3. The Cycle in Phonology

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0 Introduction

The principle of cyclic rule application is taken as a fundamental property in much current theoretical work in phonology, with far-reaching effects on the behavior of phonological rules and rule systems.[1] Cyclicity is invoked to explain many characteristics of rule application, such as:

- the failure of rule application in nonderived, monomorphemic environments;
- the application of a rule to a morphological constituent which is a substring of the word;
- rule ordering paradoxes – apparent violations of the strict linear ordering hypothesis, which requires all phonological rules to apply in a sequence, with each rule applying only once.

Cyclicity was at the core of some of the earliest work in generative phonology, playing an important role in the analysis of English stress in the landmark work of Chomsky and Halle (1968, hereafter *SPE*).[2] Laying out the crucial role of morphological structure in constraining phonological rule application, cyclicity in early generative theory paved the way for the future development of the influential theory of lexical phonology (Mohanan 1986; Kiparsky 1982c, 1985a; inter alia). Current research on the syntax–phonology interface can be seen as further extending our understanding of the nature of domains which constitute complex phonological expressions (Nespor and Vogel 1986; Inkelas and Zec 1990; Kisseberth 1992). From the perspective of current work, it appears an irrefutable truth that phonological rules can be classified and constrained according to the type of structured domain in which they apply.

The principle of cyclic rule application provides a mechanism for identifying phonological rule domains (though as discussed in section 4.4, it offers at best a partial account), but its scope extends beyond the matter of domains, to include questions concerning the abstractness of phonological representation, the use of diacritics to constrain rule application, and the proper application of certain classes of rules, among others. To appreciate the multifaceted set of constraints invoked by the principle of cyclicity, we begin by considering the history and development of the Strict Cycle Condition.

1 SPE

The principle of cyclic rule application is defined in *SPE* as a component of the theory of rule ordering (p. 20). It is argued there that phonological rules appear within a grammar in a strict partial order; for two rules R_1 and R_2, either R_1 precedes R_2, R_2 precedes R_1, or the two rules are unordered (in which case either ordering will produce the correct results).[3] Phonology takes as its input a string with its labeled morphological bracketing. The ordered sequence of rules, $R_1,\ldots, R_n$, applies first to the innermost constituent of a morphologically complex word, the maximal string that contains no

brackets, with each rule applying only once. The final rule in the rule sequence, R_n is a special rule that erases the innermost brackets, as in (1).

(1) Rule R_n applying on cycle 1:...$[_2X[_1Y]_1Z]_2$...→...$[_2XYZ]_2$...

After the inner brackets are erased, the derivation continues with another round of application of the rules R_1,..., R_n applying on the next cycle, which is as before the maximal string that contains no brackets [XYZ], in our example above). The result of this convention is that each cyclic rule has a chance to apply exactly once on each cycle in the derivation of a word, with the total number of applications for any rule bounded by the maximal depth of the morphological structure.

Evidence for cyclic rule application in the analysis of English stress is adduced in the contrasting pattern of nonprimary stress in the pair of words *còmpĕnsătion, còdènsătion*. In the latter form, stress assigned on the inner cycle *condénse* carries over in the form of a secondary stress on the outer cycle. In contrast, còmpĕnsátion has no comparable inner cycle **compénse*, and hence derives no secondary stress rules assign a secondary stress on the first syllable of *còmpensátion*. These two words are in other respects nearly identical in phonological form. The *SPE* analysis of stress derives the different stress patterns of the two words from their differing morphological structures by allowing stress assignment to apply on each morphologically defined cycle.[4]

2 The Strict Cycle Condition (SCC)

In his 1976 thesis on Catalan phonology, Mascaró, introduces an important reformulation of the principle of cyclic rule application. Drawing from Chomsky's (1965) proposal of the Strict Cycle Condition (SCC) for syntax, and the extension of that principle into phonology by Kean (1974), Mascaró proposes a set of constraints governing the proper application of cyclic rules. A simplified version of Mascaró's SCC (from Kiparsky 1982a, p. 41) is presented in (2).

(2) Strict Cycle Condition

1 Cyclic rules apply only to derived representations.
2 *Definition*: A representation ϕ is *derived* w.r.t. rule R in cycle j iff ϕ meets the structural analysis of R by virtue of a combination of morphemes introduced in cycle j or the application of a phonological rule in cycle j.

The SCC has two principal empirical effects: (1) it prevents a cyclic rule R applying on cycle *j* from reaching back inside an earlier cycle i to apply to a string contained wholly within cycle i (hereafter referred to as the Reaching Back Constraint); (2) it prevents R from applying to a string contained within a single morpheme (the “derived environment” constraint), except under very special conditions. The cyclic rule R can apply to a monophemic string only if that string has been altered by the prior application of another phonological rule. In the literature on lexical phonology (discussed below in section 3), it is assumed that all the cyclic phonological rules preceeds all the noncylic rules (those rules not subject to the SCC); the noncyclic rules apply in a single pass to the complete string. Therefore, the only kind of the rule that could precede the cyclic rule R would be another cyclic rule, which would itself be subject to the SCC.[5] The effect of the SCC is that cyclic rules typically apply across a morpheme boundary and are prohibited from applying within a morpheme. In fact, the most common argument presented for the cyclic application of a phonological rule is its failure to apply within roots or other monomorphemic environments.

We will consider both parts of the SCC in turn, beginning with the claim that cyclic rules do not reach back inside previous cycles. Consider a language with the cyclic rules in (3) applying in the counterfeeding order $a < b$. These rules applying on a single cycle will map the strings AD BD and CE DE. The SCC prevents the two-cycle derivation in (4) mapping ACE BDE, where the rule (3a) applies on cycle 2 to a string which is not by any criterion derived on cycle 2. Given the SCC, (3a) would be blocked on cycle 2, or any subsequent cycle.[6]

(3)

(a) A → B/—D
(b) C → D/—E

(4)

[ACE] *cycle* 1
n/a (3a)
[ADE] (3b)
[X ADE Y] *cycle* 2
[X BDE Y] (3a) *SCC violation
n/a (3b)

Without the SCC, the counterfeeding or counterbleeding ordering of cyclic rules would be undermined in words with multiple with multiple derivational cycles, and so a principle limiting the domain of application of cyclic rules would seem necessary. And yet a review of the literature on cyclic phonology reveals very few arguments which make an explicit appeal to the Reaching Back Constriant of the SCC.[7]

2.1 The Alternation Condition

We turn now to consider the motivation for the "derived environment" constraint on cyclic application. In his formulation of the SCC, Mascaró builds on a condition proposed by Kiparsky (1968–1973) governing the proper application of neutralization rules. Kiparsky claims that rules that apply without exception (automatically), with the effect of neutralizing a phonemic distinction, must not be allowed to apply to all occurrences of a morpheme. This condition is termed the *Alternation Condition*, and is the precurser to the SCC, as it prohibits analyses in which neutralization rules wholly within morophemes, in nonderived environments

Kiparsky proposes the Alternation as a way of constraining the abstractness of phonological analysis. He raises several strong arguments against the use of diacritics, or the diacritic use of phonological features, as a means of expressing exceptionality in forms that fail to undergo a phonological rule whose structural description is otherwise satisfied. The *SPE* analysis of English Trisyllabic shortening and early treatments of vowel harmony in Hungaria and Finnish are used to illustrate the objectionable use of diacritics in phonological analysis.

(5) Trisyllabic Shortening
$V \rightarrow [-long] / \_\_C_o V_i C_o V_j$, where V_i is not stressed

The *SPE* analysis of English involves a rule of Trisyllabic Shortening (5), which is responsible for the shortening (and subsequent laxing stem vowels when certain suffixes are added. It applies to shorten the long stem vowels in *divinity, opacity, tabulate, derivative*, but is somehow blocked from shortening vowels in monomophemic words like *ivory, nightingale, Omaha*. How is Trisyllabic Shortening to be blocked in monomorphemic words? The SPE analysis involves setting up abstract underlying representations so that these forms no longer satisfy the structural description of Trisyllabic Shortening; *nighinagle* derives from underlying /nixtVngael/, with ix *ay* by independent rules, and *ivory* is analzed as bisyllabic /ivory/, with a final glide which vocalizes after Trisyllabic Shortening has applied. In some cases, the underlying representations receive no independent support beyond blocking Trisyllabic Shortening, and hence Kiparsky argues that they involve the diacritic use of phonological features to mark rule exceptionality.

Kiparsky (1982b) notes another problem with Trisyllabic Shortening – many words with invariant short vowels in the environment for Trisyllabic Shortening have ambiguous derivations. Words like *alibi, sycamore, camera, Pamela* can be represented with an underlying short vowel or with a long vowel that takes a "free ride," undergoing Trisyllabic Shortening. He observes that "absolute neutralization [as opposed to contextual neturalization–JC] is a consequence of setting up underlying distinctions for the sole purpose of classifying segments into those that do not meet the structural description of a rule (p. 128)." In this example, the analysis of Trisyllabic Shortening involves neutralization rules such as ix → i → ay, and glide vocalization (y → i).

The analysis of transparent vowels in Hungarian vowel harmony presents another example where neutralization is necessitated by positing abstract underlying representations.[8] In this system of back harmony, suffixs vowels assimilate in backness to root vowels. A class of exceptions to this regular process involves roots with the "transparent" vowels /i, e/. A certain subset of such roots unexpectedly condition back suffix. vowels. These pseudo-back vowel roots can be accounted for by positing the abstract back vowels /I E/, which function regularly in harmony by conditioning back suffix vowels, and are later neutralized by a rule which attributes the feature [-back] to all unrounded non-low vowels.

Kiparsky argues on the basis of sound change that absolute neutralization does not occur in phonological systems. There are no known cases of analogical reversal of absolute neutralization, as there are for contextual neutralization. In order to constrain the use of abstract underlying representations, and the concomitant use of absolute neutralization, Kiparsky formulates the Alternation Condition, as in (6).

(6) The Alternation Condition
Obligatory neutralization rules cannot apply to all occurrences of a morpheme.

The Alternation Condition constrians underlying representation in several ways. It requires the lexical representation of a nonalternating form to be identical to its surface form (with low-level, automatic phonetic processes factored out); it requires a single underlying representation for distinct morphemes which are always identical in surface form; and it requires morphemes which are always distinct in surface form to have distinct underlying phonological representations. For the analysis of Trisyllabic Shortening, it disallows the abstract underlying representations set up in *SPE* to block the application of the rule in forms like *nightingale*. Kiparsky suggests that the exceptionality of such forms can be achieved through the judicious use of rule features, such as [-Trisyllabic Shortening]. For the Hungarian vowel harmony example, the abstract analysis sketched above is ruled out since it necessitates a rule of absolute neutralization for deriving/i, e/ from /I.E/.An alternative analysis, consistent with the Alternation Condition, requires that all roots with nonalternating neutral vowels bear the same vowels in underlying form. The rule of Vowel Harmony is formulated to take an underlying back suffix vowel and convert it into a front vowel after a front vowel root. Roots with neutral vowels that trigger back suffix vowels are marked as exceptions to Vowel Harmony, and the back suffix vowels that follow are just the underlying suffix vowels.

In a subsequent development the Alternation Condition is modified, resulting in the Revised Alternation Condition (7), which introduces the notion of a "derived environment" as the constraining factor in the application of neutralization rules (Kiparsky 1973b). The Revised Alternation Condition constrains the abstractness of underlying representation by limiting neutralization rules to apply only in environments derived by morphological concatenation and other morphological or phonological processes. Thus, the Revised Alternation Conditions blocks Trisyllabic Shortening from applying in the nonderived forms *nightingale, ivory*, as well as ruling out abstract underlying representations containing long vowels in forms like *Pamela, Omaha*. It provides a straightforward way of capturing the generalization that all nonderived words fail to undergo Trysyllabic Shortening without systematically marking such forms as exceptional.[9]

(7) Revised Alternation Condition (RAC):
Obligatory neutralization rules apply only in derived environments

Kiparsky (1973b) discusses two rules in support of the Revised Alternation Condition: the Sanskrit rule of s-rtroflexion (Ruki), and the Finnish rule of Spirantization. The Sanskrit Ruki rule accounts for a regular process by which s becmes s following one of the class of Ruki triggers, /r, u, i,/ and velars. Ruki applies regularly across morpheme boundaries (8a), and fails to apply in monomorphemic strings (8b). However, Ruki does apply morpheme-internally when its environment is created by morpho-phonological processes (ablaut, reduplication) affecting root vowels (8c).

