diphthongs from stressed mid vowels.)

(40) a.

inf.	bebér	perdér	contár	cosér
1sg.	bébo	piérdo	cuénto	cóso
	'drink'	'lose'	'count'	'sew'

b. [ie,ue] → [e,o] / in unaccented syllables

Spanish has compound nouns such as *hierbabuéna* and *cuentagótas* in (41) whose stress contour is the same as that of monomorphemic *Venezuéla* in containing just a single word accent on the penultimate syllable.

(41)

hiérba	'grass'	contár	'to count'
herbóso	'grass' adj.	cuénto	'I count'
hierbabuéna	'mint'	cuentagótas	'eyedropper'

The unaccented diphthongs in the initial member of the compounds can be explained if monophthongization (40b) applies at level 1 and the compounds are formed at a later stratum of the lexicon, where there is a rule suppressing the accent of the initial member of the compound. We thus postulate the derivation of (42) for *hierbabuéna*.

(42)

level 1	[hierb-a] [buen-a]	
	hiérb-a buén-a	penultimate accent
	inappl. inappl.	monophthongization
level 3	[[hiérba] + [buéna]]	compounding
	hierba buéna	deaccenting

The point of this discussion is the following. Since compounding is a lexical process, and since the [e]≈[ie] alternation in *hiérba* must be implemented before the compounding in *hierbabuéna,* it follows that the phonological rule responsible for the [e]≈[ie] alternation must be a lexical rule. This analysis is permitted by Structure Preservation, because as evidenced by such minimal pairs as *neto* 'net' and *nieto* 'grandson', both [e] and [ie] belong to the phonemic inventory of Spanish.

Another example of the role of Structure Preservation in Spanish is furnished by a rule depalatalizing the nasal [ñ] and the lateral [l^y]. (43a) contains paradigms built on the stems [desdeñ] and [doncel^y]. The final consonant of these bases is depalatalized when the stem is unaffixed by the general rule (43b) of Spanish that bars [ñ] and [l^y] from syllable codas (Harris 1983). Interestingly, the vowel-initial plural suffix [-es] fails to "restore" the palatals, in contrast to stem-forming suffixes such as the feminine [-a], the infinitival [-ar], or the derivational [-os].

(43) a.

desdeñ-ar	'to disdain'	doncel^y-a	'lass'
desdeñ-os-o	'disdainful'	doncel^y-a-s	'lasses'
desden	'disdain' noun	doncel	'lad'
desden-es	noun pl.	doncel-es	'lads'

b. [ñ,l^y] → [n,l] / in coda

These data are explained if the plural suffix [-es] is added at a later lexical stratum (level 2) and the depalatalization rule applies at this level. The [desdeñ] paradigm then receives the derivation in (44).

(44)	[desdeñ]	[desdeñ]	[desdeñ]	level 1
	des.deñ	des.deñ	des.deñ	syllabification
	[des.deñ]ar	———	———	WFR
	des.de.ñar	———	———	resyllabification
	[des.de.ñar]	[des.deñ]	[des.deñ]	level 2
	inappl.	des.den	des.den	depalatalization
			[des.den]es	WFR
	———	———	des.de.nes	syllabification

On the root cycle at level 1, syllabification puts [ñ] in the coda. But this segment will not change to [n] because the depalatalization rule only operates at level 2. Addition of a suffix such as [-ar] at level 1 prompts resyllabification of the [ñ] to syllable onset in [des.de.ñar]. Both this representation and [des.deñ] then enter level 2, at which point the depalatalization rule becomes applicable. It applies to [des.deñ] but fails to apply to [des.de.ñar] since the latter's nasal has been shifted to onset position by resyllabification at level 1. The representation [des.den] now serves as the base for the plural suffix, yielding [des.den.]*es*. Resyllabification produces [des.de.nes]. No further lexical rules of relevance are applicable and the representations [des.de.ñar], [des.den], and [des.de.nes] result.

The upshot of the above analysis (due to Harris (1983)) is that the depalatalization rule must apply at level 2 and hence must be a lexical rule. Structure Preservation requires that both the inputs [ñ,l^{y}] and the outputs [n,l] of depalatalization belong to the phonemic inventory. This requirement is met, as suggested by such minimal pairs as *cana* 'grey hair' vs. *caña* 'cane' and *polo* 'pole vs. *pollo* 'chicken'.

Let us now look at two cases where Structure Preservation blocks a rule from applying in the lexicon. Two of the best-known processes operating in Spanish dialects are an aspiration rule turning [s] to [h] and a velarization rule turning [n] to [ŋ] (Harris 1983). Both operate in syllable codas.

(45)	standard	dialectal	
	cantan	ca[ŋ]ta[ŋ]	'sing' 3pl.
	desden	de[h]den *or* de[h]de[ŋ]	'disdain'

The aspiration and velarization processes differ from monophthongization and depalatalization in that the [h] and [ŋ] segments introduced by these rules are not contrastive elements in most dialects. Rather, they arise only from these rules. Consequently, the principle of Structure Preservation bars these segments from the lexicon and predicts that they will only develop postlexically. One immediate consequence is that [h] and [ŋ] will not be introduced before the plural suffix [-es]. This prediction is confirmed by the paradigms in (46). When [-es] is suffixed at level 2, the final consonants of [mes] and [pan] resyllabify to onset position and thus escape postlexical aspiration and velarization.

(46)

standard	dialectical	
mes	me[h]	'month'
mes-es	mes-e[h]	'months'
pan	pa[ŋ]	'bread'
pan-es	pan-e[h]	'breads'

Since compounding is also a lexical process, we predict that stem-final [s] and [n] will be preserved by lexical resyllabification before a vowel-initial second member of the compound. Wong-opasi (1986) cites the paradigms in (47) that confirm this prediction.

(47)

mu[h]	'mouse'	pa[ŋ]	'bread'
mus-e[h]	'mice'	panikeso	'name of a dish'
mus-araña	'shrewmouse'	pa[ŋ][i] queso	'bread and cheese'

In *panikeso* the three morphemes are compounded lexically. Resyllabification applies to place the nasal in onset position, [pa.ni.ke.so], preempting postlexical velarization. Velarization does apply to the phrasal combination [paŋ] [i] [keso] and must precede application of resyllabification at the phrasal level.

5.7 Multistratal Rules

In Kiparsky's original exposition of the Lexical Phonology model (1982a), it was assumed that the rules applying at the various lexical levels form disjoint blocks. In a study of Malayalam, Mohanan (1982) posited a number of distinct lexical strata but found that a given phonological rule appears to apply in more than one lexical stratum. If the lexical rules form disjoint blocks, then it would be an accident that the same phonological process applies in several different strata of the same grammar. This rule overlap prompted Mohanan to propose that the phonological rules of the grammar constitute a single system, individual members of which may be assigned to a particular lexical stratum or to the postlexical component of the grammar. From the Lexical Phonology perspective, we may compare the lexical and postlexical applications of what appear to be the same rule. Since lexical applications are constrained by Structure Preservation while postlexical applications are not, the same phonological process may display different properties depending upon which module of the grammar (the lexicon or the syntax) the rule applies in.

As illustration, let us look at a Catalan example drawn from Kiparsky's (1985) discussion of this modularity. According to Kiparsky, Catalan has nasal phonemes at four distinct points of articulation: [m,n,ñ,ŋ]. A number of additional nasals are produced by a postlexical rule that assimilates [n] to the precise point of articulation of the following consonant.

(48)	unassimilated alveolar	so[n] amics	'they are friends'
	bilabial	so[m] pocs	'they are few'
	labiodental	so[ɱ] felicos	'they are happy'
	dental	so[n̪] dos	'they are two'
	alveolar	so[n] sincers	'they are sincere'
	postalveolar	so[n̠]rics	'they are rich'
	palatal	so[ñ] [l^{y}]iures	'they are free'
	velar	so[ŋ] grans	'they are big'

The feature [distributed] that differentiates between the bilabial and labiodental and between the dental and alveolar points of articulation is predictable in Catalan and hence is barred from the lexicon by Structure Preservation. The [+continuant] labiodental [f] is [+distributed], while the [−continuant] nasal [m] and stops [p,b] are bilabial [−distributed]; similarly, the [+coronal, +anterior] stops [t,d] are [+distributed], while the nasal [n] is alveolar [−distributed]. The fact that the nasal assimilation in (48) takes place between words means that the rule is applying postlexically. Hence, it may take the [distributed] feature into account. Catalan also has a lexical rule simplifying clusters composed of a homorganic sonorant plus stop through the deletion of the stop. The rule applies when the cluster is in the syllable coda. The stems [kamp] and [bint] illustrate this rule.