(8)

(a)	2 sg. /-si/	bi-bhar-ṣi	"you carry"
	aorist /-s/	a-bha:r-ṣ-am	"I carried"
	future /-sya/	bak-ṣya-ti	"he will say"
	desid. /-sa/	ni-ni:ṣa-ti	"he wants to lead"
(b)	kisalaya	"sprout"	
	barsa	"tip"	
	kusuma	"flower"	
(c)	śa:s	"instruct"	
	/śas-ta/ → śiṣ-ṭa	"taught"	
	vas	"shine"	
	/va-vas-us/ → u:ṣ-us	"shone"	
	ghas	"eat"	
	/ja-ghas-anti/ → jakṣati	"they eat"	

The Revised Alternation Condition permits Ruki in the morphologically derived forms (8a) as well as the phonologically derived forms (8c), and blocks Ruki in the nonderived environment of (8b). Similarly, in Finnish, the Spirantization rule (t → s/__i) applies across a morpheme boundary (9a), and in environments derived by Raising (e → i/__#) (9b), but not in nonderived monomorphemic environments (9c).[10]

(9)

(a)	halut-a	"want"
	halus-i	"wanted"
(b)	vete-nä	"water" (ess.)
	vesi	"water" (nom.)
(c)	tila	"place"

It is worthwhile to note that in the two decades of research since the proposal of the Revised Alternation Condition, many examples have been cited in which rules apply only across a morpheme boundary, yet there have been no additional examples in which a derived environment can be created morphemeinternally by the prior application of a phonological rule. The absence of further examples calls into question Kiparsky's definition of "derived environment." If cyclic were restricted to *morphologically* derived environments alone, it would be possible to reforumalate the SCC as a condition requiring the positive specification of morphological structure, in which case cyclic rules would be those which are lexically governed.

2.2 The SCC in Catalan

We have seen that two independent lines of research resulted in two distinct constraint in phonological theory: (1) the revised Alternation Condition provides a constraint on the application of

neutralization rules limits the abstractness of phonological analysis, and links underlying representation more closely with surface form in the case of nonalternating morphemes; and (2) Chomskyi's condition on cyclic rule application, extended to phonology, prevents cyclic rules from reaching back. Mascaró's (1976) proposal is to merge these two constraints by identifying the class of neutralization rules with the class of cyclic rules. He recognizes that the Revised Alternation Condition's constraint on derived environments has a close connection to the Reaching Back Constriant argued to be required by cyclic rule application. By collapsing neutralizing and cyclic rules into a single class, he can derive the effects of both constraints from a single condition on rule application. Mascaró argues for this position with the analysis of a complex range of phenomena in Catalan phonology. Of the rules he proposes for Catalan, "six" are neutralizing and obligatory, and can apply either cyclically or noncyclically... The other eight obligatory and neutralizing rules have to be cyclic... The remaining rules are optional or non-neutralizing. Neither can [they] be cyclic [*sic*]" pp.17-18).

What kind of evidence does Mascaró present for the cyclicity of eight obligatory and neutralizing rules? The most convincing type of argument would involve a rule which must apply on each cycle, does not apply to nonderived (monomophemic) strings, and for which there is clear evidence of the Reaching Back Constraint. Although Mascaró presents five arguments for the cyclicity of eight phonological rules, no single argument demonstrates the cluster of properties noted above. Cole (1992b) reviews Mascaró's cyclic analyses of Catalan and shows that each argument for cyclicity breaks down under reanalysis of the data. It is argued there that the only rules that may require cyclic application are the metrical rules which assign stress.

In several instances, dropping Mascaró's assumption that stress is underlying in Catalan in favor of a metrical analysis of stress assignment (along the lines of Harri's 1983, 1991 and analysis of Spanish) radically alters the nature of the rules which interact with stress. The resulting system no longer provides the rule interactions and rule-ordering system no longer provides the rule interactions and rule-ordering paradoxes that lead Mascaró to posit cyclic rule application. Similar results obtain when Mascaró's analysis of obstruent contraction and deletion is replaced with one which incorporates more recent insights into the nature of affricates. The updated rules system is entirely different and does not present the problems that lead Mascaró to propose a cyclic analysis. In other cases, the phonological rules posited by Mascaró are said to be cyclic since they are subject to domain restrictions, such as applying in lexical and phrasal domains, or in word and compound domains. In current phonological theory, there are mechanisms other than cyclicity to establish rule domains, and since the rules in question do not need the cyclic constraints prohibiting "reaching back" or applying in nonderived environments, they do not provide support for the SCC. Cole (1992b) considers these and other factors of Mascaró's cyclic analyses, ultimately rejecting the claim that Catalan provides important empirical support for the SCC. The alternative analyses for the phenomena motivating Mascaró's proposals do not refute the SCC; they merely fall outside of its scope. The only rule which may plausibly have a cyclic application it stress assignment, and there is no evidence that stress assignment in Catalan is affected by the SCC.

In light of these findings, the Catalan data cannot be taken as providing decisive support for the SCC. We must now consider what empirical evidence does contitute support for the SCC. As Kiparsky notes, "the SCC is essential for *any* cyclic phonology, irrespective of theose cases [of rules blocked in nonderived representations—JC], in order to permit countrerfeeding order among cyclic rules." (1985a, p. 88). Thus, given that cyclic rule application is required for *any* analysis (e.g., English stress), and given that rules may be extrinsically ordered, some principle must prevent cyclic rule application from undermining the ordering of rules within the grammar. It is relevant to note at this point that extrinsc rule ordering itself seems to play less of a role in phonological analysis than it did a decade or two ago, reflecting the general trend to look for explanations in the nature of phonological representation and the constraints that govern it, rather than in the principles of rule organization that dominated much of the early work in generative phonology. We further investigated the empirical basis for the principles of cyclic rule application in sections 5-7, where we review cyclic analyses of a range of phonological phenomena, including stress, syllable structure, and some segmental processes. But before turning empirical evidence, we complete this historical overview by considering the role of the cycle in the theory of lexical phonology.

3 Lexical Phonology

Lexical phonology is a word-based theory of morphology in which morphology and phonololgy interact in a component of morphophonological derivation called the lexicon. Its origins lie in Siegel's 1974 proposals for interleaving phonology and morpholog, as well as Pesetsky's (1979) cyclic analysis of Russian phonology and Strauss's (1982) work on lexicalist phonology. The theory of lexical phonology is worked out in the 1982 dissertation by K. P. Mohanan (revised in Mohanan 1986), and in the contemporaneous paper 'Lexical Morphology and Phonology" of Kiparsky (1982a). A revision of the theory is presented in Kiparsky (1985a).[11] Lexical phonology is based on the idea that some phonological rule apply cyclically, and presents a framework in which the basic principles and constraints of cyclic rule application derive from the model of morphology-phonology interaction.

Kiparsky (1982a) raises three questions that follow from the theory of cyclic phonology, as formulated in Mascaró (1976):

> 1 Why should there be two types of phonological rules, cyclic and noncyclic?
>
> 2 Why should the definition of proper cyclic application have the particular and very complex form it has?
>
> 3 What is the *inherent* connection between cyclicity, a property of rule ordering, and the restriction to derived environments? (P. 44)

He argues against Mascaroó's proposal to identify the class of cyclic rules with the class of obligatory neutralizing, rules, on the basis of several counter examples. First, Kiparsky notes the existence of cyclic rules which are not neutralizing, and which must apply in nonderived environments, in apparent violation of the SCC. One such example involves the English rules of stress assignment. Kiparsky (1979) and Hayes (1981) present arguments for the cyclic application of the English word stress rules, in addition to the arguments presented in *SPE* (noted above, see also discussion in section 6.1). Yet stress applies on the root cycle, a morphologically nonderived environment. Furthermore, there is no evidence that any other phonological rules precede stress, rules which might create a phonologically derived environment.[12] Thus, in English the stress rules apply in violation of the derived environment constraint of the SCC.

Harris (1983) presents an analysis of Spanish phonology in which he argues that syllabification is cyclic. Syllabisfication is (universally) obligatory, but not neutralizing, since syllable structure is presumed to be unmarked in lying representation.In other words, the rules that build syllable structure do not create output that is distinct from other lexical items on the basis of a */lexically* (i.e., phonemically) distinct feature. Harris argues for the cyclicity of syllabification on the basis of its interactin with the rules of Lateral and Nasal Depalatalization. The depalatalization rules are responsible for the alternations ñ → n and λ → /in a syllable rhyme, as seen in the forms in (10) (the palatal lateral is represented by orthographic *ll*).

(10)

be*ll*o	"beautiful"	be*l*dad	"beauty"
donce*ll*a	"lass"	donce*l*	"lad"
reñir	"to quarrel"	re*n*cilla	quarrel (n.)
desdeñkar	"to disdain"	desdé*n*	"disdain" (n.)

The rules of Lateral and Nasal Depalatalization follow syllabification, since they refer to syllable constituency (the rhyme) in their structural descriptions. Lateral Depalatalization is argued to be a cyclic rule, on the basis of forms like *donce[l]es* "lads". As shown in (11), on the first cycle, syllabification applies, followed by Lateral Depalatalization, and on the second cycle syllabification applies again, this time placing the derived [l] in onset position. A noncyclic application of Lateral Depalatalization would be bled by syllabification), on the second cycle (or with postcyclic

syllabification) since the palatal [λ] would be in a syllable onset.

(11)

1st cycle: [doncelλ] → [don.celλ.] → [don.cel.]
syll. depal.
2nd cycle: [doncel es] → [don.ce.les.]
syll.

The evidence for cyclic Nasal Depalatalization involves a similar example, in which a morpheme-final ñ depalatalizes, even though it is in onset position in the surface form, *desde[n]es* from underlying / desdeñ-es / "disdains" (n. pl.).

Both Depalatalization rules apply cyclically, but do not themselves violate the SCC, since in each case they apply to the output of syllabification, which Harris claims creates a derived environment for depalatalization. The analysis requires that syllabification apply cyclicaly; yet, its application on the root cycle in *doncel[1]es* and *desde[n]es* is in clear violation of the derived environment constraint of the SCC.[13]

Kiparsky cites a rule of English phonology as another counterexample to the claim that all obligatory neutralizing rules respect the SCC.

(12)

Velar softening (Kiparsky 1982c, p. 40):

$$k \rightarrow s / \_\_\_\_ \begin{bmatrix} -\text{back} \\ -\text{low} \end{bmatrix}$$

The rule of Velar Softening (12) is responsible for the *k* □ *s* alternation in forms like *electric* □ *electricity* and *critic* □ *criticize*. Folowing the analysis of *SPE*, Kiparsky (1982a, p. 40) argues that the same rule applies in the derivation of *conceive, proceed, recite* from underlying /kAn-kiv/, /pro-kid/, and /rikayt/, respectively. The two arguments in support of this fairly abstract analysis focus on the exceptional behavior of a very restricted class of bound morphemes in English, and thus lack generalization. If one wants to maintain the *SPE* account, then Velar Softening stands as a neutralizing rule which applies in a nonderived environment, within the stem / kiv, kid, kayt /, in apparent violation of the SCC.[14]

From these four examples – English stress, Spanish syllabification and Aspiration, and English Velar Softening – we may conclude that (1) not all cyclic rules are neutralizing; (2) not all obligatory neutralizing rules apply on each cycle; and (3) not all obligatory, neutralizing rules are subject to the constraints imposed by the SCC.

To resolve these difficulties with Mascaró's analysis of cyclic rules, lexical phonology proposes a reinterpretation of cyclicity. In lexical phonology, morphology and phonology are interleaved in the process of word formation; phonological rules apply to the immediate output of each morphological process (affixation or compounding). For example, the derivation of *illegality* from / iN-legal-ity / contains three cycles of morphology and phonology, as seen in (13).[15]

(13)

[legal]	*1st cycle*
[légal]	stress
[iN [legal]	*2nd cycle*
[il [legal]]	assimilation

[il [légal]] stress
[[illegal] ity] *3rd cycle*
[[illegál] ity] stress

In this model, cyclicity does not have to be stipulated; it results automatically from the interleaving of morphological and phonological processes. The details of the theory address the questions of which (if not all) morphological processes are *cyclic*, in that their output is subject to immediate phonological derivation, and which phonological rules apply *lexically*, in the process of word formation. The cyclic phonological rules then are those that apply lexically (in the process of word formation) to the output of the cyclic morphology. The criteria for determining lexical rules and cyclic morphology have changed with the evolution of the theory of lexical phonology. Kiparsky (1982a) claims that all word-formation processes are cyclic, and therefore all lexical phonological rules are intrinsically cyclic. This claim has been greatly revised in later work, as we discuss below.

3.1 Deriving the SCC

The cyclic application of phonological rules to morphological subconstituents of the word derives from the model of how morphology and phonology interact. However, lexical phonology derives not only the notion of cyclic domains, but also the constraints on the proper application of cyclic rules, formerly encoded in the SCC. Kiparsky (1982a, p. 46) argues that every lexical entry constitutes a phonological rule – an identity mapping, $\alpha \rightarrow \alpha$, for every lexical entry / α /. The identity rule competes for application with every other phonological rule in the lexical component of the grammar. Thus, in the phonology of English there is an identity rule for *nightingale*, /ni:tVngæ:l/:/ni:tVngæ:l/, which competes against an application of Trisyllabic Shortening producting / ni:tVngæ:l/ → /nitVngæ:l/. The input to both rules is the same, but only one can apply since their outputs are distinct (in this case, mutually exclusive). Kiparsky argues that since both rules belong to the lexical component, they are subject to the Elsewhere Condition, a principle of rule ordering that imposes a disjunctive ordering on two rules whose structural descriptions are overlapping, and whose output is distinct.[16] The Elsewhere Condition states that only the more specific of the two rules will apply. Thus, a lexical identity rule will always take precedence over a lexical phonological rule applying to the same lexical entry, since the identity rule is the most specific (contains the most detailed structural description) of all phonological rules. Given (1) the Elsewhere Condition; (2) lexical identity rules for every lexical entry; and (3) phonological rules assigned to the lexical component, lexical phonology can derive the constraint of the SCC that prevents cyclic (now lexical) rules from applying to underived monomorphemic strings.

In addition to the lexical entries that correspond to root morphemes such as *nightingale*, lexical phonology also maintains that the output of every layer of derivation constitues a lexical entry. This means that there will be lexical entries for nonderived forms like *topic*, as well as for derived forms like *topical* and *topicality*. Cyclic rules are blocked from "reaching back" by the presence of these derived lexical entries.

To summarize, we have seen that cyclicity in phonology derives from the architecture of morphology-phonology interaction in the lexical phonology model, and the constraints of the SCC derive from the Elsewhere Condition, together with the assumption that lexical entries constitute lexical identity rules. Within this model, rules which apply across word boundaries are outside the scope of lexical derivation. These *post-lexical* rules are not within the lexical component of the grammar. The output of the post-lexical rules do not derive lexical identity rules, and therefore the post-lexical rules are not blocked by the Elsewhere Condition from applying in nonderived environments. So, in lexical phonology only lexical rules apply cyclically, with each step of morphological derivation, and the post-lexical rules apply noncyclically. Similarly, only lexical rules are subject to disjunctive ordering by the Elsewhere Condition, deriving the effects of the SCC, and post-lexical rules apply in an unrestricted ("across-the-board") fashion. This analysis predicts that there is no cyclic iteration of phonological rules at the phrasal level, since the model has no way of deriving cyclic rule application outside of the lexical component. Any attempt to derive an account of post-lexical cyclicity similar to the analysis of lexical cyclicity would involve the bizarre claim that words are inserted into phrase

structure one at a time, with phonological rules applying to the output of each step of insertion.

3.2 Structure-building Rules and the SCC

Earlier in this section we reviewed four counterexamples from English and Spanish to Mascaró's proposal that cyclic rules are the obligatory, neutralizing rules. In lexical phonology, the cyclic rules are the lexical rules, and there is nothing that requires lexical rules to be neutralizing or obligatory. However, all cyclic rules are subject to the Derived Environment Constraint, now resulting from the Elsewhere Condition. Yet, we have seen that stress assignment in English and syllabification in Spanish must apply cyclically and must apply cyclically and must apply in the nonderived environment of the root cycle. Kiparsky (1982c, p. 47) argues that rules that assign metrical structure (stress and syllable structure) derive output which are not *distinct* from their input, because they do not bear contradictory feature specifications, or contradictory metrical structure. These *structure-building* rules therefore are not subject to disjunctive ordering with lexical identity rules by the Elsewhere Condition. The Elsewhere Condition applies only in the case of two rules whose input is identical, and whose output is distinct. So, structure-building rules are never blocked by the Elsewhere Condition, and may apply on any lexical cycle. The question arises whether a structure-building rule applying on the root cycle qualifies as creating a derived environment for the further application of *structure-changing* lexical rules. Kiparsky claims that "cyclically derived phonological properties can trigger subsequent rules on the same cycle. Thereby, even feature-changing rules can apply on the first cycle if they are fed by cyclic rules" (Kiparsky 1982c).

In section 4.1, we examine several arguments against the claim that the SCC is derivable from the Elsewhere Condition. In later work, Kiparsky (1985a, p. 91) rejects this notion, maintaining that only lexical rules that produce *distinct* output create phonologically derived strings. The stricter interpretation of derived environment requires a reanalysis of Spanish Depalatalization, since as it stands, Harris's analysis of Spanish involves the cyclic application of Depalatalization on the root cycle, fed only by cyclic syllabification.[17] Kiparsky suggests instead that Depalatalization applies to palatal/ñ, ñ/ in coda position at the word-level. Word-level rules are noncyclic lexical rules applying at the last lexical level of the phonology, not subject to the SCC (discussed further in section 4.2). The word-level Depalatalization rule must be ordered before syllabification, which applies in both the cyclic and noncyclic levels. Under this analysis, the derivation of *doncella* "lass" and *donceles* "lads" proceeds as in (14) (cf., (11)). Note that the noncyclic rules apply after the plural suffix *es* has been added. The plural suffix is not part of Level 1 morphology, which is the cyclic level, and thus does not derive an environment for the application of cyclic rules. Noncyclic lexical rules apply after all noncyclic lexical affixation.

(14)

Cycle 1:	donceλ	donceλas
Syllabification	don.ce.λ.	don.ceλas
Noncyclic:	don.ceλ.-es	don.ce.λas
Depalatalization	don.cel.-es	n/a
Syllabification	don.ce.les	don.ce.λas

4 Challenges to the Theory of Cyclic Phonology

The formulation of lexical phonology in Mohanan (1986) and Kiparsky (1982a) stands as the strongest, most restrictive formulation. But several claims central to the strong version of lexical phonology are challenged in subsequent work. In this section we consider arguments against the following claims concerning the formal status of cyclicity in the strong version of lexical phonology:

1 The SCC is derived from the Elsewhere Condition.

2 All lexical rules are cyclic.

3 The derived environment constraint applies to all and only cyclic rules.

4 Cyclicity derives from the interleaving of phonology and morphology.

4.1 Another Look at Deriving the SCC

Mohanan and Mohanan (1984) argue against the claim that the SCC can be derived from the Elsewhere Condition. In their analysis of Malayalam, they maintain that a single rule can apply in both the lexical and post-lexical components. Therefore, there are not two disjoint sets of phonological rules contained in the lexical and post-lexical modules, but rather a single set of ordered rules, each of which is assigned to some lexical and/or post-lexical domain. In this interpretation, there is no principled explanation for why only lexical rule application should be subject to disjunctive ordering by the Elsewhere Condition. Yet, if the Elsewhere Condition applies uniformly to all phonological rules, then it will have the undesired result that post-lexical rules will be subject to the derived environment constraint. If a post-lexical phonological rule tries to apply to a form which is identical to a lexical entry (either a root form, or a morphologically derived form), and if the post-lexical rule creates a distinct output (is not a structure-building rule), it will be blocked by the Elsewhere Condition, just as lexical rules are.

In a revision to lexical phonology, Kiparsky (1985a) abandons the argument that the SCC is derivable, resorting to an independent stipulation of the SCC in Universal Grammar. This move enables him to formulate analyses of Catalan Nasal Assimilation, Russian consonant voicing, Vata ATR Harmony and Guraní Nasal Harmony in which a rule applies in both the lexical and post-lexical stages of derivation, subject to the SCC only in its lexical application.

Iverson and Wheeler (1988) also argue against deriving the SCC from the Elsewhere Condition. They argue that beyond the dubious status of Lexical Identity Rules, there is virtually no evidence of phonological rules which require disjunctive application (pp. 331–332). The only possible case involves the English rules which build metrical structure, argued to apply disjunctively in *SPE*. But Kiparsky (1982a, p. 52) presents a reinterpretation of those stress rules which eliminates the need for their disjunctive application.

Iverson and Wheeler maintain the *pace* lexical phonology, the Elsewhere Condition is not required to account for phonological blocking in nonderived environments. Instead, they argue that the Revised Alternation Condition is the appropriate condition to account for phonological blocking, and is independently required even in a theory that has the SCC, in order to prevent abstract analyses involving "free rides." As it stands, the SCC does not prevent potentially neutralizing *noncyclic* rules from applying in nonderived environments. In principle it is not possible to prevent the kind of neutralization that was the focus of the early debate on abstractness – neutralization that is explicitly ruled out by the Revised Alternation Condition. Yet, as Iverson and Wheeler note, including the Revised Alternation Condition in phonological theory makes the SCC wholly unnecessary, at least in its capacity to enforce the derived environment constraint. The only duty left for the SCC is to preserve counterfeeding or counterbleeding order among cyclic rules (the Reaching Back Constraint).[18]

4.2 Noncyclic Lexical Rules

In the strong formulation, lexical phonology maintains that all lexical phonological rules are subject to the SCC. However, this claim is challenged by Mohanan and Mohanan (1984) and Halle and Mohanan (1985), who argue that there are certain structure-changing lexical rules in English and Malayalam that must apply in the lexicon, yet which violate the SCC by applying in nonderived environments. We have already seen one example in the application of Velar Softening to forms like *receive* from underlying /ri-kiv/. Another example is the English rule of *n*-Deletion, discussed by Halle and Mohanan, that deletes the syllable-final *n* in a nonderived environment in *damn, hymn*, but does not delete the *n* before Level 1 suffixes, as in *dam[n]ation, hym[n]al*. Thus, *n*-Deletion is a structure-changing rule (as all rules of deletion are) applying in a nonderived environment. If these were all of the facts, we might formulate a post-lexical rule to delete the syllable-final *n*; but there is evidence that the rule in question cannot be post-lexical. Notice that the rule applies in words with inflectional suffixes, such as *damning*, even though at the post-lexical level, the *n* should have been

resyllabified into the onset of the following syllable, cf. *dam.na.tion*. Halle and Mohanan propose that *n*-Deletion is in fact a lexical rule, applying at Level 2, before the inflectional suffixes are added. They argue that all Level 2 lexical rules apply noncyclically, exempt from the SCC. For Halle and Mohanan, cyclicity is a property of an individual level, rather than a general property of all lexical rules. Level 1 is argued to be a cyclic level, so all Level 1 phonological rules, like stress assignment and certain lengthening and shortening rules affecting vowels, apply cyclically. Other noncyclic Level 2 rules in English include *g*-Deletion, which applies in a nonderived environment in *long* as well as in *longing* and Velar Softening.[19]

In addition to the work cited above, Booij and Rubach (1987) argue for a set of lexical, noncyclic rules (termed "post-cyclic") in their analysis of Polish phonology. As discussed in section 7.2, the cyclic analysis of Polish *yer* vowels involves a rule of *yer*-Deletion, which deletes any *yer* which is not followed by a *yer* in the next syllable. *Yer*-Deletion feeds Noncontinuant Depalatalization, a rule which is shown not to apply across word boundaries. Therefore, both *yer*-Deletion and Noncontinuant Depalatalization are lexical rules. Yet Booij and Rubach (1987) demonstrate that the cyclic application of *yer*-Deletion cannot derive the output; it would delete nearly every *yer*. The status of cyclic and noncylic rules in Polish *yer* phonology is discussed in more detail in section 7.2. Further evidence for noncyclic lexical rules is presented by Rubach (1990) in his analysis of German syllabification, reviewed below in section 7.3.

4.3 Cyclicity and the Derived Environment Constraint

The view that only cyclic, lexical rules are subject to the Derived Environment Constraint is brought into question by certain facts from Finnish (Kiparsky 1968–73) and Ondarroan Basque (Hualde 1989). Consider first the Finnish case. As mentioned in section 2.1, Finnish has a rule raising *e* → *i* word-finally. Raising feeds the rule of Spirantization, (*t* → *s*/__*i*), as seen in the surface form *vesi* "water" (nom.) from underlying *vete*. The Spirantization rule is restricted to apply only in derived environments, as evidenced by monomorphemic forms like *tila* "place", which maintain/t/ preceding/i/. Thus, by the criteria of lexical phonology, Spirantization is a cyclic lexical rule, subject to the SCC. Raising, on the other hand, cannot be a cyclic rule. In the first place, it applies to monomorphemic strings, as in *vesi*. Moreover, even if it did apply cyclically, it would incorrectly apply on the root cycle in every derivation of a form with a root final /e/, such as /vete-nä/, "water" (ess.) deriving *vetinä instead of vetenä.

In lexical phonology, rules that are sensitive to the presence of word boundaries must take place after all affixation, at the word level – the noncyclic level of lexical phonology. The problem here is that the noncyclic word-level rule of Raising must feed the cyclic rule of Spirantization, and yet by hypothesis, the noncyclic word level rules follow all cyclic lexical rules. One solution would be to reject the claim that Spirantization is a cyclic lexical rule. But doing so leaves no explanation for the existence of lexical exceptions to Spirantization. Another solution, discussed by Kenstowicz (1993), is to allow Raising to apply in the cyclic component, but only in the presence of a word boundary. This is possible if we stipulate that word boundaries are inserted as the final step in the lexical derivation, and further, that such insertion suffices to create a derived environment. Under such an analysis, Raising could apply on the cycle created by insertion of the word boundary. Raising would never apply on the root cycle, since at that point the string-final boundary is still a morpheme boundary, which is not sufficient to trigger Raising. While this boundary analysis technically works, it violates the spirit of lexical phonology, which is to eliminate the explicit reference to and manipulation of boundary symbols in the phonology.