(49)	kamp-et	dimin.	bi[n̪t̪]-e	'twentieth'
	kam-s	pl.	bi[n]	'twenty'
	kam	'field'	bi[m] pans	'twenty breads'
	kam es	'field is'	bi[ŋ] kaps	'twenty heads'

As in many other languages, in Catalan the point of articulation of a nasal in a tautomorphemic nasal-consonant sequence is (barring a few isolated exceptions such as *prems*[ə] 'press') predictable from the following consonant by nasal assimilation. Thus, in [kamp] the labial feature of the nasal arises from assimilation to the [p] and the dental in [bint] from assimilation to the [t]. It is clear that this nasal assimilation must precede the cluster simplification rule; otherwise, the homorganic requirement of the latter process will not be satisfied. The paradigm for [bint] also shows that if an alveolar nasal comes to stand at the end of a word through cluster simplification, it assimilates the point of articulation of the following consonant. Thus, nasal assimilation must apply both before and after cluster simplification. From the standpoint of a theory in which the phonetic representation arises from one pass through the phonological rules, this is a paradoxical state of affairs. But since the Lexical Phonology model distinguishes the lexical and postlexical components, it is possible for the same rule to apply in both components. However, if this is so, then the rule should display different properties, depending on whether the application takes place in the lexicon (where Structure Preservation holds) or in the postlexical component (where it does not). In this respect the difference between the [+distributed] dental nasal in [bin̪t̪-e] and the [−distributed] alveolar in [bin] is particularly significant. If it really is the same rule of nasal assimilation applying in both cases, then why do the prod-

ucts of the rule differ? The Structure Preservation principle answers this question. Because it is not contrastive, the [+distributed] feature of the dental stop [t] only enters the representation postlexically. Since this feature is barred from the lexicon, the lexical application of nasal assimilation will not assign [+distributed]. Consequently, when the [t] of [bint] is deleted lexically, the nasal will be unable to receive the [+distributed] feature. It instead takes the default value [−distributed] that is assigned to unassimilated [+coronal, +anterior] nasals postlexically. But in [bint̪-e], the [t] is assigned [+distributed] postlexically. Postlexical nasal assimilation then transmits this property to the nasal consonant. The nasal in [bint̪-e] thus undergoes two rounds of nasal assimilation. Lexically, it is assigned the distinctive [+coronal, +anterior] features of the [t]; postlexically, it assimilates the [+distributed] feature of the [t].

If more cases like the Catalan one just reviewed are uncovered in which the different properties displayed by the lexical and postlexical applications of a phonological process are predictable on general grounds, then we are justified in claiming that indeed it is the same phonological rule applying at two separate points in the grammar. Suppose that this turns out to be true. Then Mohanan's conception of the phonological rules as forming a single system separate from the lexical and postlexical positions in the grammar at which they apply would be validated (50). The question then arises whether any principles constrain the assignment of a given phonological rule to the various levels of the grammar.

(50)

level 1	rule 1
level 2	rule 2
.	.
.	.
.	.
level *n*	rule *n*
postlexical	

One principle we are familiar with is Structure Preservation, which bars rules assigning or referring to nondistinctive features from the lexicon. An additional principle suggested by Mohanan's study of Malayalam is that if a phonological rule is assigned to more than one level, then the levels must form a continuum. Kiparsky (1985) suggests a still stronger constraint (the *Strong Domain Hypothesis*), according to which all rules are free to apply at the earliest lexical level. (Structure Preservation will of course bar lexical application for many rules whose domain assignment is thereby restricted to the postlexical level.) For any given rule, one must simply stipulate when the rule ceases to apply. Thus, for example, TSL in English would have to be marked as holding of just the initial level, while nasal assimilation in Catalan is unrestricted and free to apply at all levels. Much further study of individual grammars from the Lexical Phonology standpoint is needed before it can be determined which of these hypotheses is closest to the truth.

5.8 Outstanding Problems

In this section we will review some of the unresolved problems that confront the Lexical Phonology model. One problem is presented by rules triggered by the word boundary. The Dutch rule devoicing syllable-final obstruents furnishes a simple example (Booij and Rubach 1987). In virtue of this rule, underlying [hɛld] 'hero' is realized as [hɛlt]. Addition of vowel-initial suffixes prompts resyllabification of the stem-final consonant to onset with the following vowel. This process bleeds the devoicing rule. Thus, the underlying voiced consonant of [hɛld] emerges in [hɛl.d-in] 'heroine'. Assuming that syllabification is assigned cyclically, the devoicing rule cannot itself be cyclic. It must wait until all suffixes have been added that prompt resyllabification and thus bleed the rule. But there is evidence that syllable-final devoicing cannot be postlexical either. In casual speech, Dutch also resyllabifies a consonant across word boundaries. But this process does not bleed syllable-final devoicing. According to Booij and Rubach (1987), *een hoed opzetten* 'to put on a hat' is realized [ən. hu.t ɔp.sɛ.tən]. Here the underlying voiced consonant of /hud/ 'hat' is devoiced even though it is in onset position.

5.8.1 The Word Level

The Dutch data suggest that there is a stage – after all of the affixation takes place but before the word is inserted into the phrase – at which the syllable-final devoicing process is defined to operate. To accommodate such cases, Booij and Rubach (1987), Kiparsky (1985), and others have postulated a special component of *postcyclic lexical rules*. This block of rules (often called the *word level*) intervenes between the cyclic lexical rules and the postlexical, phrasal rules. Any representation is passed through the phonological rules of this component just once. Being noncyclic, it is a natural location for the rules of absolute neutralization such as Yawelmani vowel lowering (section 3.4) or the English Vowel Shift (section 5.1), which apply morpheme-internally and thus violate the SCC. Although such rules are generally automatic, they typically do not apply at the phrasal level – a fact that would follow from their being lexical.

We can flesh out the role of this postcyclic lexical component by recapitulating some of the rules of Polish phonology discussed by Booij and Rubach (1987). The Polish rule raising [o] to [u] before a word-final voiced nonnasal consonant is a natural candidate for the postcyclic lexical rule block. Recall from section 2.7 that this rule (plus final devoicing) accounts for the realization of the root [rob] 'do' as *rup* in the imperative. Since raising is triggered by the word boundary, it cannot be a cyclic rule. Any suffixation automatically displaces the triggering word boundary: for example, *rob'-e* lsg. We must wait until all suffixation has taken place in order to apply the rule. But the fact that the rule has exceptions (e.g., [skrob] 'scratch' is realized as *skrop,* cf. *skrob'-e* lsg.) suggests that it is a lexical rule.

Another argument that raising is a postcyclic lexical rule derives from the fact that it is ordered after a rule that applies in nonderived contexts; hence, raising must be postcyclic by the rule-ordering thesis. Like other Slavic languages, Polish

has a pair of abstract vowels – known as *yers* – that are phonologically distinct in that they delete in contexts where other vowels do not. For example, *lew* and *sweter* participate in the alternation while the nearly identical *zlew* and *krater* do not (51a). It is not possible to analyze all yers as epenthetic vowels, since there are consonant clusters that remain unseparated by a yer (51b).

(51) a.	lew	'lion'	zlew	'sink'
	lw-em	instr.sg.	zlew-em	instr.sg.
	sweter	'sweater'	krater	'crater'
	swetr-y	pl.	krater-y	pl.
b.	mask-a	'mask' nom.sg.	trosk-a	'concern' nom.sg.
	masek	gen.pl.	trosk	gen.pl.
	dekl-a	'cap' gen.sg.	cykl-u	'cycle' gen.sg.
	dek'el	nom.sg.	cykl	nom.sg.

When a derivational suffix follows a yer, sometimes the root yer emerges and sometimes it does not. It turns out that those suffixes that allow a preceding yer to surface themselves contain a yer; furthermore, their yer emerges when they in turn are followed by another yer suffix. The yers thus "vocalize" when followed by a yer or by the "zero" nom.sg. and gen.pl. suffixes. Elsewhere they appear as ∅. The vocalization rule can be simplified if we say that these "zero" suffixes are also yers. Since they are never themselves followed by a suffix, this point cannot be verified directly. But it is a natural analytic step, given the overall framework. The basic generalization thus is that the yers delete everywhere, except when the following syllable contains a yer. In the latter case they surface as [e] – a process traditionally known as "vocalization" of the yers. We can account for the Polish yer phenomenon by the rules in (52a,b), which yield the derivations of (52c). (*Y* is used here as a cover symbol for a yer.)

(52) a. yer → [e] / ___ C_0 yer

b. yer → ∅

c.

[lYw-Y]	[lYw-em]	[zlew-Y]	[zlew-em]	
lew-Y	inappl.	inappl.	inappl.	yer vocalization
lew	lw-em	zlew	inappl.	yer deletion

For our purposes, the most important point about the yers is that the rule deleting the yer applies in a nonderived context. Like Yawelmani vowel lowering and English Vowel Shift, it neutralizes an underlying phonemic contrast in a context-free fashion and thus must be postcyclic. By the ordering thesis, any rule ordered after yer deletion must be postcyclic. In particular, the raising rule must be postcyclic, for it is only in virtue of the loss of the final yer in underlying [voz-Y] that the triggering voiced consonant comes to stand at the edge of the word, so that [voz] gives [vuz] (and eventually [vus]).

The diagram in (53) depicts the Lexical Phonology model of Polish. By their

ordering with respect to the yer deletion process, Booij and Rubach (1987) pinpoint the location of several other rules of Polish phonology.

(53) lexical rules
  cyclic
    palatalization
    yer vocalization
  postcyclic
    yer deletion
    raising
 postlexical rules
    final devoicing

One of these rules devoices the fricatives [v] and [ž] after a voiceless consonant. The [ž] itself derives from a palatalized [r'] by a special rule [r'] → [ž]. Thus, in the contexts where other consonants simply palatalize (54a), [r] is replaced by [ž].

(54)	a.	vu[s]	'cart'	vo[z'-e]	loc.sg.	[voz] root
		kar-a	'penalty'	ka[ž-e]	dat.sg.	[kar]
	b.	Piotr	'Peter'	Piot[š-e]	voc.sg.	[Piotr]
	c.	kufer	'trunk'	kuf[š-e]	loc.sg.	[kufYr]
		list[f-a]	'board'	liste[v]-ek	dimin.gen.pl.	[listYv]

In *Piot*[š-e] we see voicing assimilation applying within a morpheme. This application is consistent with the Lexical Phonology model if the rule belongs to the noncyclic component. Assignment to this component is confirmed by the fact that the rule must be ordered after yer deletion – a rule that we know to be postcyclic on independent grounds. This point is shown by the forms in (54c); *kuf*[še] has the derivation in (55).

(55)	[kufYr-e]	cyclic
	kufYr'-e	palatalization
		postcyclic
	kufYž-e	r' → ž
	kufž-e	yer deletion
	kufš-e	progressive assimilation

To briefly summarize the discussion, we have located three rules in the postcyclic lexical component of Polish: yer deletion, raising, and progressive voicing assimilation. We have strong grounds for the first assignment because yer deletion applies in a nonderived context. The other two cannot be cyclic because they are ordered after yer deletion. But what about the postlexical component? Can any of these rules be assigned there? Raising cannot, since it has lexical exceptions. Yer deletion is not likely to be, because it is a rule of absolute neutralization. But what about progressive assimilation and final devoicing?

Evidence from the phrasal phonology helps us to answer some of these questions. The key is provided by another voicing assimilation rule, the more pervasive regressive assimilation of all remaining obstruent clusters. This process has both voicing and devoicing components; furthermore, it operates between words as well as within the word (56).

(56)	a.	Warsza[v-a]	'Warsaw'	Warsza[f]-ski	adj.
		pros'-ic'	'to request'	pro[z']-ba	'a request'
	b.	zakaz-y	'prohibitions'	zaka[s] postoj-u	'no parking'
		kryzys-y	'crises'	kryzy[z] gospodarczy	'economic crisis'

In this respect it differs from progressive assimilation, which may not apply between words. This point is illustrated by the fact that *but* [V]*ojtk-a* 'Wojtek's shoe' is pronounced *bu*[d V]*ojtka* and not *bu*[t F]*ojtka*. This difference is automatically explained if progressive assimilation is a lexical rule while regressive assimilation is postlexical and thus may apply at the phrasal level.

Regressive voicing assimilation also establishes a difference between the raising rule and final devoicing – both rules triggered by the word boundary. Regressive assimilation may undo the effects of final devoicing. This is shown by the derivations of *sad wiśniowy* 'cherry tree orchard' and *sad owocowy* 'fruit tree orchard' in (57).

(57)	sad viśnovɨ	sad ovocovɨ	
	sat viśnovɨ	sat ovocovɨ	final devoicing
	sad viśnovɨ	inappl.	regressive voicing assimilation

But the raising rule is never undone when the word is placed in the phrase. [voz] undergoes raising even if the triggering voiced consonant is devoiced by assimilation: *v*[us K]*atarzyny* 'Katherine's cart'. This difference is explained if raising is assigned to the lexical phonology while final devoicing is a postlexical rule.

To summarize the discussion, we have looked at several pieces of evidence, some stronger than others, for the rule assignment depicted in (58).

(58) lexical rules
- cyclic
  - palatalization
  - yer vocalization
- postcyclic
  - yer deletion
  - raising
  - progressive voicing assimilation

postlexical rules
- final devoicing
- regressive voicing assimilation

For the Polish data, suffixation always suppresses the application of a rule triggered by the word boundary (e.g., the raising rule). Such suppression does not always obtain under affixation. The rule of English phonology that simplifies final [mn] clusters through deletion of the [n] furnishes a simple example. This rule, stated in (59a), accounts for the "silent" [n] of *damn, hymn,* and so on (59b). The data in (59c) show that the rule cannot be cyclic; otherwise, the [n] would never emerge to the surface.

(59) a. [n] → ∅ / [+nasal] ____]
b. dam[ ]; hym[ ]
c. damn-ation, damn-atory; hymn-al, hymn-ology
d. dam[ ]-ing, dam[ ]-s, dam[ ]-ed; hym[ ]-s, hym[ ]-less

We thus assign the rule to the postcyclic lexical component. But unlike Polish raising, the English cluster simplification rule is not suspended when level 2 suffixes are added (59d). We can account for these forms by assuming that the affixes of (59d) are added in the postcyclic lexical component. This effectively identifies level 2 with the word level. Since this component is not cyclic, only one run through the rules will take place. Hence, the triggering bracket will still be present. However, the internal brackets will crucially have been erased from the level 1, cyclic suffixes of (59c) by the bracket erasure convention. Under these assumptions, the following derivations obtain for *damn, damnation,* and *damning*.

(60)	[damn]	[damn]	[damn]	cyclic
		[[damn]ation]		affixation
				no phonological rules apply
		[damnation]		bracket erasure
	[damn]	[damnation]	[damn]	postcyclic
			[[damn]ing]	affixation
	[dam]	inappl.	[[dam]ing]	cluster simplification (59a)

Since [n] does not delete after a liquid in words such as *kiln* and *corn,* it is natural to pursue a slightly different analysis that treats the deletion in [damn] as the elimination of a syllabically "stray" consonant (see section 6.5): {dam}*n* → {dam}, where braces indicate the syllabification. The rules of English syllabification (section 6.3) will group a vowel-liquid-nasal sequence into a syllable but will fail to group a vowel plus two successive nasals, taking in just the vowel plus the first nasal to give {dam}*n*. However, certain problems arise with this approach. The lexical items in (59b) are the morphological bases for the words in (59c). But the nasal may not delete before the level 1 affixes are added. The deletion of the unsyllabified nasal must wait so that the addition of the level 1 suffixes prompts syllabification of the nasal to onset position, saving it from deletion: [{dam}n]*ation* → {dam}{na}{tion}. If we assume that the distinction between syllabically incorporated and syllabically stray material introduced by the syllabification rules does not constitute a derived context, then the lack of deletion follows from the SCC.

The identity rule *damn* → *damn* subsumes and hence blocks the rule deleting the stray nasal by the Elsewhere Condition. On this account, the problem then becomes one of explaining how deletion is possible in the first place, since it is not triggered by another morpheme and hence may not go by case (a) of the SCC. This problem arises more generally with any rule that is triggered by the word boundary (e.g., the Finnish rule that raises word-final [e] to [i]). We know that postlexical rules are not subject to the SCC. But the nasal deletion rule cannot be postlexical: the bracket erasure operation obliterates the distinction between the stem + level 1 form *damn-ation,* where no deletion occurs, and the stem + level 2 form *damn-ing,* where deletion does apply. Consequently, *damn-ation* and *damn-ing* would be equivalent at the postlexical level. The deletion process would be unable to distinguish the two cases. Thus, the deletion rule must be lexical even though it violates the SCC. These data appear to require relaxation of the SCC in certain cases.

One solution suggested by Kiparsky (1985) simply stipulates that the final stratum of the grammar – the word level – is not subject to the SCC. We can then locate the deletion rule at this stratum. The derivations in (61) illustrate how this solution is supposed to work.

(61)

[damn]	[damn]	[damn]	level 1
{dam}n	{dam}n	{dam}n	syllabification
[{dam}n]ation			WFR
{dam}{na}{tion}			syllabification
[{dam}{na}{tion}]	[{dam}n]	[{dam}n]	level 2
inappl.	{dam}	{dam}	stray nasal deletion
	{dam}ing		WFR
	{da}{ming}		(re)syllabification

On the first cycle at level 1, syllable structure is assigned and the [n] is defined as stray. The WFR affixing *-ation* applies and resyllabification places the [n] in onset position. The derivation then enters level 2, where the rule eliminating syllabically stray nasals is housed. It will apply to [{dam}n] since the SCC is stipulated to be inapplicable at this level.