A similar problem arises in the analysis of Vowel Assimilation in Ondarroan Basque, as discussed by Hualde (1989). Vowel Assimilation raises *a* → *e* following an /i/ in the preceding syllable, and applies only at the word boudary, as in *layune* "friend", (abs. sg.) from underlying / lagun-a/. As a word-boundary rule, Vowel Assimilation would be ordered in the noncyclic lexical component. Yet, Hualde presents clear evidence that Vowel Assimilation applies only in morphologically derived environments, as seen by monomorphemic forms such as *eliša* "church". Thus, Vowel Assimilation is a noncyclic rule which nonetheless is constrained by the Derived Environment Constraint. Hualde concludes that the Derived Environment Constraint is not an exclusive property of cyclic rules, and suggests that cyclic application and the Derived Environment Constraint constitute independent characteristics of rule application. As with Finnish, the Basque case could be resolved under the assumption that word

boundaries are inserted at the end of lexical derivation and create a derived environment for the application of cyclic rules. Then, Vowel Assimilation could be maintained as a cyclic rule, with the SCC accounting for its restriction to apply in derived environments.

4.4 Bracketing Paradoxes

The claim in lexical phonology that cyclicity follows from the interleaving of morphology and phonology has as a corollary that the constituency of phonological cycles is determined by morphological constituency. In other words, if phonological rules apply to the output of (a subset of) morphological processes, then the strings that are the input to phonological rules should always constitute well-formed morphological constituents. Unfortunately, the situation appears to be more complicated than this simple prediction affords. Specifically, there are well-documented cases in which a phonological rule applies to a substring containing the morphemes [A B], a part of a larger string ABC, even if the corresponding morphological constituent structure [A[B C]] does not identify [A B] as a well-formed constituent. Such cases are referred to in the literature as "bracketing paradoxes."

Bracketing paradoxes have long been the subject of heated debate in generative phonology. As early as 1974, Siegel discusses the constituency of the form *ungrammaticality*, which has become a classic example of a bracketing paradox in English. Given that *un*-attaches to adjectives but not to nouns, it must attach to the stem before the suffix *-ity* transforms the base adjective into a nominal. The morphological structure must therefore be $[[un[grammatical]_{adj}]_{adj}. ity]_{n}$. However, this structure is at odds with the structure motivated by phonological considerations. The suffix *-ity* belongs to the "Class 1" affixes, which trigger a stress shift and a host of phonological rules such as Trisyllabic Shortening.[20] The prefix belongs to the "Class 2" affixes, which characteristically do not affect stress and do not trigger the other "Class 1" rules. Siegel observes that Class 1 affixes typically do not attach to Class 2 affixes, a constraint which she explains by ordering Class 1 affixation prior to Class 2 affixation. Thus, on phonological grounds, the constituency of *ungrammaticality* should be $[un [[grammatical]ity]_{1}]_{2}$, with the Class 1 suffix contained in the inner constituent.

In lexical phonology, the Class 1 affixes are assigned to the cyclic lexical level (or stratum), while Class 2 affixes are assigned to the noncyclic stratum. Each stratum is characterized by different sets of morphological processes, and the cyclic phonological rules are assigned to the cyclic lexical stratum alone. Siegel's ordering principle is encoded in the Stratum Ordering Hypothesis, which maintains that morphological and phonological derivation passes sequentially through the ordered strata. Thus, forms like *ungrammaticality* present ordering paradoxes for lexical phonology as well. As discussed below, the crux of the problem is not in identifying cyclic rules and Class 1 affixes with a single lexical stratum of morpho-phonology, but in maintaining that all cyclic lexical domains occur internal to noncyclic lexical domains.

Bracketing paradoxes are not a special property of English, and examples similar to the English one discussed above have been identified in Russian (Pesetsky 1979), Warlpiri (Nash 1980), Chamorro (Chung 1983), and Indonesian (Cohn 1989). In each case, a problem arises because the because the cyclic domains of the phonology are not strictly internal to other noncyclic domains, thus creating a mismatch between the morphological and phonological constituency, under the assumptions of stratum ordering. The challenge for lexical phonology is how to derive the necessary phonological constituent while maintaining that phonological and morphological derivation are interleaved. One class of solutions recommends that phonological constituents (cycles) be derived from morphological structure through the optional application of a restructuring operation. Kiparsky (1983), Pesetsky (1985), and Sproat (1985) all present analyses which propose restructuring to account for bracketing paradoxes, although they differ in other details. Thus, the two structures [A[B C]] and [[A B]C] are related by an operation akin to associative rebracketing.

A second approach is taken by Halle and Kenstowicz (1991), who reject the framework of lexical phonology, maintaining that phonology and morphology belong to separate components of the grammar.[21] They claim that the Class 1/Class 2 distinction is formally encoded by the property of cyclicity, which characterizes both affixes and phonological rules. Cyclic affixes are those which define domains for the application of cyclic phonological rules, whereas noncyclic affixation creates morphological constituents which do not define a domain for cyclic phonological rules. For English, Class 1 affixes like *-ity* are cyclic, and Class 2 affixes like *un-* are not. This proposal does not assert any necessary ordering relationship between the two types of affixes, allowing cyclic and noncyclic

affixes to be intermingled.[22] Thus, the phonological component does not need to restructure the morphological form. In the analysis of a form like *ungrammaticality*, the two cyclic domains are "interrupted" by a noncyclic domain which has no affect on the phonological derivation: [[un [grammatical]$_c$]$_{nc}$ity]$_c$ where *c* and *nc* mark "cyclic" and "noncyclic" constituents respectively. Halle and Kenstowicz argue that only their analysis can account for ordering paradoxes which involve two suffixes, rather than a prefix and a suffix, as presented by forms like *patentability*. As with *ungrammaticality*, this example has a Class 2 noncyclic affix *-able* internal to the Class 1 cyclic affix *-ity*. However, unlike the previous example, no amount of rebracketing is going to result in a structure in which all cyclic affixes are internal to all noncyclic affixes, without altering the linear order of the affixes.In their analysis, this example goes through the phonology with its morphological structure intact, [[[patent]$_c$able]$_{nc}$ ity]$_c$.

Halle and Kenstowicz resolve the debate over the analysis of bracketing paradoxes with an analysis in which there is no bracketing paradox at all. It applies not only to the English examples, but also to the case of Russian *yer*- Lowering and Warlpiri. It is of interest to note that their solution would not easily extend to examples of an ordering paradox that involves two cyclic affixes, such as [A [B C]] vs. [[A B] C], where both A and B define cyclic domains for the application of a phonological rule. Klamath appears to be such an example, since in at least some examples phonological structure requires [prefix [root suffix]], while the morphology suggests [[prefix root] suffix]. In the cyclic analyses of Klamath, the cyclic rules must apply in both the prefix and suffix domains.[23] Perhaps a more serious challenge to the Halle and Kenstowicz proposal concerns the existence of "cyclic" domains that are not in any sense derivable from morphological constituent structure by associative restructuring. Cole and Coleman (1992) discuss several such cases which involve, for example, phonological domains such as [Prefixes][Stem], when the morphological constituent structure gives [prefix [prefix [...[Stem] ...]]]. Kisseberth (1992) presents similar examples in his discussion of domains for High tone spread in Xitsonga.

5 Summary: The Theoretical Status of the SCC

In the preceding sections, we have traced the evolution of the principle of cyclic rule application, including the notion of the cyclic domain, the Derived Environment Constraint, and the Reaching Back Constraint. We have seen that some phonological rules apply to constituents, termed *cyclic domains*, which are internal to the word. Cyclic domains are not always isomorphic to morphological constituents, and thus cannot derive from the interleaving of morphology and phonology.

The Derived Environment Constraint, which is responsible for limiting the abstractness of phonological analysis, is supported by the existence of phonological rules which apply only in derived environments. The precise formulation of the Derived Environment Constraint is not clear however, if it must prevent the morpheme internal application of neutralization rules such as Velar Softening that would give rise to unmotivated abstract derivations of, e.g., *city* from underlying /kity/, while still allowing the morpheme internal application in morphologically derived forms such as *receive, proceed*.

In most discussions of cyclic phonology, the rules which are subject to the Derived Environment Constraint are equated with the cyclic rules. However, the Derived Environment Constraint, or a similar domain restriction, is needed for some rules which apply only at word boundaries, as seen in Basque and Finnish. If word-level rules are necessarily noncyclic, then the Derived Environment Constraint must be extended to apply to a subclass of noncyclic rules as well as the cyclic rules. In addition, there are some lexical rules – rules that apply within but not across words- which violate the Derived Environment Constraint, suggesting that not all lexical rules are cyclic.

Finally, structure-building rules such as metrical structure assignment for stress and syllabification are not subject to the Derived Environment Constraint, typically applying in derived and nonderived environments alike.

The second effect of the SCC is termed the *Reaching Back Constraint*; it is required to preserve rule ordering in cyclic derivations. There is no clear empirical support for this constraint.

Based on these findings, it is not clear that the two dimensions of cyclicity -the cyclic domain and the Derived Environment Constraint – are related at all. The arguments concerning the Derived

Environment Constraint, abstractness, and domain restrictions for the most part do not overlap with the arguments for the existence of word-internal domains in which some phonological rules apply. This conclusion is even more strongly suggested by recent research on the syntax-phonology interface, which points to the existence of phrase-level domains as an extension of the cyclic domain beyond the lexical level (Inkelas and Zec 1990).

In the sections that follow, we will consider the cyclic analyses of stress systems, syllable related processes, and rule ordering paradoxes that have appeared in the literature of the past two decades. The goal is not only to present an overview of some classic examples of cyclic phonology, but also to examine which aspects of cyclicity arise in the various applications under consideration.

6 Stress Systems

Stress systems provided the basis for the earliest discussions of cyclicity in generative phonology. The stress systems of languages like English, Arabic, and Chamorro also constitute some of the most transparent evidence for cyclic rule application, and thus serve as an excellent place to begin an overview of the empirical evidence for cyclic phonology.

6.1 English and Chamorro

SPE argues for the cyclicity of English stress based in part on the contrasting pattern of nonprimary stress in the pair of words *còmpênsătion* and *Còndènsátion.* The main stress of *condénse* carries over in the form of a secondary stress on the second syllable in the derived form *còndènsátion*, but the stress pattern of the base *cómpênsàte* does not produce a second syllable stress in the derived form *cómpênsátion.* Halle and Vergnaud (1987a) point to difficulties with the SPE analysis in light of two kinds of exceptions. First, words like *àffirmátion*, *cònfirmátion, cònsultátion* fail to show a secondary stress on the syllable which is assigned stress in the base forms: *affírm, confírm, consúlt.* Second, nonderived forms like *ìncàntátion, òstèntátion*, have a pretonic secondary stress which is analogous to the secondary stress in *còndènsátion*, and yet the secondary stress is clearly not derived in such examples.

Halle and Kenstowicz (1991) account for the pattern of secondary stress with the noncyclic Alternator rule, which parses the pretonic string of syllables from left-to-right into binary feet. This rule stresses every other syllable starting with the initial syllable (but avoids placing stress on the syllable immediately preceding the main stress). In some specially marked lexical items, the secondary stress rule is quantity- sensitive - it will always stress a heavy syllable. This explains the secondary stress on the second syllable of *còndènsátion, ìncàntátion*. Words like *còmpênsătion* are not marked for the heavy syllable rule, and therefore do not show stress on the second syllable.

Despite the failure of the original argument, it can still be argued that English stress assignment is cyclic. Hammond (1989) presents important new evidence that an inner cycle main stress can surface as a secondary stress in a derived word. He contrasts the pattern of secondary stress on strings of pretonic syllables in derived and nonderived words, demonstrating that the principles which place secondary stress in the nonderived words can be overridden by the presence of an inner cycle stress in derived words. For example, nonderived *Winnepesáukee* stresses the first syllable of the pretonic string *ĹLL*, while the derived form *orìgináĺity* has stress on the second syllable of a similar pretonic string *LĹLL*. Hammond argues that the secondary stress of *orìgináĺity* must be attributed to the main stress of the inner cycle *orìginal*. Hammond's argument is similar to the original argument for cyclic stress in *SPE*; however, while the secondary stress on *còndènsátion* may be attributed to a special noncyclic rule stressing heavy syllables, many of Hammond's examples involve contrasting stress patterns on light syllables. To account for these data, Hammond proposes that inner cycle stresses are preserved in the form of accents that carry over onto subsequent cycles.[24] The preserved inner cycle stress can prevent a light syllable from later undergoing a destressing rule which applies to other light syllables.

The conclusion to be drawn from the evolving analysis of English stress is that the rules assigning secondary stress to a string of pretonic syllables must take into account inner cycle stresses. There is no stress algorithm that could correctly place secondary stress on the basis of the outermost stress domain alone, as seen by the contrast in *Winnepesáukee* and *orìgináĺity*.

A parallel argument for cyclic stress assignment comes from the analysis of Chamorro. Chung (1983) argues that the distribution of secondary stress in morphologically derived words requires cyclic stress assignment. Stress is regularly assigned to the penult, or antepenult in words with a final extrametrical syllable (15a), and shifts rightward under suffixation (15b).