There are a couple of unsettling features of this analysis. Deletion of the syllabically stray nasal must apply before the rule suffixing *-ing*. If the suffix is added first, then rules of syllabification would be expected to intervene and to parse the stray nasal as onset to the vowel of the suffix and thus to block deletion of the nasal. While the derivation in (61) avoids this outcome by ordering stray nasal deletion before affixation, one should expect the rules of affixation to apply first before any phonological rules, given that level 2 is noncyclic and the representation is passed through the rules just one time. Furthermore, this solution fails to generalize to the Finnish raising rule. On the strength of [vete-nä], the raising rule cannot apply on the root cycle [vete] and in fact will be barred from applying there by the SCC. Just as in the case of the English *n*-deletion rule, we might pursue a solution that suspends the SCC at the final lexical level in order to permit the raising of the final [e] of [vete] to [veti]. But if we do so, we then lose the

explanation for why the $t \rightarrow s$ rule applies on [veti] but blocks on [äiti]. Consequently, the SCC must still hold for the $t \rightarrow s$ rule even though the derived context is created by a word-level rule.

Evidently we need to (re)introduce the word boundary symbol from the earlier generative model and stipulate that it may count as defining a derived environment for phonological rules. This is not a very attractive solution, however, because the elimination of boundary symbols was one of the early signs that the Lexical Phonology model was on the right track. Clearly, rules applying at the word boundary constitute a problem that requires further study. See sections 5.8.4 and 11.4.4 for further discussion.

Borowsky (1986, 1992) undertakes a more systematic study of level 2 in English. The next few paragraphs summarize her results. In addition to the cluster simplification found in *dam*[ɱ]≈*damnation,* several other rules operate at the word level. They share two peculiarities. First, they introduce allophones and hence violate Structure Preservation (in contrast to the aspiration and velarization rules of Spanish discussed in section 5.6).

(62) a. [b,g] → ∅ / [+nasal] ___]

lon[g]	lon[g]-ing	elong-ate
stron[g]	stron[g]-ly	strong-est
bom[b]	bom[b]-ing	bomb-ard

b. [l,r] → [l̥,r̥] / C ___]

cyc[l̥]e	cyc[l̥]-ing	cycl-ic
cente[r̥]	cente[r̥]-ing	centr-al
mete[r̥]	mete[r̥]-ing	metr-ic

c. [t,d,n] → [+distrib] / ___ (ə)r ...]

dental	alveolar
spi[d̪]er	wi[d]er
pi[l̪l̪]ar	fi[ll]er
ma[t̪t̪]er	fa[tt]er

One rule deletes noncoronal voiced stops after a tautosyllabic nasal (62a) while another converts stray sonorant consonants to syllabic nuclei (62b). They cannot apply at level 1 because they must wait until all level 1 affixes have been added, allowing the stem-final consonant to onset the following vowel and hence escape the rule. Both rules violate Structure Preservation: sonorant syllabification introduces syllabic liquids while deletion of the [g] in *long* generates a free-standing velar nasal [lɔŋ]. Borowsky points to a number of dialectal processes applying at level 2 that also introduce allophones. For example, in Belfast English (Harris 1989) the alveolar noncontinuants [t,d,n,l] are dentalized before tautosyllabic [r]: [t,d] are dental ([+distributed]) in [t̪]*rain,* [d̪]*rain, sani*[t̪]*ary* but remain alveolar in *bedroom* and *hard rain,* where a strong juncture separates the following rhotic. The rule cannot be postlexical because it fails to apply before the level 2 comparative and agentive suffixes (62c). Given bracket erasure, a postlexical appli-

cation would be unable to distinguish the dental [d̪] of *spider* from the alveolar [d] of *wider*. This example illustrates a second peculiarity of level 2 in English: the rules applying at this level treat the stem and affix independently from each other and never have to refer to both. That is to say, there are no level 2 rules of assimilation or dissimilation that require simultaneous reference to both the stem and the affix. As a result, the stem is treated as if it ended the word. In the Lexical Phonology model, boundaries are not elements present in the string but simply reflect different morphological domains. Consequently, Borowsky proposes to account for the isolation of the stem and affix in English by a parameter that allows the stem and the affixes to enter the level 2 rule block before they are concatenated by the morphology. They are only joined together after the level 2 phonological rules have applied. Given this architecture, the stem and suffix are phonologically invisible to one another at level 2. Any interaction between them (as in the flapping in *eat* vs. *ea*[*D*]*ing*) must take place postlexically.

The representations that arise at the two different levels have distinct formal properties as well. Since Structure Preservation holds at level 1, the output of a level 1 rule has the same phonotactic structure as words lacking any internal morphology. Representations arising from level 2 rules are quite different: they contain allophones as well as clusters not found morpheme-internally (e.g., the [rldl] substring in *world-ly*). Borowsky proposes to explain this difference by restricting Kiparsky's notion of "lexical item" to the product of level 1 rules. These items are independently listed in the lexicon; the level 1 rules can be thought of as relating items in this list. Allophones (elements not belonging to the phonemic inventory and hence not listed) thus cannot be introduced by the level 1 rules. Kaye and Vergnaud (1990) hypothesize that words constructed at level 2 are processed differently from level 1 items in speech recognition. Items listed in the lexicon will be derived by simple lookup. Words containing level 2 morphology are not stored; hence, in order for them to be recognized, the parser must recover the stem and affixal components. The introduction of allophones and complex consonant clusters in close proximity to the stem-affix juncture thus has a functional advantage in marking the position where the parser must make a cut in order to recognize the string. Other things being equal, we expect a stem + level 2 suffix to take longer to recognize than a stem + level 1 structure. This implication has yet to be tested experimentally.

5.8.2 Affixal Ordering and Bracketing Paradoxes

Another well-known problem is presented by cases in which a level 1 affix appears outside a level 2 affix. Aronoff (1976:85) noted the data in (63) as potential counterexamples to Siegel's affixal ordering generalization.

(63)	a.	ánalyze	b.	ánalyzable	c.	analyzabílity
		stándard		stándardize		standardizátion
		góvern		góvernment		governméntal

The problem is the following. The affixes [-able, -ize, -ment] do not trigger the reapplication of stress to a preceding heavy syllable. They thus contrast in be-

havior with an affix like [-al]: *párent, parént-al;* but *góvern-ment,* not *govérn-ment*. This difference could be explained if these morphemes were treated as level 2 affixes like [-less] (e.g., *párent-less*). But then the forms in (63c) become problematic. They are completed by the addition of a level 1 suffix that does count for stress, attracting the accent to the preceding heavy syllables. Consequently, if there is no provision to return from level 2 back to level 1, then the Lexical Phonology model cannot derive a word such as *governmental*. The alternative is to treat [-ment], [-ize], and [-able] as level 1 affixes that exceptionally fail to count for stress.

A similar problem is presented by so-called *bracketing paradoxes*. These are cases in which the morphology demands a certain constituent structure while the phonology appears to require a different one. A much-discussed example is the word *ungrammaticality*. The [un-] prefix attaches to adjectival bases (e.g., *un*[lucky], *un*[American]), not to nominal bases (**un*[luck], **un*[America]). Consequently, [un-] must take as its sister constituent the adjectival base [grammatical] and not the nominal [grammaticality]. Since *un*[grammatical] is still an adjective, it may serve as the base for the WFR that suffixes the nominalizing [-ity]. Hence, the morphological structure of *ungrammaticality* must be that in (64a).

(64) a. [[un[grammatical]] ity]
b. [un [[grammatical] ity]]

However, as observed earlier, there are phonological reasons for distinguishing [un-] from [in-] in terms of levels. The latter prefix may at least sometimes count for stress. It also undergoes nasal assimilation while the former does not: *ím-potent*. This phonological contrast might be explained by assuming that [in-] attaches at level 1 and [un-] at level 2. But if this is so, then *ungrammaticality* must have the constituent structure of (64b) in which the level 2 [un-] appears outside the base [grammaticality] containing the level 1 suffix [-ity]. However, as we have just seen, this structure is inconsistent with the constituent analysis required by the morphology: [un-] may not attach to a nominal base.

The literature is replete with attempted solutions to these bracketing paradoxes. Some major references are Selkirk 1982a, Mohanan 1982, Kiparsky 1983, Booij and Rubach 1984, Pesetsky 1985, Halle and Vergnaud 1987, Inkelas 1989. Halle and Vergnaud (1987) propose that individual affixes must be lexically marked for activating the cyclic phonological rules of a given lexical level. On this view, the constituent structure of *ungrammaticality* is that required by the morphology – namely, (64a). The [un-] prefix is lexically marked as [−cyclic]. Consequently, the morphological constituent *un*[grammatical] is simply not submitted to the cyclic phonological rules. But [-ity] is [+cyclic] and so stress and TSL will be applicable to the representation [ungrammatical]*ity* that arises from affixation of [-ity]. The SCC prevents the cyclic rules from affecting the [un-] prefix on subsequent cycles. If we have the option of marking any given affix as [±cyclic] independent of its ordering with respect to other affixes, then we can also account for *government* and *standardize*. The [-ment] and [-ize] affixes will be [−cyclic] and thus stress is not reassigned upon affixation of these suffixes to the bases in [góvern]*ment* and [stándard]*ize*. It should be noted that this solution is not equiv-

alent to simply marking these morphemes as exceptions to stress. They do count for stress upon subsequent affixation of the [+cyclic] [-al], as in [governmént]*al*. An additional strong claim is made. Since they are [−cyclic], we predict that these affixes will fail to trigger other cyclic rules such as TSL. Forms such as [lēgal]*ize*, [blāzon]*ment*, [īron]*able* corroborate this analysis.

Halle and Vergnaud (1987) adopt Mohanan's (1982) idea that phonological rules may occupy more than one lexical stratum. This assumption is crucial to their solution to another well-known bracketing paradox noticed for Russian originally by Lightner (1972) and later by Pesetsky (1979). Like Polish, Russian has the yer≈Ø alternation. Yers "vocalize" when the following syllable contains a yer and delete otherwise. These rules are repeated in (65a). Vocalization is cyclic; but yer deletion is necessarily postcyclic, since it applies in a nonderived context. The paradox concerns the behavior of prefixal yers (65b).

(65) a. yer → V / ___ C_0 yer
yer → Ø

b.

verb	UR	
pod-žok	[podY+žYg+Y]	'he burned up'
podo-žg-la	[podY+žYg+la]	'she burned up'

Vocalization of the prefixal yer in [podY] is contingent on whether or not the yer in the root [žYg] is vocalized. But the latter is determined by whether or not the inflectional affix is a yer. Given that yer vocalization is cyclic, it appears that the root must group with the inflectional suffix before it groups with the prefix: *podY*[[žYg]Y]. But this bracketing contradicts the one required by the morphology and the semantics. The prefix is a derivational affix more closely bound to the root than the inflection is.

Halle and Vergnaud's solution is based on two key assumptions. First, they mark the prefix [−cyclic]; consequently, it fails to initiate a pass through the cyclic rules. No rules apply to the [prefix[root]] assembly and the derivation moves out to the inflectional affixes, which are [+cyclic]. The representation is now submitted to the cyclic phonological rules. In [podYžYg]*Y*, vocalization does not apply to the substring comprising the first two yers because they are contained within the domain of a preceding cycle. But the rule may vocalize the root yer, because it is followed by the suffixal yer that spans a cyclic boundary. No rules apply in [podYžYg]*la*.

(66)

[podY[žYg]]	[podY[žYg]]	
no rules apply	no rules apply	cycle II
[[podYžYg]Y]	[[podYžYg]la]	cycle III
podYžog Y	inappl.	yer vocalization
[podYžogY]	[podYžYgla]	postcyclic
inappl.	podožYgla	yer vocalization
podžog	podožgla	yer deletion

These representations are now submitted to the postcyclic component. Suppose crucially that yer vocalization is also assigned to this stratum. The Elsewhere Condition orders vocalization before deletion. It now vocalizes the prefixal yer in [podYžYgla], since the SCC is suspended in the postcyclic stratum. Subsequent yer deletion yields [podožgla]. For the masculine form [podYžogY], only yer deletion is applicable, resulting in [podžog].

This intricate rule application follows from the network of assumptions underlying the model. While the intermingling of cyclic and noncyclic affixes weakens the original Lexical Phonology model, this move appears to be required empirically. Fabb (1988) shows that the original affixal ordering generalization was too hastily formulated and not based on a thorough survey of English word structure.

5.8.3 P1 versus P2 Rules

Analogous to the lexical versus word-level distinction in the lexical phonological rules, there is evidence that the postlexical, phrasal rules subdivide into two broad classes, termed *postlexical 1* (P1) and *postlexical 2* (P2) rules by Kaisse (1985). In the original Lexical Phonology model, the paradigm postlexical rules are those like Polish regressive voicing assimilation which are totally automatic (no exceptions), may introduce allophones, and hence are typically below the threshold of consciousness and consequently not reflected orthographically. On the other hand, there are phrasal rules whose application requires relatively rich information on grammatical context (e.g., to distinguish noun from verb, or head from complement), and which may apply cyclically instead of across-the-board, may be restricted to applying at the juncture between words and hence show strict cyclic effects, and may have lexical exceptions. Let us look at a few examples of these P1 rules.

Kaisse (1987) argues that the English "rhythm rule" that retracts the prominence from the end of the word to an earlier stressed syllable under stress clash with a following word is a P1 rule. This rule accounts for the stress shift in such cases as *Mìssissíppi,* but *Míssissìppi délta*. It displays a number of lexical-like features. First, its input and output are independently contrastive stress contours (*álligàtor* vs. *màcaróni*), and thus it is structure-preserving. Second, the rule has many lexical exceptions in disyllabic cases: while *àbstráct* and *còmplex* retract their stress, *àbsúrd* does not (*an ábstràct nótion* vs. *an àbsúrd nótion*). Also, as Kiparsky (1982a:144) observes, the stress-shifted output may be lexicalized: *ábstràct art* has the meaning 'art that is not representational'. Finally, cyclic application of the rhythm rule accounts for the contrasting stress contours in such four-word phrases as ***one-thirteen Jay*** *Street* vs. *Bill's* ***thirteen clothes*** *pins*.

Another much-discussed phrasal rule with lexical characteristics is Kimatuumbi vowel shortening (Odden 1987). In this Bantu language, a long vowel located in a noun or verb shortens when followed by a phrasal complement. Following Odden, we will express the rule as (67a), deleting the second half of a tautosyllabic (essentially geminate) vowel when located in the head of a phrase X and followed by some phonological material Y in the same phrase. The "same phrase" requirement distinguishes (67b) from (67c,d). In the former, the two words share

the same maximal projection (NP); in the latter, *kįkóloombe* occupies a different projection than the following word does. The lack of shortening on *kįkeéle* in (67e) shows that the rule isolates the phrasal head.

(67) a. 

$$V_1\ V_2 \rightarrow V_1 \,/\, [[\ \underline{\quad}\ ]_X Y]_{X'}$$

b. kįkóloombe 'cleaning shell'
kįkólombe chaángu 'my cleaning shell'
c. kįkóloombe chaapúwaanįįke 'the shell broke'
d. naampéį kikóloombe Mambóondo 'I gave Mamboondo the shell'
e. kįkólombe kįkeéle chaángu 'my red shell'

The Kimatuumbi shortening interacts with long vowels that are the by-products of a glide formation process. The glide formation in turn is intricately tied to the constituent structure of the verbal and nominal word phrase. Odden distinguishes three levels: 1 root + derivation suffixes, 2 inflectional prefixes + stem, and 3 locative (prepositional) prefixes. Glide formation devocalizes a prevocalic high vowel, lengthening the conditioning vowel if short: *i,u* + V → *y*VV, *w*VV. For example, the class 4 nominal prefix *mį-* (e.g., *mį-kaáte* 'loaves') illustrates glide formation at level 2 when added to the root [otó] that appears in *ma-otó* 'large fires': *my-oótó* 'fires' (from [mį + oto]). The locative prefix *kų-* (e.g., *kų-sųúle* 'to school') devocalizes before the class 8 prefix in *kw-įįsíwá* 'to the islands', which in turn derives from *į-síwa* 'the islands'. A form such as *kųyaáį* 'to the cooking pots' from [kų[į[aaį]]] shows that glide formation applies cyclically: the class 8 prefix in *į*[aaį] must devocalize before the locative prefix *kų-* does. A similar inside-out application of glide formation is required by *mųyuúlá* 'in the frogs' from [mų[į-úlá]].

Let us now consider the interaction between the two rules. A long vowel derived from glide formation at level 2 or 3 does not undergo phrasal shortening, while one derived on the stem at level 1 does. These points are revealed in the following paradigms.

(68) a. ák-a 'to net-hunt'
ák-**a**n-a 'to net-hunt each other'
ák-y-**aa**n-a 'to net-hunt for each other' [ak-į-an-a]

b. tw**aa**kyana įtúmbili 'we net-hunt monkeys for each other'
< [tų-ak-į-an-a]
tw**aa**mámandwįle ñųúmba 'we plastered a house'
< [tų-a-mámaandųįle]

The last form in (68a) illustrates glide formation and lengthening at level 1 [stem + suffix]: *ák-y-**aa**n-a*. When embedded in a phrase, this vowel shortens: note *twaakyana* in (68b). But a lengthened prefixal vowel does not: *tw**aa**kyana*.

To account for this difference, Odden (1990) assigns the shortening rule to level 1 of the lexical phonology. However, the rule is granted the power to look outside

the word into the phrasal context, in a derivation such as (69). Shortening does not affect the lengthened prefix vowels because they are derived at level 2 while shortening is assigned to the level 1.

(69)	ak-ị-an-a ɨtúmbili	level 1
	akyaana ɨtúmbili	glide formation
	akyana ɨtúmbili	shortening
	tụ-akyana ɨtúmbili	level 2
	twaakyana ɨtúmbili	glide formation

This analysis abandons the assumption that the lexical phonology precedes the syntax. Like Halle and Vergnaud's analysis of the Slavic yers, it rejects Lexical Phonology's interleaving of the word formation and lexical phonological rules and returns to the earlier generative model in which morphology is separated from phonology but still defines the cyclic domains required for the phonology. It also permits the earliest phonological stratum to access the syntactic phrase and thus effectively denies any correlation between the power to refer to the syntax and the depth of the lexical stratum.