(15)

(a)	kítan	"cross-eyed"	aságwa	"spouse"
	púgwa?	"betel nut"	inéksa?	"cooked rice"
	inéŋŋulu?	"peeping"	dáŋkulu	"big"
(b)	nána	"mother"	nanáhu	"my mother"
	gúma?	"house"	gumá?mu	"your (sg.) house"
	dáŋkulu	"big"	daŋkulónña	"bigger"

The forms in (16) show that the stress assigned on the inner cycle is realized as a secondary stress. The placement of these secondary stresses could not be achieved by any general parsing of the pretonic syllables on the outer cycle, since their position varies depending on the number of syllables and the presence of a final extrametrical syllable in the inner cycle.

(16)

(a)	swéddu	"salary"	(b)	swèddunmámi	"our (excl.) salary"
	inéŋŋulu?	"peeping"		inèŋŋulu?níha	"his peeping"

Halle and Vergnaud (1987a) analyze these facts by assigning stress on every cycle, and copying over each inner cycle stress as secondary stress, subject to Stress Clash avoidance, which disallows a secondary stress immediately preding a primary stress: *gúma*ʔ, gumáʔ, *gùmáʔ.

In considering the role of the cycle in accounting for the stress patterns of Chamorro and English, it is useful to distinguish two aspects of cyclic rule application. First, cyclic rules are subject to the SCC, which enforces both the Reaching Back Constraint and the Derived Environment Constraint. Cyclic analyses of stress assignment in English and Chamorro maintain that the parsing of stress feet is unaffected by structure assigned on previous cycles. The entire string is parsed, including those elements which are wholly contained on an inner cycle. Clearly for these analyses, cyclic stress assignment is not governed by the prohibition on "reaching back." As for the Derived Environment Constraint, stress rules clearly do apply on the root cycle and in nonderived words. The fact that stress rules are structure building provides a plausible explanation for their apparent violation of these two constraints, as discussed above in section 3.2.

The second aspect of cyclic rule application concerns cyclic domains. Cyclic rules may apply in domains which are substrings of the entire word, where the domains correspond to morphological constituents, and the derivation of an inner cycle domain *precedes* the derivation of an outer cycle domain. In other words, cyclic derivation is sequential, proceeding from the innermost to the outermost cycle. The sequential analysis of cyclic domains sets the stage for potential feeding and bleeding effects between each successive stage in the cyclic derivation. Moreover, in the (revised) lexical phonology view of cyclicity, cyclic derivation precedes the application of lexical, noncyclic (= post-cyclic) rules, giving rise to further opportunities for feeding and bleeding interaction between cyclic and noncyclic rules. The analyses of stress in English and Chamorro reviewed here provide clear evidence for the notion of a cyclic domain; however, since cyclic stress is calculated from scratch on each cycle, they do not support the need for a sequential derivation of cyclic domains. As for the ordering of cyclic and noncyclic derivation, there is evidence from the secondary stress systems of both languages that all the cyclic stresses play a role in constraining a subsequent, noncyclic rule of secondary strese assignment, supporting the view that cyclic derivation precedes noncyclic derivation.

In Chamorro, in addition to the secondary stresses that derive from inner cycle stress, there is a rule assigning secondary stress to alternating syllables from left to right, as in the monomorphemic word *pùtamunéda* "wallet". The Alternator rule is also subject to the condition on Stress Clash, accounting for the absence of secondary stress on the third syllable of *pùtamunéda*. Note that an inner cycle stress has the same affect as the outer cycle main stress in preventing the preceding syllable from bearing a secondary stress by the Alternator stress rule. Thus, in *inèŋŋulu*ʔ*-níha*, the secondary stress on the second syllable, derived from the inner cycle *inéŋŋulu*ʔ, blocks the assignment of additional secondary stresses on the first syllable. The Alternator rule for English proposed by Halle and Kenstowicz is also sensitive to the presence of inner cycle stresses, as noted above.

To account for the bleeding relation between the cyclic and noncyclic stress rules in English and Chamorro, the analyses reviewed here assume a derivation in which cyclic rules precede the noncyclic lexical rules. They also assume that the cyclic derivation is sequential, although without direct empirical support. Cole (1992a) explores analyses of English and Chamorro in a nonderivational, constraint-based approach to phonology. Allowing the stress-assigning rules to apply simultaneously within each cyclic stress domain, blind to the stress assigned in any other domain, is shown to overgenerate stress. The overgeneration can be resolved in a number of ways. For instance, independent stress rules can simultaneously mark a syllable as a stressed position and an unstressed position, in which case a ranking defined over the set of phonological rules (or principles) determines which rule wins.[25] Alternatively, in a dynamic, network-based model such as that proposed by Goldsmith (1992a, in press), stress assigned to individual syllables exerts a negative stress influence on adjacent syllables, with the final stress values reflecting the harmonic balance achieved by the system as it attempts to optimize each principle of stress assignment.

In any nonderivational approach to cyclic stress in English and Chamorro, there must be some way of encoding the fact that the stress assigned on the outermost cyclic domain is dominant, and the only cyclic stress which is realized as primary. This is trivial for English, in which each successive cycle causes stress to shift to the right; it suffices to promote the rightmost stress in a string of cyclic stresses to primary, leaving the rest as secondary. The situation is more complex in Chamorro. Whereas cyclic suffixes cause stress to shift to the right (15b), cyclic prefixes cause stress to shift to the left: *bátku* "ship", *míbàtku* "abounding in ships", and *mìbatkónña* "more abounding in ships". Cole (1992a) observes that a directional account of stress shift will not suffice for Chamoro; both the traditional and the nonderivational cyclic accounts of stress must stipulate that the prefix cycle derives stress on the prefix (perhaps by a special stress accent on the prefix itself), and that the stress derived on the outermost cycle is designated as primary.

Goldsmith (1990) presents a different sort of argument for cyclic stress in English. He observes a prohibition on the attachment of Level 2 suffixes when suffixation would derive a stress clash across the # juncture. This constraint explains the absence of forms such as **cartóon#ístic*, **escáp#ístic*, **alá#ístic* (cf., *fátal#ístic, régal#ístic*) as well as well as **fál#ístic, *maganíne#íze* (cf., *wínter#íze*, *Jóurnal#íze*). Under Goldsmith's account, it is crucial that stres be assigned to the stem to which the Level 2 suffix attaches. Note also that these data provide counterevidence to the strict level-ordering hypothesis: the Level 1 suffix-*ic* attaches outside the Level 2 suffix -*ist*.[26] Thus, in the derivation of fátal#íst + ic stress must be allowed to apply cyclically to the stem [fátal] prior to Level 2 suffixation, and again on the subsequent cyclic domain [fataléstic].

6.2 Spanish Stress

English and Chammorro present rather transparent evidence for cyclic stress assignment; the inner cycle stress may surface as a secondary stress, which is nonetheless distinct from the secondary stress assigned by the Alternator rule. Spanish presents less direct, but equally compelling evidence for the assignment of stress within a cyclic domain that comprises an internal morphological constituent of the word. Harris (1969) argues for cyclic stress assignment on the basis of the interaction between stress and the rule of Diphthongization.[27] Certain roots contain a mid vowel which surfaces as a diphthong under stress, as in (17).

(17)

cont-á-ba	“he counted”	c[ué]nt]-a	“he counts”
neg-á-ba	“he denied”	n[ií]g-a	“he denies”
pens-ámos	“we think”	p[ié]ns-o	“I think”
solt-ámos	“we release”	s[ué]lt-o	“I release”

In addition to the forms with stressed dipthongs, some words surface with diphthongs which are not stressed. Contrast the forms in (18b) with (18a) and (18c).

(18)

(a) b[ué]n-o	“good”	m[ié]l	“honey”
(b) b[ue]n-ísimo	“very good”	m[ie]l-ecíta	“honey” (dim.)
(c) b[o]-dád	“goodness”	m[e]l-òso	“like honey”

The analysis of these data proposed in Halle, Harris, and Vergnaud (1991) is summarized here. The forms in (18a) show the regular dipthongization under stress seen in (17). The (18c) forms are accounted for under the assumptions that the suffixes /-dad/, /-oso/ define cyclic domains, and stress is assigned from scratch on each cycle, i.e., inner cycle stresses are not carried over to subsequent cycles. When the cyclic suffixes /-dad/, /-oso/ are added, stress assignment stresses the suffix vowel and not the root vowel. A noncyclic rule of Diphthongization is formulated, affecting only those non-low vowels which are stressed in the input to noncyclic derivation, i.e., stressed on the outermost cycle. Halle, Harris, and Vergnaud (1991) suggest that the difference between (18b) and (18c) has to do with the cyclic status of the suffixes. They propose that the suffixes in (18b) are non-cyclic, which means that on the outermost cyclic domain the underlying non-low root vowels are stressed, yielding *bón, mél*. However, the stress rules are allowed to apply again in the noncyclic stratum, where stress is assigned to the suffix vowels, yielding *bónísimo, mélecíla*.[28] Only the rightmost stress in a word is realized, which is accomplished by a special process of conflation that has the effect of deleting all but the rightmost primary stress in a word.[29] Noncyclic Dipthongization is crucially ordered before the conflation process eliminates the stress on the root vowel.

The analysis of stress and diphthongization reviewed here relies crucially on the identification of a cyclic domain internal to the word. Although the formalism employed in this analysis gives rise to word structures with multiple, nested cyclic domains, only the stress assigned to the outermost domain can trigger Diphthongization. These data do not provide evidence for the sequential derivation of cyclic domains; in fact, all of the surface forms can be derived with cyclic stress assignment in the final cyclic domain alone. The analysis also requires a distinction between cyclic and noncyclic stress assignment, with the rule of Diphthongization ordered in between. Thus, as we saw for English and Chamorro, the cyclic derivation precedes the noncyclic derivation, with cyclic stress feeding noncyclic Diphthongization in Spanish.[30]

6.3 Palestinian Arabic

Palestinian Arabic provides evidence for word-internal cyclis stress domains that is entirely parallel to the Spanish data seen above. As noted by Brame (1974), in the first discussion of cyclic stress to follow *SPE*, the application of a syncope rule deleting unstressed vowels is sensitive to the presence of stress assigned on a cyclic domain, even when the cyclic stress fails to be realized on the surface. The syncope rule in question deletes an unstresed high vowel in a nonfinal open syllable, as seen in the paradigm in (19).

(19)

(a) fíhim "he understood"
(b) fíhim-u "thy understood"
(c) fíhim-ti "you (sg.f.em.) understood"
(d) fíhim-na "we understood"

A consonant-initial subject suffix causes stress to shift rightward onto a heavy penult, as in (19c, d), from underlying *fihim-CV*. A vowel initial suffix does not create a heavy penult, and stress is assigned to the antepenult (19b). Taking stress shift to be a property of cyclic affixes, Halle and Kenstowicz (1991) propose that the subject suffixes are cyclic. The derivation of the forms in (19b, c), involves two cyclic domains (e.g., [[fihim] na]), but only the outermost cyclic stress is preserved.

Brame notes an interesting difference in the application of syncope in words with subject markers and words with object markers. For example, the 1pl. suffix *-na* is used both as a subject suffix and an object clitic, as in underlying *fihim+na* "we understood" and *fihim#na* "he understood us". Yet only the subject suffix induces synocope, giving rise to *fhímna*, as opposed to the form with the object clitic, *fihímna*, where syncope fails to apply. Note that stress shifts rightward with both the subject suffix and the object clitic. Halle and Kenstowicz present the following analysis. The subject suffixes are cyclic, and therefore trigger the cyclic application of the stress rules. The object clitics are noncyclic; when they attach to a stem the resulting constituent is a noncyclic phonological domain. Stress applies in the cyclic as well as the noncyclic phonology, and so after cliticization of the object suffixes, stress will shift to the right, as it does with the subject suffixes. Syncope applies noncyclically, but before the noncyclic assignment of stress. It deletes a high vowel that is unstressed as it enters the noncyclic derivation. In other words, Syncope deletes a high vowel which is not stressed by the cyclic stress rules applying on the outermost cycle. The form *fihim+na*, with a cyclic subject suffix, emerges from the cyclic derivation as [*fihím na*]. The noncyclic Syncope rule then deletes the initial vowel, yielding *fhímna*. In contrast, *fihim#na*, with a noncyclic object clitic, emerges from the cyclic derivation as [*fíhim*]. Addition of the clitic produces [*fíhim*] *na*]. Syncope cannot apply to the first vowel, since it still bears the cyclic stress. Noncyclic stress assignment then applies, yielding [[*fíhím*] *na*]. As in the analysis of Spanish, all but the rightmost stress is deleted by the process of conflation, resulting in the correct surface form, *fihímna*.

As with Spanish, the cotrast between object and subject markers in the application of syncope is achieved by distinguishing cyclic and noncyclic stress assignment, and by recognizing a cyclic domain which is internal to the word. Again, only the outermost cycle is relevant for determining the placement of surface stress, and only the outermost cyclic stress is seen to have the effect of protecting a high vowel from undergoing syncope. As with Chamorro, English, and Spanish, the cyclic analysis of the Palestinian data requires that cyclic derivation precede noncyclic derivation; in this case cyclic stress assignment may bleed noncyclic Syncope.