Another possible interpretation of these data more in keeping with the tenets of the Lexical Phonology model is that vowel shortening is a P1 phrasal rule, but one whose application ignores the inflectional prefixes. In some Bantu languages, the stem is prosodically separated from its inflectional prefixes (as revealed in the tonology). It is possible that this prosodic constituency defines the domain for the Kimatuumbi shortening rule rather than the purely grammatical domain. The juncture between a prefix and a following stem often has a different phonology from the stem + suffix juncture. This asymmetry may reflect a parsing advantage for signaling the onset of the stem – the semantically heaviest and most valuable information in the decoding of the speech signal. See Hayes 1990 for another interpretation of these controversial Kimatuumbi data.

5.8.4 P-Structure Rules

Building on the work of Clements (1978) and Chen (1985, 1987), Selkirk (1986) singles out for special treatment rules that display traits intermediate between those of Kaisse's P1 and P2 rules. Unlike P1 rules, these "prosodic" rules are generally automatic (no lexical exceptions) and typically fail to distinguish noun from verb, or head from complement; rather, they treat all phrases of a given complexity of branching the same. But unlike the typical P2 rule (e.g., Catalan nasal assimilation), the prosodic rules do not apply between any arbitrary pair of words but instead are sensitive to the phrasing. However, while based on the surface syntax, the phrasing does not coincide exactly with syntactic constituent structure. Rather, the prosodic grouping reflects an impoverishment of the surface syntax arising from the elimination of all but a designated set of syntactic constituent boundaries. The boundaries that survive impoverishment are then interpreted as divisions within the string of phonological segments. Phonological rules applying at this point or later thus do not see surface syntax directly but only

obliquely through the bracketing that survives impoverishment. Such rules are thus predicted to be sensitive to only a limited amount of syntactic information.

The syntactic constituent boundaries that are passed on to define the phonological phrasing are defined by two parameters in Selkirk's model: (i) the level of syntactic projection: X^{lex} (where X = a Noun, Verb, Adjective) or X^{max} (Noun Phrase, Verb Phrase, Adjective Phrase); and (ii) the left or right edge of the projected constituent. Since only one edge (right or left) is projected, the resultant phonological phrasing will not necessarily delimit a syntactic constituent. In a number of well-documented cases, this failure of the syntax and the prosodic grouping to coincide gives exactly the correct phonological delimitations. To close this chapter, we will look at examples from two languages. For further discussion and exemplification, see Selkirk 1986, Nespor and Vogel 1986, Kaisse and Zwicky 1987, and Inkelas and Zec 1990.

One of Selkirk's best examples concerns the realization of vowel length in the Bantu language Chi Mwi:ni (based on data from Goodman 1967 and from Kisseberth and Abasheikh 1974). In Chi Mwi:ni long vowels come from several sources: from underlying lexical contrasts (e.g., *x-so:ma* 'to read' vs. *x-tufa* 'to spit'); from rules lengthening vowels before certain suffixes such as the locative *-ni* (e.g., *madrasa* 'school', *madrasa:-ni* 'at school') and in word-final phrase-medial position (e.g., *na* 'by', *na: noka* 'by a snake'; *hujo* 'one who eats', *hujo: mbele* 'the one who eats first'). Vowel length is realized phonetically only within a maximal three-syllable window at the end of the phonological phrase: long vowels falling outside this window are shortened: *x-so:m-a* 'to read', *x-so:m-esh-a* 'to teach', but *x-som-esh-añ-a* 'to teach each other'. Furthermore, the window shrinks to two syllables when the penult of the phrase is heavy: *su:xu* 'market', *suxu:-ni* 'at the market'; *xsoma: chuwo* 'to read a book'; *xfungula xalbi* 'to open one's heart'.

Building on an earlier proposal of Hayes (1981), Selkirk develops a metrical interpretation of the Chi Mwi:ni window that is equivalent to the structure underlying the Latin stress rule: it may reach to the antepenultimate syllable, but only when the penultimate syllable is light; if it is heavy, then the window stops at the penult. The derivations in (70) illustrate the intended analysis.

(70)	[xso:mesha]	[su:xu-ni]	[xso:ma chuwo]	UR
	————	su:xu:-ni	xso:ma: chuwo	lengthening
	{xso:mesha}	su:{xu:-ni}	xso:{ma: chuwo}	metrical window
	————	su{xu:-ni}	xso{ma: chuwo}	shortening

We now turn to certain properties of the vowel-shortening phenomenon and its bearing on the phonological phrasing. First, certain pairs of words in Chi Mwi:ni join together to form a phrase for the realization of the metrical window while others do not.

(71)			
	a.	nthi: nkhavu	'dry land'
	b.	nthi ni: nkhavu	'land is dry'
	c.	mayi malada	'fresh water'
	d.	ma:yi ni malada	'water is fresh'

For example, when *nthi* 'land' and *nkhavu* 'dry' are combined into a Noun Phrase (71a), they form a single prosodic phrase. This phrasing is relevant for two rules: medial lengthening and pre-antepenult shortening. Since the final vowel of *nthi* 'land' falls inside the metrical window, it emerges lengthened at the phonetic surface. But when *nthi* and *nkhavu* form a subject + predicate construction (71b), they belong to separate prosodic phrases. Consequently, no vowel length is assigned to the final syllable of *nthi* 'land'; rather, the copula *ni* and the following adjective *nkhavu* form a phonological phrase. Being phrase-medial and word-final, the vowel of the copula *ni* is lengthened; and once again this length may surface because it falls within the phrase-final three-syllable window. In (71c) the underlying vowel length in *ma:yi* is shortened since it groups with *malada* and hence lies outside the three-syllable window. For exactly the same reason, vowel length does not surface on the final syllable of the noun *ma:yi*. But in the copular construction (71d), the subject phrases separately from the following predicate. The underlying length in *ma:yi* now surfaces. But the length assigned to the final vowel of the copula *ni* does not because it lies outside the window, given that the predicate adjective *malada* 'fresh' is trisyllabic.

From these examples as well as others such as (72), it is evident that the proper phrasing can be determined by projecting the right edges of maximal phrasal categories.

(72) verb + object NP
xf**u**ngul**a** xalbi 'to open one's heart' (cf. xfu:ngula 'to open')

preposition + NP
na: noka 'by a snake' (cf. na 'by')

NP + VP
mwa:rabu vete chile:mbe 'an Arab has put on a turban' (cf. ve:te 'has put on')

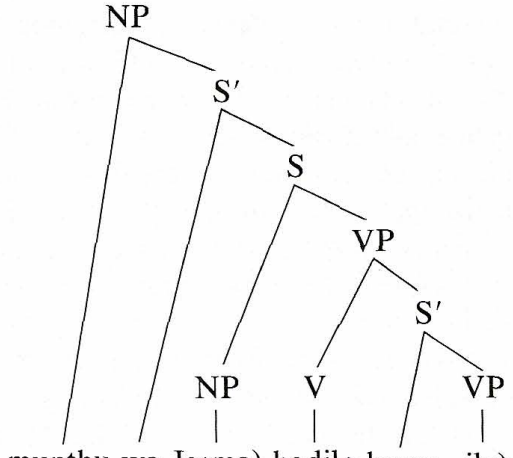
In other words, the phonological phrasing in Chi Mwi:ni is determined by the following parameter settings for the impoverishment operation: X^{max}, right. The three-syllable window is then measured right to left from the resultant boundaries. The derivations in (73) show how this analysis works. The syntactic brackets that survive impoverishment and thus translate into prosodic boundaries are notated by parentheses.

(73)	$[mwa:rabu]_{NP}$	$[ve:te\ [chile:mbe]_{NP}]_{VP}$	UR
	mwa:rabu)	ve:te chile:mbe)	impoverishment
	inappl.	ve:te: chile:mbe)	medial lengthening
	{mwa:rabu}	ve:te: chi{le:mbe}	metrical window
	inappl.	vete chi{le:mbe}	shortening
	mwa:rabu	vete chile:mbe	surface

Since just the right edges of phrasal constituents define prosodic phrasing in Chi Mwi:ni, the material lying between any two such boundaries need not form a syntactic constituent by itself. Two examples will illustrate this point. In (74)

the NP subject of the complement clause projects its right edge and so groups with the preceding complementizer and head noun *munthu* into a prosodic phrase. But *munthu wa Ja:ma* 'the man who Jama' clearly is not a syntactic constituent.

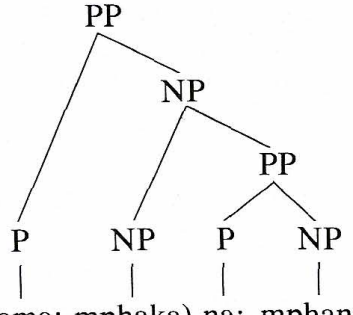
(74)



munthu wa Ja:ma) hadilo kuwa ile) '(the) man who Ja:ma said that came'

In (75) the PP takes an NP complement that itself consists of an NP with a PP complement. Once again, the syntactic and phonological groupings do not coincide.