6.4 Vedic Sanskrit

Cyclicity has been involved to account for the stress systems in a variety of languages with lexical stress, such as Vedic Sanskrit, Russian, and Lithuanian. These are languages in which stress "accent" is a contrastive feature within classes of morphemes. Accented morphemes are strong (or dominant) and attract stress, while unaccented morphemes are weak (or recessive) and typically receive stress only in strings which contain no strong morphemes. Below we sketch the cyclic analysis of the dominant/recessive contrast in Vedic Sanskrit proposed by Halle and Mohanan (1985).[31]

Morphemes in Vedic are divided into four categories by the features Dominant/Recessive and Accented/Unaccented (Halle and Mohanan 1985; Halle and Vergnaud 1987a). Dominant suffixes neutralize the lexical accent on any preceding morpheme, including the stem. Recessive suffixes do not affect the accentual properties of the stem. Both Dominant and Recessive suffixes may themselves bear lexical accent. The surface stress patterns are given in (20). Dominant suffixes are marked *D*, Recessive suffixes are *R*, and lexical accent is marked with an asterisk.

(20)

Stress patterns in words with Dominant suffixes						
underlying:	SD̊D	SD̊D̊	ŚD̊D̊	ŚD̊D	SD̊D	SDR
surface:	SDÓ	SDÓ	SDÓ	ŚDD	ŚDD	ŚDR

The patterns in (20) can be summarized as follows: in the [Stem D … D] domain, the rightmost vowel is stressed if it is accented. (Note that the *D* suffixes are always internal to the *R* suffixes.) If the final vowel is not accented, the (leftmost vowel of the) stem is stressed. Stress is assigned to a *R* suffix in the [Stem…R] domain only if there is no accented Stem or *D* suffix present, as shown in (21).

(21)

underlying:	SRR	SR̊R	SŔR	ŚŔR
surface:	ŚRR	SRŔ	SŔR	ŚRR

Halle and Mohanan argue that the *D* suffixes are cyclic. Within a cyclic domain, the leftmost accented element is stressed. Since a new metrical grid is constructed on each cyclic domain, disregarding any accent and metrical structure on inner cyclic domains, only the accent of the outermost *D* will be stressed. If the outermost *D* is not accented, the stress is placed by default on the leftmost vowel of the stem. In contrast, the *R* suffixes are not cyclic, and do not delete accent from the prior cyclic domain. The stress rule applies again in the noncyclic derivation, assigning stress to the leftmost accented element. It follows that an accented *R* suffix will get stressed only when it is the leftmost accented element, i.e., when there is no *D* suffix or accented stem preceding.[32]

The essential property of the Vedic Sanskrit stress system is that stress must be assigned within the domain defined by the last *D* suffix: [S…D], as noted in Cole (1990). In the cyclic analysis sketched above, every *D* suffix defines a domain for stress assignment, although in fact it is only the outermost cyclic stress that surfaces. Thus, as we saw in the cases of Spanish and Arabic above, it is essential that stress apply in a "cyclic" domain which is internal to the word, and which is defined in terms of morphological structure. Outside of this domain, stress may apply again, in the larger noncyclic domain. In Spanish and Arabic, the noncyclic application of stress has the effect of eliminating the stress assigned to the cyclic domain (via conflation of metrical structure), although traces of the cyclic stress remain elsewhere in the phonology. On the other hand, in Vedic Sanskrit the stress assigned in the noncyclic domain is in essence eliminated in favor of the cyclic stress (again, by conflation).

6.5 Diyari

As we noted in the discussion of Vedic Sanskrit, stress assignment can be sensitive to accentual properties of individual morphemes. Morphology also plays a role in the stress system of Diyari (Austin 1981), though in a manner different from that of Vedic Sanskrit. Diyari is argued by Poser (1989) to require cyclic stress assignment. The facts are quite simply described: stress is placed on odd numbered syllables counting from the left (reflecting a binary, left-headed foot parsed left-to-right), with the exclusion that an odd-numbered final syllable is not stressed (reflecting a defooting of degenerate feet). The leftmost stress in a word is primary. The peculiar aspect of the system is that each morpheme must count as an independent stress domain. Some examples are seen in (22).

(22)

ŋándawàlka+tàda	"to close"+pass.
púluru+ni+máta	"mud"+loc.+ident.
yákalka+ìli+na	"ask"+ben.+recip.+part.

Poser (1989) rejects the possibility that the morpheme is indeed the stress domain in Diyari, noting

that in "all known theories of rule application…non-root morphemes are not permitted to serve as domains of rule application" (p. 120). He also argues that it is not possible to view every morpheme in Diyari as an independent root or word, since the suffix morphemes do not independently meet either lexical or phonological requirements for word status; many of the suffixes are bound morphemes, and do not independently satisfy phonotactic conditions on syllable structure that hold of words (e.g., they have initial consonant clusters that are not well-formed syllable onsets). Thus, he concludes that stress must be assigned on every cycle, but with the property that it does not alter the metrical structure assigned on any internal cycle. Poser's analysis of cyclic stress is directly opposed to the Halle and Vergnaud (1987a) analysis, in which cyclic stress erases all inner cycle metrical structure.[33] Halle and Vergnaud discuss Diyari, and in light of their treatment of cyclic stress, are forced to accept the morpheme as the stress domain in their analysis.[34]

The issue of cyclicity in the analysis of Diyari stress is addressed again by Idsardi (1992), who presents an extension of the Halle and Vergnaud theory of the metrical grid (see chap. 11). Idsardi allows metrical rules to introduce the boundary symbols that define stress feet, which are later incorporated into the metrical parse of a string. In the case of Diyari, Idsardi proposes that each morpheme projects a left boundary at its left edge onto the metrical grid. These boundaries then serve as the basis for the noncyclic rule of constituent construction, which matches each left boundary with a right boundary to construct a bounded foot. Idsardi gives the derivation in (23).

(23)

Project	(*x x x*	(*x x*	(*x x*	(*x*
Lex. Edgess:	yakalka-	yirpa-	mail-	na
Construct	(*x x*)*x*	(*x x*)	(*x x*)	(*x*
Feet:	yakalka-	yirpa-	mali-	na
Mark	*x*	*x*	*x*	*x*
Heads:	(*x x*)*x*	(*x x*)	(*x x*)	(*x*
	yakalka-	yirpa-	mali-	na

Although the final morpheme projects a left metrical boundary, that boundary does not initiate a foot, since there are not enough syllables following to create a full binary foot. Unmatched, extra boundaries are later deleted, which has the effect of "defooting" all degenerate feet.

By introducing foot boundaries directly on the basis of morphological structure, Idsardi is able to derive all the surface forms without cyclic stress assignment. The projected boundaries allow feet to be constructed without necessarily parsing an entire string, or even a cyclic substring of the word. In the cyclic analysis, the only way to construct a metrical foot is to parse a string, which for Diyari entails parsing each morpheme individually.

Idsardi's analysis relies on the direct manipulation of boundary symbols, a device that is rejected in much post-SPE work (c.f., Siegel 1974). However, the desired effects of aligning a morpheme boundary with a stress foot boundary can be attained without direct reference to boundary symbols, through the mechanism of a constraint which aligns morphological and prosodic constituents, as discussed in McCarthy and Prince (1993b).

6.6 Interior Salish

Idsardi's proposal to allow morphemes to project boundaries onto the metrical grid provides an elegant solution to another class of lexical stress systems, which like Vedic Sanskrit, have been argued to require cyclic stress assignment.

Idsardi (1991, 1992) discusses the stress systems of several Interior Salish languages. Like Vedic Sanskrit, they manifest a contrast between dominant ("strong") and recessive ("weak") morphemes. However, the Interior Salish systems are somewhat simpler, in that all dominant morphemes appear to fall into a single class; they uniformly attract stress, behaving like the *accented* dominant suffixes of

Vedic Sanskrit. Czaykowska-Higgins (1993) discusses in detail the stress system of Moses-Columbian Salish, noting the similarity between that the system and Vedic Sanskrit. She provides a cyclic analysis of Moses-Columbian which parallels the cyclic analysis of Vedic, with one important difference – recessive and dominant suffixes are freely interspersed. Nonetheless, the generalization remains that stress is assigned to the rightmost dominant (= cyclic) suffix. Idsardi shows that it is possible to capture the dominant/ recessive distinction in Moses-Columbian, as well as in other Interior Salish languages, under the proposal that dominant morphemes project metrical boundaries, without requiring that stress assignment apply in cyclic domains.

Idsardi's analyses of Interior Salish languages show that the property of stress shift under affixation can be accounted for in a principled metrical theory that allows direct insertion of foot boundaries. Thus, it can no longer be considered valid to equate stress shift with cyclic affixation. However, this does not imply that all cases of stress shift can be reduced to morphologically governed rules inserting metrical boundaries. In particular, the analysis of Vedic Sanskrit within Idsardi's framework would still seem to require that the rules of metrical constituent construction apply within the (outermost) cyclic domain [S…D] prior to applying in the larger domain [S…(D)…R]. Idsardi's approach allows for a simplification of the apparent stress-deleting property of the *D* suffixes within the cyclic domain in Vedic Sanskrit, but it does not entirely eliminate the need to identify such a domain.

6.7 Summary

The stress systems of English, Chamorro, Spanish, and Palestinian all demonstrate the need to identify word-internal domains for the application of stress rules. In English and Chamorro, the structure of cyclic domains is recursive, with evidence that stress is assigned on each nested domain. In Spanish and Palestinian, however, there is evidence only for stress assignment on the outermost cyclic domain. Important to the analysis of all four systems, the cyclic application of stress assignment can restrict the application of rules applying in the noncyclic domain, suggesting a sequenced derivation in which cyclic derivation precedes noncylic derivation.

Domain restrictions are one indication of cyclic rules. Other signs of a cyclic rule are the restriction to apply only in a derived environment and the prohibition on “reaching back” to affect material contained on an inner cycle, both the result of the SCC. The stress systems considered here do not appear to be subject to either of the SCC constraints.

From the discussion of Diyari and the lexical stress/accent systems, it is clear that cyclicity cannot be deduced on the basis of stress shift or morphological domains alone. In particular, allowing lexically specified metrical boundaries to define stress feet eliminates the need for cyclic stress assignment in Diyari and Interior Salish languages. This approach raises the interesting possibility of defining cyclic domains on the basis of lexically specified domain boundaries, such as has been suggested in Kisseberth's (1992) analysis of Xitsonga tone.

7 Syllable-related Processes

In this section I review evidence from English, Polish, and German for the cyclic application of syllable-related processes.

7.1 English: Level 1 Phonology

There is a class of rules of English phonology which apply in a morphologically restricted domain; they apply to stems derived by Level 1 affixation, but fail to apply to Level 2 stems. Largely on this basis, rules such as Trisyllabic Shortening, Closed Syllable Shortening, *m*-Deletion, and *g*-Deletion have been said to apply cyclically, in Level 1 of the lexical phonology. In this section I briefly review the behavior of several rules with domain restrictions, concluding that while the domain restriction is necessary, there is no other strong evidence of cyclic rule application.

Kiparsky (1982a) argues for the cyclic application of the Trisyllabic and Closed Syllable Shortening rules on the basis of two observations: (1) they are triggered by Level 1 suffixes and not by Level 2 suffixes (*provôc-ative* vs. *hȳphenate, clêanse* vs. *clēanly*); (2) they do not apply morpheme-internally (*Oberon, stēvedore*). The Level 1 restriction renders the shortening rules cyclic only because Level 1 is argued to be the (only) cyclic level of the lexical phonology; stress assignment, which is independently

argued to be cyclic, applies in each Level 1 domain. In contrast, no known cyclic rules like stress assignment apply in Level 2 domains, which leads to the claim that Level 2 is uniformly noncyclic. The existence of nonderived lexical exceptions to shortening follows from cyclicity, since individual morphemes would not constitute a derived environment in which the shortening rules, subject to the SCC, could apply.

Myers (1987) proposes a reanalysis of the shortening facts in which Trisyllabic Shortening and Closed Syllable Shortening both result from a general constraint on syllable structure that prohibits long vowels from occurring in closed syllables in roots and stems with Level 1 affixes.[35] Shortening occurs because the syllabification rules can license only a single V-position (or mora) of an underlying long vowel when it occurs in a closed syllable. The unlicensed V-position is later stray-erased. To account for the failure of shortening with Level 2 suffixes, Myers proposes a domain restriction that limits the licensing condition on long vowels to bare roots and stems derived from Level 1 suffixation. For Myers, the domain restriction does not follow from cyclicity.

Myers argues that the restriction on the licensing of long vowels reflects a fundamental generalization about English roots; like Kiparsky, he notes that most monomorphemic words do in fact conform to the vowel length patterns predicted by the shortening rules.[36] In Myers's analysis, vowel "shortening" (which is now properly stray erasure of an unlicensed vowel position) is not restricted to derived environments, although he acknowledges that there are a moderate number of exceptional morphemes in which long vowels do occur in closed syllables. As Sainz (1992) notes in her critical review of cyclicity in English phonology, the list of exceptions to shortening include "a large number of proper names of foreign origin, rare or archaic words, and unassimilated loan words: just the sort of words one expects to be exceptional" (p. 182).[37] Thus, rather than treat forms like *Oberon* and *stevedore* as regular forms which reflect the derived environment restriction on a cyclic shortening rule, Myers chooses to treat them as exceptional. The only remnant of cyclicity in his analysis lies in the domain restriction of the syllable licensing constraint on long vowels. Simply put, while shortening is restricted to certain morphological domains, it does not exhibit any of the effects of the SCC, such as the Derived Environment or Reaching Back Constraints.