(75)



kama: mphaka) na: mphana) 'like (a) cat and/with (a) rat'

An example in which the left edge of a maximal phrase defines prosodic boundaries is provided by the tonal phonology of the Anlo dialect of Ewe (Clements 1978). Anlo Ewe distinguishes three tonal levels in isolation: high, mid, and low (marked by the acute, macron, and grave, respectively): *ètó* 'mountain', *ētō* 'mortar', and *ètò* 'buffalo'. As shown by the alternation of *àkplò* 'spear' but *ākplō dyí* 'on a spear', certain low tones neutralize to mid when not phrase-final. The rule of interest here is one that raises a mid tone (basic or derived) to superhigh (marked by the double acute) between high tones. This rule is stated informally in (76).

(76) $\bar{V} \rightarrow \H{V} / \acute{V}$ ___ $\acute{V}$

It accounts for a number of the alternations observed in the phrases in (77) such as the superhigh on the postposition *mēgbé* 'behind' in *èkpḗ mḗgbé* 'behind a stone' or the superhigh in *àtyíkḗ dyí* 'on medicine', where the final low tone on

àtyíkè has shifted to mid in phrase-medial position and then raised to superhigh between the high tones of [tyí] and [dyí]. An underlying high tone may optionally assimilate to a following superhigh: [èkpé mēgbé] → [èkpé mégbé] → [èkpé́ mégbé].

(77)	àkplò	èkpé	àtyíkè	N
	ākplō ó	èkpé ó	àtyíkḗ ó	N pl.
	ākplō dyí	ékpé dyí	àtyíkḗ dyí	'on N'
	ākplō mēgbé	èkpé́ mégbé	àtyíkē mēgbé	'behind N'
	m' ākplō dzrá-gé	mè kpé dzrá-gé	m' àtyíkḗ dzrā́-gé	'I'll sell N'
	m' ākplō flē-gé	mè kpé́ flḗ-gé	m' àtyíkē flē-gé	'I'll buy N'
	'spear'	'stone'	'medicine'	

Anlo Ewe has a number of constructions in which the verb precedes its complement NP. In these cases the verb and the NP belong to different prosodic phrases because the mid tones do not shift to superhigh even though they are located between high tones. A few examples are cited in (78). We may account for the difference in terms of Selkirk's phrasing parameter by saying that Anlo Ewe projects {X^{max}, left}. An NP is thus separated from the preceding verb even though they evidently form a syntactic constituent. Once again, a parenthesis marks the constituent boundary that survives impoverishment.

(78)		
	àblá kplé kōfí 'Abla and Kofi'	NP and (NP
	kpɔ́ ānyí 'saw (a) bee'	V (NP
	mē ná àtyí kōfí 'I gave (a) stick (to) Kofi'	V (NP (NP
	mē xé fē né kòdzó 'I paid (a) debt to Kwadzo'	V (NP (PP
	mē yī dé tɔ̄ tó 'I went to the riverside'	V V (NP
	wố nɔ̃ví 'their brother' (cf. nɔ̄ví 'brother')	(NP N
	kófí yī dé kḗtá 'Kofi went to Keta'	V (PP
	mí ā-dzó 'we will leave'	NP Infl (VP
	wó má-ā dzó ò 'they will not leave'	neg-tense (VP

Suggested Readings

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Selkirk, Elisabeth. 1986. On derived domains in sentence phonology. Phonology Yearbook 3.371–405.

Exercises

5.1 Icelandic (Anderson 1974)

A. Recall the *u*-umlaut rule (1a) from section 2.7 that accounts for alternations such as those in (1b).

(1) a. [a] → [ö] / ___ C_0 [u]

b.	barn	'child'	börn-um	dat.pl.
	svangt	'hungry'	svöng-u	dat.sg.
	kall-a	'I call'	köll-um	'we call'

Formulate a syncope rule that accounts for the V≈Ø alternation in the data of (2a) and use the data in (2b) to order syncope and *u*-umlaut. (The nom.sg. suffix *-r* assimilates to a preceding sonorant, and stress is on the initial syllable.)

(2) a.	hamar	'hammer'	hamr-i	dat.sg.
	fífil-l	'dandelion'	fífl-i	dat.sg.
	morgun-n	'morning'	morgn-i	dat.sg.
b.	ketil-l	'kettle'	regin	'gods'
	katl-i	dat.sg.	ragn-a	gen.pl.
	kötl-um	dat.pl.	rögn-um	dat.pl.

What problem do the data in (3) pose for the analysis? Suggest a solution.

(3)	bagg-i	'pack'	jak-i	'piece of ice'
	bögg-ul-l	'parcel'	jök-ul-l	'glacier'
	bögg-l-i	'parcel' dat.sg.	jök-l-i	'glacier' dat.sg.
	þagg-a	'to silence'		
	þög-ul-l	'taciturn'		
	þög-l-an	'taciturn' acc.sg.masc.		

B. Recall from section 2.7 the paradigms in (4a) that motivate [-r] as the underlying representation for the nom.sg. suffix in the *r*-stem nouns. Following Kiparsky (1984), the epenthesis rule may be expressed as (4b) to insert a [u] before an unsyllabifiable [r] (indicated by the tick), assuming that the syllable-building rules fail to syllabify an [r] in the context C___# (unless followed by a vowel). Treating epenthesis as supporting an unsyllabified consonant implies the derivation in (4c).

(4) a.	nom.sg.	dag-ur	hest-ur	bæ-r
	acc.sg.	dag	hest	bæ
		'day'	'horse'	'farmhouse'

b. Ø → u / ___ r′

c.

[#dag+r#]	[#bæ+r#]	
{dag}+r	{bæ+r}	syllabification
{dag}+ur	——	epenthesis
{da}{g+ur}	——	resyllabification

Relying on the concept of strict cyclicity as a reflex of the Elsewhere Condition, develop an analysis for the paradigms in (5). *#inn* is the definite clitic, added in the syntax as a separate word. Hint: Consider assigning epenthesis to both the lexical and the postlexical modules.

(5)

nom.sg.	lifur	dag-ur	akur	hamar
dat.sg.	lifr-i	dag-i	akr-i	hamr-i
dat.pl.	lifr-um	dög-um	ökr-um	
nom.sg.def.	lifr#inn	dag-ur-#inn	akur#inn	hamar#inn
	'liver'	'day'	'acre'	'hammer'

5.2 Polish

This exercise (based on Rubach 1984) introduces several additional rules of Polish phonology. Building on the text analysis developed in section 5.8.1, determine the grammatical component (cyclic, postcyclic lexical, postlexical) of each rule. What reasons can be given for each assignment?

A. Formulate a rule to account for the alternations between [t',d',n'] and [t,d,n]. Determine its ordering with respect to other rules of Polish developed in the text.

(1) a.

noun	adjectival	
sekret	sekret-n-i̯	'secret'
brut	brud-n-i̯	'dirt'
s'an-o	s'en-n-i̯	'hay'
v'ilgot'	v'ilgot-n-i̯	'humidity'
čelat'	čela'd-n-i̯	'household'
kon'	kon-n-i̯	'horse'

b.

v'in-a	'fault'	podob-n-i̯	'similar'
v'in'-en	'guilty' masc.sg.	podob'-eń-stf-o	'similarity'
v'in-n-a	fem.sg.		
v'in-n-i̯	attributive		

c.

d'en'	'day'	star-i̯	'old'
dn'-a	gen.sg.	staž-ec	'old man'
d'en-n-i̯	'daily'	star-c-a	gen.sg.

d.

dobrot'	'goodness'	jes'en'	'autumn'
dobrot-liw-i̯	'good-hearted'	jes'en-n-i̯	adj.
dobrot' lucka	'human goodness'	jes'en' našego žiyt'a	'autumn of our life'

B. The front vowel [i] is assigned the feature [+back] after nonpalatalized [+back] coronal consonants, where it is realized as [ɨ] (orthographic *y*). This rule is responsible for the alternations displayed by the *-it'* and *-ist* derivational suffixes. You may assume a rule [r'] → [ž].

(2) a.

noun	derived verb	
kapris	kapris'-it'	'whim'
vus	voz'-it'	'cart'
brut	brud'-it'	'dirt'
tentn-o	tentn'-it'	'pulse'
tovažiš	tovažiš-it'	'companion'
partač	partač-it'	'bungle'
kuš	kuž-it'	'dust'
xmur-a	xmuž-it'	'cloud'

b.

zwot-o	'gold'	zwot'-ist-i	'golden'
srebr-o	'silver'	srebž-ist-i	'silvery'

C. Consider the realization of "i" in loanword adaptation. What bearing does it have on the nature of the backing rule?

(3) a.

kretin	'idiot'	crétin	French
krip-a	'boat'	Krippe	German
cipel	'cape'	Zipfel	German
šifr	'code'	chiffre	French
p'ilot	'pilot'	*pilote*	French
v'itraš	'stained-glass window'	vitrage	French
k'itel	'frock'	Kittel	German

b. U.S. Polish

sink	'sink'
strita	'street'
grinhorn	'greenhorn'
ofis	'office'
spikovat'	'to speak'

5.3 Chumash

Review the discussion of Chumash sibilant harmony in section 4.3.4. Recall that coronal affricates and fricatives assimilate the [±anterior] value of a following sibilant. As a result, the 3sg. subject prefix [s-] of *ha-s-xintila* 'his Indian name' appears as [−anterior] [š] in *ha-š-xintila-waš* 'his former Indian name', where the suffix [-waš] has been added. The data in (1b) motivate another rule (1a) that assigns [−anterior] to [s] when it appears before the nonstrident coronals [t,l,n].

(1) a. [s] → [š] / ___ [Coronal, −strid]

b.

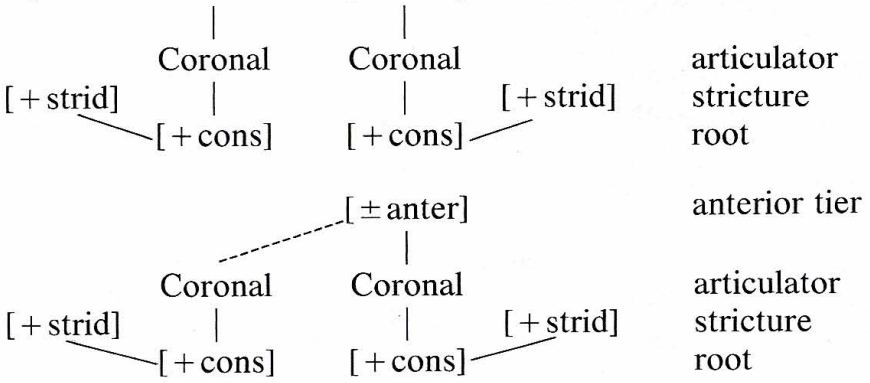
š-nanʔ	'he goes'	/s+nanʔ/
š-tepuʔ	'he gambles'	/s+tepuʔ/
š-loxitʔ	'he surpasses me'	/s+loxitʔ/

The [š] that arises from (1a) has the following two special properties: (i) it fails to harmonize with a following sibilant, and (ii) it starts a new harmonic domain, causing all sibilants to its left to harmonize to it. The first property is evident in (2a), where the [š-] prefix derived by (1a) fails to harmonize to the [+anterior] [s] of the suffix; and the second is evident in (2b), where the [š] of the dual prefix /-iš/ starts a new harmonic domain.

(2) a. š-ti-yep-us 'he tells him' /s+ti+yep+us/
b. š-iš-lu-sisin 'they two are gone awry' /s+iš+lu+sisin/

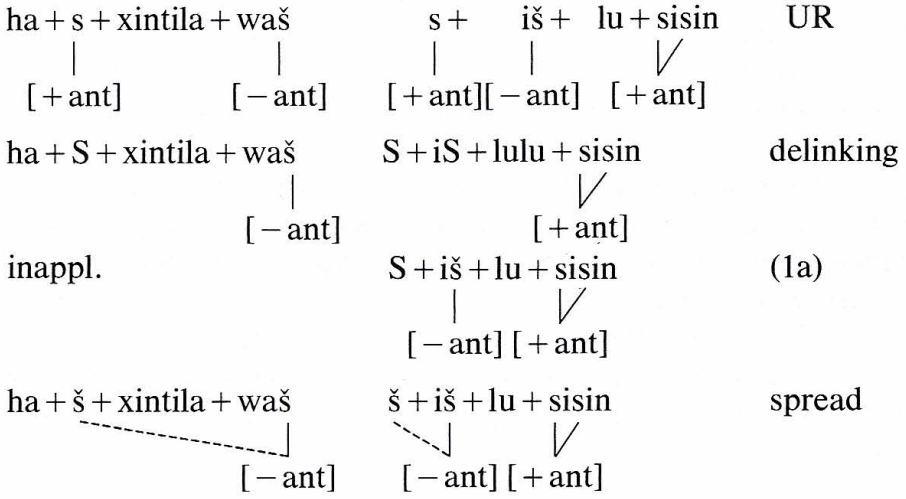
Poser (1982) accounts for this range of data by breaking the sibilant harmony process of (38) in section 4.3.4 into two parts: the first delinks all but the rightmost specification on the [±anterior] tier when the anchoring root is [+strident]; the second is a feature-filling process that spreads [±anterior] leftward to [+strident] segments that lack an anterior specification.

(3) [±anter] → Ø / ___



The rule of (1a) is ordered in between the delinking and spreading parts of the harmony. To see how this solution works, examine the derivation in (4), where [S] stands for a sibilant unspecified for [±anterior].

(4)



(5a) lists tautomorphemic [s] + nonstrident coronal clusters. How can they be exempted from the rule in (1a)? (5b) exemplifies the stem /wašti/ 'of a flow, liquid

in motion'. Assuming the analysis developed above, show the derivation of *swastilokʔinus* (5c) and compare it with the derivations in (4). What role does the SCC play in your analysis?

(5) a. stumukun 'mistletoe'
slowʔ 'eagle'
wastuʔ 'pleat'

b. wašti-nanʔ 'to spill' /wašti + nanʔ/

c. s-wasti-lokʔin-us 'the flow stops on him' /s + wašti + lokʔin + us/

5.4 Sundanese

In Sundanese (Robins 1953, 1957) vowels assimilate the nasality of a preceding nasal consonant (1). Nasality propagates through a string of vowels (2) and is interrupted by a supralaryngeal consonant (1). There is one systematic exception to this statement: nasality crosses a liquid, but only when it comprises the infix-*ar/al-* marking plurality in verbs (3).

(1) mãke 'to use'
ŋũsap 'to stroke'
mãrios 'to examine'
ŋũliat 'to stretch'

(2) mĩãk 'to stand aside'
ñãũr 'to say'
ñãĩãn 'to wet'
nĩʔĩr 'to pierce'
mãhãl 'to be expensive'

(3) ñ-ãr-ãhõ cf. ñãhõ 'to know'
n-ãr-ĩʔĩs nĩʔĩs 'to cool oneself'
m-ãr-ãhãl mãhãl 'to be expensive'
ñ-ãl-ãũr ñãũr 'to say'

Develop an analysis for these data that will account for the behavior of the infix and thus explain the contrast between *mãrios/ŋũliat* and *mãrãhãl/ŋãlãũr*. Briefly discuss the relevance of these data to the issue of whether morphology precedes phonology or is interleaved with it. Are the data susceptible to an analysis along the lines suggested by Halle and Vergnaud (1987) for Russian (section 5.8.2) in which morphemes can be marked [±cyclic]? (For the data in (3), Robins transcribes the vowel that immediately follows the liquid of the infix as oral. In her phonetic study, Cohn (1990) found such denasalization only in certain contexts and with certain speakers. The transcriptions given here abstract away from this complication.)

5.5 Chi Mwi:ni

The following sentences are taken from a Chi Mwi:ni folktale (Kisseberth 1986). Assuming Selkirk's (1986) analysis discussed in section 5.8.4 in which the pho-

nemic string is metrically parsed according to the Latin stress rule and vowels are shortened in nonprominent position, examine the following sentences to determine what their prosodic phrasing must be. Mark the constituent boundaries that survive impoverishment by a parenthesis. Indicate which cases are consistent with the parameter settings of Selkirk's analysis and which ones (if any) are not; comment on cases where there is a disparity between the syntactic and the prosodic constituency. (Hints: Recall the rule lengthening a word-final vowel that is not phrase-final; long vowels shorten in closed syllables; homorganic nasal-stop clusters count as syllable onsets.)

(1) sku mo:yi jira:ni wa?ale numba:-ni wamwambile mamaye
one day neighbors came house-loc [and] they-tell mother-of

Hasi:bu kuwa: wo wanakenda maduri:-ni xtinda skuñi na
Hasib that they were-going forest-loc to-cut firewood and

wataxpenda Hasi:bu kenda na: wo.
they-wanted Hasib to-go with them

(cf. nu:mba 'house', ma:ma 'mother')

(2) ma:ma shxi:ra chiwa?ambila kuwa: ye tamulila mphu:nda
mother agreed [and] told-them that she would-buy a-donkey

(cf. x-wa:mbila 'to tell')

(3) sku ya pi:li wachenda te:na wachiruda na skuñi zi:ŋgi.
day of p. they-went again [and] returned with firewood much
'The next day they went again and returned with much firewood.'

(4) ichanza kuña: nvula.
it-began to-rain rain
'It began to rain.'

(5) Hasi:bu chimuza ma:maye zi:kopi ziwo za wa:waye.
Hasib asked mother-his where-be books of father-his
'Hasib asked his mother where the books of his father were.'

(6) ma:ma chimji:ba ya kuwa ziwo za wa:waye zimo nthini ya mivu:ŋgu.
mother answered him that books of father-his are under of bed
'Mother answered him that the books of his father are under the bed.'