Domain restriction is a property of another class of so-called cyclic Level 1 rules of English involving syllable structure. As discussed by Borowsky (1986), the rules deleting a stem-final nasal in *damn* (cf., *damnation*) and g in *sign* (cr., *signature*) can be reformulated as the effects of stray erasure on unsyllabified segments, if bare roots and Level 1 stems count as domains for syllabification. Syllabification of *sign* or *damn* cannot incorporate the stem-final consonant cluster into the rhyme without violating the Sonority Sequencing Constraint. The examples differ in which of the two consonants in the cluster gets incorporated into syllable structure. Addition of a Level 1 vowel-initial suffix takes the second consonant of each cluster as the onset of the suffixal syllable (*sig.na.ture, dam.na.tion*). As with shortening, Level 2 vowel-initial suffixes do not have the same effect, and "deletion" still applies (*si(g)ning, dam(n)ing*). The behavior of Level 2 suffixes is accounted for if there is an inner suffixation domain, with stray deletion applying on that inner domain prior to syllabification on the outer "Level 2" domain. Like the shortening rules, the deletion rules show no evidence of being constrained by the SCC, and thus behave cyclically only in their domain restriction.

7.2 Polish

There are two independent lines of argument for the cyclic application of certain rules of Polish phonology. One concerns the treatment of the abstract *yer* vowels, and the other concerns a class of rules which apply only in derived environments. The latter type of argument is presented in Rubach and Booij (1990) in their discussion of Polish syllable structure. They argue for the cyclicity of certain phonological rules (syllabification, Comparative Allomorphy, Iotation) on the grounds that they are ordered before other rules (Coronal Palatalization, *j*-Deletion), which apply only in derived environments. The latter rules are argued to be cyclic, since the Derived Environment Constraint applies only to cyclic rules.[38] Under all versions of cyclic or lexical phonology, the cyclic rules apply in one block prior to the application of the noncyclic rules. Therefore, any rule which precedes a known cyclic rule must itself be cyclic. Rubach and Booij offer no evidence for the cyclicity of the earlier rules beyond their ordering with respect to Coronal Palatalization and *j*-Deletion. This argument for cyclicity is therefore rather indirect, resting entirely on the soundness of equating the Derived Environment Constraint with cyclic rule application, and on the necessity of ordering all rules subject

to the Derived Environment Constraint in a single block.[39]

The behavior of yer vowels provides evidence for phonological rules applying in morphologically defined domains, as we have seen above in the analysis of several English syllable-dependent processes. Like the English examples, the analysis of Polish yers does not require either of the two constraints imposed by the SCC (the Derived Environment Constraint and the Reaching Back Constraint).

A fundamental characteristic of Polish, and one it shares with other Slavic languages such as Russian (Lightner 1965; Pesetsky 1979; Farina 1991) and Slovak (Kenstowicz and Rubach 1987), is the occurrence of vowels which alternate with Ø in certain environments, e.g., *pi[e]s* "dog" (nom.) vs. *ps-a* "dog" (gen. sg.), and *m[e]ch* "moss" (nom.) vs. *mx-u* "moss" (gen. sg.). Traditionally, the vowels underlying this type of alternation are analyzed as abstract high lax vowels /ĭ, ŭ/, which are either deleted or neutralized with their mid vowel counterparts by a rule called Lower. Lower applies to a *yer* only when it is followed by another yer in the next syllable, and all yers not subject to Lower are subsequently deleted. In the examples above, Lower applies to the stem *yer* in the nominative forms because of the presence of a yer in the nominative suffix /-ĭ/:/pŭs-ĭ/ → [p'es] and /mĭx-ĭ/ → [mex]. The genitive singular suffix contains no yers to trigger lowering of the stem yers, which subsequently delete.[40]

Rubach (1981) has suggested that the cyclic application of Lower accounts for the failure of Lower to apply in some prefixed forms.[41] For example, the adjective *bezdenny* "bottomless" is derived from underlying /bezĭ-dĭn-ŭ nĭ/ with three yer vowels (*bezĭ-* "without", *dĭn* "bottom", *-ŭ n* adj.). If yer Lower were to apply to the entire string, it should lower all but the last yer, resulting in **bezedennĭ*. In order to prevent the first yer from undergoing lower, the cyclic analysis derives the unprefixed form *denny* first: /dĭn-ŭ nĭ/ → /den-ŭ nĭ/. Lower gets another chance to apply on the next cycle, when the prefix is attached, but since there is no longer a yer in the syllable following the prefix yer, it cannot undergo lowering. Instead, the noncyclic, lexical rule of *yer*-Deletion applies to delete the remaining yers: /bezĭ-den-ŭ nĭ/ → [bezdennĭ].

An important note regarding the cyclic analysis is that it presents a bracketing paradox; the cyclic phonological structure requires the prefix to attach to a suffixed stem [prefix [root suffixes]], while the morphological structure requires the prefix to attach directly to the root, as in [[prefix root] suffixes]. Assuming that the appropriate cyclic structure can be derived (perhaps through a restructuring rule), this analysis is one of the few cases where the cyclicity of a rule is evident in the feeding, or in this case bleeding relation between successive cyclic applications of the rule. It is essential for the analysis sketched above that the lowering of the first stem vowel takes place *before* the application of Lower on the prefix cycle. Cyclicity in this analysis goes beyond simply defining domains in which a rule must apply, but determines the sequential order of multiple applications of the cyclic rule.

Szpyra (1992), citing Nykiel-Herbert (1984), notes several problems with the cyclic analysis of Polish Lower. In particular, Lower fails to apply to some prefix *yers*, even though they are followed in the next syllable by a nonlowered *yer*. Consider for example, the cyclic analysis of *bezpłciowy* "sexless" from underlying /bezĭ-płĭć-ov-ĭ/. Lower will not apply on the suffixed stem /płĭć-ov-ĭ/, which contains only a single yer. Lower will apply on the prefix cycle, yielding /beze-płĭć-ov-ĭ/. Postcyclic *yer*-Deletion will delete the remaining stem yer, which yields the incorrect surface form *[bezepłćov ĭ]. Clearly, Lower must be blocked on the prefix cycle to derive the correct surface form.

Szpyra argues that the nonapplication of Lower on the prefix cycle is the unmarked case, characterizing a large number of regular forms in several different morphological paradigms, such as the denominal adjective *bezdenny* "bottomless". Her solution is to place the prefixes and the suffixed

stem into two distinct prosodic domains. Lower applies within each prosodic domain, but does not apply across domains. For example, bezpłciowy “sexless” is parsed into two domains [bezɨ] [płć-ov-ɨ], each containing a single yer which does not meet the structural description of Lower. Szpyra cites about thirty verb forms in which Lower exceptionally does apply to a prefix yer, triggered by a yer in the following stem vowel. All but one of these examples are seen to involve CYC roots (Y = yer). Szypra's suggests that with CYC stems the prefix is parsed as part of the stem+suffix prosodic domain.

To summarize, there is evidence in Polish for a domain restriction on certain phonological rules. In the case of Lower, the necessary domains are not taken directly from morphological constituent structure, and there are no interactions between rules applying in different prosodic domains. Specifically, in Szpyra's prosodic reanalysis there is no requirement that Lower apply in one domain prior to its application in another domain; there is no cyclic feeding or bleeding. Beyond the analysis of yers, Rubach and Booij argue that certain other rules are subject to the Derived Environment Constraint, and do not generally apply morpheme-internally. However, these so-called cyclic rules are not seen to be restricted to the morphological domains that characterize the cyclic analysis of yers. Consequently, the arguments for cyclic domains and the arguments for rules governed by the Derived Environment Constraint are entirely independent.

7.3 German Syllabification

Rubach (1990) presents an analysis of German Devoicing which provides strong evidence for the cyclic application of syllabification. He notes the controversy between analyses in which Devoicing applies syllable-finally and those in which it applies morpheme-finally. At the heart of the matter is the contrast between pairs of words such as those in (24).

(24)

Voiced obstruent		Voiceless obstruent	
Handlung	“act”	handlich	“handy”
Ordnung	“order”	Bildnis	“portrait”
Radler	“bicyclist”	glaublich	“believable”

In these examples, the same or similar consonant clusters (*ndl, rdn, ldn, dl, bl*) give rise to Devoicing in only some cases, although in most of the examples the underlying medial voiced obstruent is arguably in a syllable coda position in the surface form: *han[t].lich, Or[d].nung, Bil[t].nis, Ra[d].ler, glau[p].lich*.[42] Rubach demonstrates that in all of the cases where Devoicing fails to apply to a consonant which is syllable final in surface form, the voiced consonant is followed by a morpheme-final sonorant, e.g., /handl-ung/, /ordn-ung/. In contrast, in the examples where Devoicing does apply to a voiced consonant preceding a sonorant, the sonorant is not morpheme final, e.g., /hand-lich/, /bilt-nis/.

Rubach argues that a syllable-final rule of Devoicing can be maintained under the assumptions that (1) syllabification applies cyclically, (2) final sonorants are syllabic, giving rise to [CS] (S = syllabic sonorant) syllables at the right edge of a cyclic domain, and (3) syllabic sonorants are not resyllabified as onsets of following vowel-initial suffixes during the cyclic phonology, and only desyllabify in the post-cyclic phonology subject to many restrictions. He offers the following derivations for *Han[d]lung, han[t]lich*, and *Hän[d]e* “hands”.

(25)

Cycle 1		
handl	hand	händ

han.dl.	hand.	händ.	syllabification
Cycle 2			
han.dl.-ung	hand.-lich	händ.-e	
han.dl.ung.	hand.lich.	hän.de.	syllabification
Post-cyclic			
—	hant.lich.	—	Devoicing

In the derivations above, post-cyclic Devoicing applies only to those voiced obstruents which are syllable final at the end of the cyclic phonology. Note that in some cases, a syllabic sonorant loses its syllabicity and resyllabifies as the onset of the following vowel-initial syllable, as in *Ra[d].ler* (also *zylin.[d]risch* "cylindrical" from / zylindr-isch/). The lexically restricted sonorant desyllabification rule does not apply in *Han[d]lung*.[43]

Rubach's analysis of the German data goes beyond a stipulation that a phonological rule applies in a morphologically defined domain. In German, syllabification must apply in *every* nested cyclic domain.[44] Thus, whereas syllabification must apply on the root cycle in the derivation of *Handlung*, it must also apply on the first suffixal cycle in *Radler*. If this is an instance of cyclicity as a domain restriction, then the domain must be recursively defined in such a way that it gives rise to nested domains like [[[root] suffix] suffix]. Furthermore, the syllabification of an inner domain can affect the syllabification of an outer domain. For instance, in the derivation in (25), syllabification on Cycle 1 yields *Han.dl.*, with a syllabic sonorant. On Cycle 2 the syllabic sonorant cannot be resyllabified as the onset of the following vowel-initial syllable, *Han.dl.ung*. Thus, under Rubach's analysis derivation on Cycle 1 must precede derivation on Cycle 2.

In addition to Rubach's analysis of German Devoicing, recursive cyclic domains are also apparent in the analyses of cyclic epenthesis in Hungarian (Jensen and Stong-Jensen 1989), and Selayarese (Mithun and Basri 1986, cited in Goldsmith 1991a).

7.4 Summary

In this section we have seen evidence from English, Polish, and German that syllabification and rules that refer to syllable structure may apply in morphologically defined domains smaller than the word. In the case of German, the cyclic syllabification rules apply in recursive cyclic domains, and may bleed the post-cyclic application of Devoicing. Further, unrelated to the arguments for word-internal cyclic domains, there is evidence from Polish that some rules which are dependent on syllable structure are subject to the Derived Environment Constraint.

8 Rule-ordering Paradoxes

In this final section, we briefly consider the role of cyclic derivation in the resolution of rule ordering paradoxes.

A tenet of generative phonology, as put forth in *SPE*, is that phonological rules are ordered consistently throughout the grammar. This claim prohibits grammars in which two rules, A and B, are ordered A < B in some derivations, but B < A in other derivations. Rule ordering paradoxes arise when a phonological system violates the condition on consistent rule ordering by requiring A < B for some derivations and B < A for others. Yet apparent inconsistencies in rule ordering can arise in cyclic derivations when, given two ordered rules A < B, B applies on cycle n and A applies on cycle $n + 1$. In such a situation it is even possible that A feeds B in the application of the rules on a single cycle, while B feeds A in a two-cycle derivation. A theory with both rule ordering and cyclic rule application predicts that rule ordering "paradoxes" will occur in the cyclic phonology, even though very few such cases have actually been argued for in the literature.

Klamath (Kisseberth 1971) stands as the classic example of a paradoxical rule system, while Icelandic (Kiparsky 1985b) and stress in two Arabic dialects (Irshied and Kenstowicz 1984) have also been claimed to present rule ordering paradoxes.[45] Cole 1993 reexamines the Klamath and Icelandic data, and argues that the rule ordering paradoxes are resolved when deletion rules are given a metrical

interpretation and syllabification is viewed as a persistent process that may respond to metrical parsing by reducing weak syllables.[46] The reanalysis is presented in the framework of dynamic phonology, in which the rules building metrical and syllable structures interact.[47] Whereas in classical generative phonology rule interaction is modeled with rule ordering, in the dynamic model each structure-building process applies only once, but may have varied results depending on the constraints imposed by other structure-building processes (e.g., stress or syllable parsing). The surface form represents the optimization of all the metrical structures taken together.[48]

In those cases examined by Cole (1993), ordering paradoxes are resolved by eliminating rule ordering in favor of dynamic rule interaction (or alternately, persistent rule application). The reanalysis challenges the role of rule ordering in phonological theory, and does not rely on cyclic rule application to derive problematic rule interaction. Given the rarity, or nonexistence, of genuine rule ordering paradoxes, the dynamic or nonderivational approach which eschews rule ordering merits serious consideration. Within such a theory, it is possible to maintain the notion of the cyclic domain, critical for the analysis of some of the stress and syllable processes discussed above, without predicting widespread, unattested rule interaction.

9 Conclusion

Putting together the conclusions concerning the theoretical status of cyclic rules with the conclusions concerning their empirical evidence, the following observations can be made. First, evidence from syllable and stress systems points clearly to the need to identify word-internal "cyclic" domains for the application of rules constructing syllable and stress constituents. In some cases, the cyclic domains are recursive. The cyclic rules are at times seen to interact with the noncyclic rules, either feeding or bleeding the rules applying in the larger word- or phrase-level domain. Moreover, in some systems with recursive cyclic domains for syllabification, the analysis of an outer cycle must respect the structure derived on an earlier cycle.

Second, a theory with both cyclic rule application and rule ordering requires the Reaching Back Constraint of the SCC, as noted by Kiparsky (1985a), to prevent cyclic derivations from undermining counter-feeding and counter-bleeding rule ordering. Yet, given a reanalysis of the Catalan facts, there is no clear evidence of the Reaching Back Constraint in any individual phonological system. Moreover, cyclic rule application and rule ordering together predict the existence of systems with superficially inconsistent rule ordering (rule ordering paradoxes), a prediction for which no clear empirical support has been found. Since cyclicity, in the sense of word-internal domains, has strong empirical support, these findings raise questions about the correctness of rule ordering as the appropriate mechanism for modeling rule interaction.

Third, some phonological rules are subject to the Derived Environment Constraint – they do not apply in monomorphemic environments. Since Mascaró (1976), this property has been identified with cyclic rule application. Yet the rules which demonstrate Derived Environment Constraint effects are not necessarily, or even typically, those rules which are argued to apply in word-internal "cyclic" domains. The relationship between the Derived Environment Constraint and cyclic domain restrictions was established by Mascaró as a simplifying measure. As noted above, a cyclic theory requires the Reaching Back Constraint to preserve rule ordering in cyclic derivations. The similarity between the Reaching Back Constraint and the independently needed Derived Environment Constraint led to their generalization in the form of the SCC, with the result that only cyclic rules are subject to the Derived Environment Constraint. Since it is at best rare to have evidence for both cyclic domains and the Derived Environment Constraint in the analysis of a single rule, it is reasonable to reconsider the connection between the two.

From this discussion, we can conclude that a theory of phonology that can account for the phenomena attributed to cyclicity must include (1) a subtheory of domains which can construct domains on the basis of morphological structure, though not necessarily isomorphic to that structure, within which certain phonological rules may apply; (2) a condition like the Derived Environment Constraint (perhaps nothing more than the Revised Alternation Condition), which restricts certain rules from applying in monomorphemic environments;[49] and (3) a mechanism for modeling the interaction that can occur between rules applying in cyclic domains and those applying in the larger domains defined by word and phrase structure. While rule ordering is the solution offered by standard

generative phonology, other possibilities are suggested in dynamic models of phonological processing.

1 For helpful discussion and comments I thank John Coleman, John Goldsmith, José Ignacio Hualde, Charles Kisseberth and John McCarthy.

2 Chomsky and Halle cite Chomsky, Halle, and Lukoff (1956) as the first reference to the transformational cycle in the analysis of English stress.

3 A strict partial order is any relation which is (i) transitive, (ii) irreflexive, and (iii) asymmetric. The order is partial, and not total, since it is not the case that each rule must be ordered with respect to every other rule in the grammar. In the present case the relation is "applies before."

4 But see the discussion of English stress in section 6.1 for the reanalysis of these data proposed by Halle and Vergnaud (1987a), who rely on independent arguments for the cyclicity of English stress.

5 Kiparsky (1982a) suggests that a certain class of cyclic rules, namely those that build structure but do not change existing structure in the phonological representation, are allowed to apply to nonderived strings, and may create a derived environment for the future application of subsequent cyclic rules applying on the same cycle. See the discussion in section 3.2.

6 Arguments for the Reaching Back Constraint must rely exclusively on *lexical* rules, which apply word-internally. As discussed in section 3.1, *post-lexical* rules, applying in the phrasal domain, are not subject to the SCC. This restriction alone eliminates one of Mascaró's arguments for the Reaching Back Constraint, in which the rule of Glide Formation is said to be blocked by the SCC from applying in an environment that spans a word boundary.

7 As discussed in section 2.2, Mascaró's arguments are subject to reanalysis, none of which require the Reaching Back Constraint. The Reaching Back Constraint is also invoked in the cyclic analysis of Klamath phonology presented in Kean (1974). Kean argues that the rule of Sonorant Cluster Epenthesis is blocked by the SCC under the Reaching Back exclusion. Her analysis predates recent advances in syllable theory, which have led to alternative accounts of syllable structure and epenthesis in Klamath (Clements and Keyser 1983; Levin 1985; ter Mors 1984). While the cyclic nature of Klamath phonology continues to be debated, the particular details of Kean's analysis of the SCC blocking Sonorant Cluster Epenthesis would not be maintained under the current view of syllable theory. See the discussion of Klamath in section 8.

8 Kiparsky also notes similar facts in Finnish and Mongolian.

9 Myers (1987) presents a reanalysis of Trisyllabic Shortening, discussed in section 7.1 below. He claims that, contra Kiparsky, all roots and Level 1 derived stems are subject to vowel shortening, which results from the stray erasure of vowel positions not licensed by the well-formedness constraints on syllable structure. Myers acknowledges the existence of exceptions to Trisyllabic Shortening, both derived and non-derived, which must presumably be simply listed in the lexicon.

10 The rule of vowel Raising is also a neutralizing rule (*e* and *i* are distinct phonemes), but is not blocked by the RAC in (9b) because the environment is derived. The rule refers to a word boundary, which is not part of the underlying representation of the morpheme /vete/, but results from the morphological process of word formation. Similarly, the English rule of *y* → *i* used in the derivation of *ivory* (discussed above in relation to Trisyllabic Shortening) applies word-finally and is therefore not blocked by the Revised Alternation Condition. Finnish is discussed further in section 4.3.

11 An excellent introduction to lexical phonology is found in Kaisse and Shaw (1985).

12 Momentarily disregarding the rules of syllabification.

13 Harris cites the Spanish rule of Aspiration (*s* → *h* in rhyme position) as an example of a neutralizing rule which must not apply cyclically. However, Goldsmith (personal communication) observes that for the majority of speakers, this rule is not neutralizing, since *h* is not part of the underlying consonant inventory, and contrasts with [x] (orthographic *j*) and [ç] (orthographic *g(i), g(e)*).

14 Maintaining the correctness of Kiparsky's analysis of the Velar Softening data, Hammond (1991) focuses his explanation of these data on a morphological WYSIWYG principle governing the formulation of underlying representations. The reader is referred to Hammond's work for further details.

15 The prefix must be attached to the base $[legal]_{adj}$, and not $[legality]_{n}]$, because /N- attaches only to adjectives.

16 There is a subtle but important distinction between Kiparsky's view of lexical rules that exist only within the lexical component, and Mohanan's (1986) view that rules exist outside the morphological component, but are specified to apply within some lexical (or post-lexical) domain. This distinction is relevant to the argument that the SCC is derivable from the Elsewhere Condition (see discussion below).

17 In addition to the Spanish case, cyclic syllabification is argued to create a derived environment for the further application of cyclic rules in Clements and Keyser's (1983) analysis of Klamath. This ceases to be a problem in the analysis proposed in Cole (1993), where it is argued that the cyclic “rules” of insertion and deletion are really the effects of constraints on syllabification, and therefore part of syllabification itself.

18 Iverson and Wheeler (1988) allude to a general principle for determining rule ordering which might resolve certain cases of cyclic “counter-” orderings. They also suggest that further exploiting the notion of domain specification for phonological rules might avoid the possibility of cyclic rules violating the Reaching Back Constraint. No examples or further discussion are provided.

19 Although some domain restriction is still required, at least in the case of Velar Softening, if we care to rule out the kind of abstract analysis noted by Iverson and Wheeler (1988), discussed in section 4.1.

20 For further discussion of the Class 1/Class 2 distinction, see Siegel (1974), Allen (1978), Mohanan (1986), Kiparsky (1982a), and Sproat (1985).

21 See also Halle and Vergnaud (1987b) for a similar proposal.

22 Halle and Kenstowicz follow Fabb (1988) in rejecting the relevance of level ordering in determining restrictions of affixation.

23 In the reanalysis of Klamath mentioned in section 8, only the prefix domains are cyclic, but restructuring is still required in the phonology to derive the nested cyclic domains [prefix [prefix [prefix root suffix]]].

24 Halle and Kenstowicz (1991) accept Hammond's findings, and propose that cyclic stress is copied onto the metrical grid on which noncyclic secondary stress is assigned.

25 Kager (1989) presents a nonderivational cyclic analysis which allows the simultaneous analysis of all cyclic stresses, with a different approach to the overgeneration problem.

26 Goldsmith distinguishes the Level 2 suffixation of *-ist* and *-ize*, which is fully productive and has predictable semantics, from the Level 1 suffixation of *-ist*, *-ize* on both phonological and semantic grounds.

27 See also Harris (1983, 1989), Halle and Vergnaud (1987a), and Halle, Harris, and Vergnaud (1991) for further discussion of cyclic stress in Spanish. The examples shown here are taken from the latter two sources.

28 Following Halle and Kenstowicz (1991), this analysis assumes that the crucial difference between cyclic and noncyclic stress assignment is that the cyclic rule always constructs a new metrical grid over the entire domain, erasing any metrical structure assigned on earlier cycles, whereas the noncyclic rule leaves intact the metrical structure of the final cycle, and constructs metrical structure only over material not metrified on the final cycle, such as extrametrical material, or material added by noncyclic affixation/cliticization processes.

29 Conflation is a process which deletes a layer of structure from the metrical grid, resulting in the elimination of nonprimary stresses (Halle and Vergnaud 1987a; Halle 1990; Halle and Kenstowicz 1991).

30 A nonprocedural interpretation of the interaction between stress and Diphthongization is possible, if a distinction is made between the cyclic and noncyclic stress feet. Only the vowel in the cyclic stress foot will undergo disphthongization, while only the vowel in the noncyclically assigned stress foot realizes surface stress. In the derivation of a form like *miél*, with no noncyclic affixes, the two stress feet would be identical.

31 The material in this section is adapted from Cole (1990).

32 In *SRR* forms where the *S* is not accented, it is crucial for the analysis sketched here that there be no cycle of stress assignment in the domain [*S*]. If there were, the *S* would be assigned stress by the default

clause, as the leftmost element in the domain, with the result that in the noncyclic derivation the unaccented stem would always surface with word stress. Recall that in this case it is the leftmost *R* that receives word stress. Halle and Mohanan claim that the SCC blocks stress from applying in the nonderived [*S*] domain. Unlike in English, stress assignment is not a purely structure-building operation in Vedic, since morphemes may bear constrastive stress accent.

33 See also Halle and Kenstowicz (1991).

34 In discussing Poser's analysis, Goldsmith (1991a) notes that the phonological cycle required in Diyari does not correlate with the phonological word, since not all cyclic domains will qualify as minimal words. Thus, Poser's analysis requires a more lenient definition of the cycle than that proposed in the word-based approach of lexical phonology (Kiparsky 1982a). The same is obviously true of the Halle and Vergnaud analysis.

35 For the cases of Trisyllabic Shortening, his analysis involves a rule of resyllabification, in which a V́.CV string is resyllabified as V́C.V, reflecting a tendency to make stressed syllables heavy. For a critique of the resyllabification process, see Halle and Vergnaud (1987a).

36 A large class of apparent exceptions includes lexical items such as *paint*, in which a long vowel is followed by a cluster of coronal consonants. Myers suggests that a string of coronals can be extrasyllabic at the edge of a morpheme, thus rendering the final syllable open; however, this explanation does not extend to examples like *mountain*, in which the coronal sequence is not word final, as discussed by Goldsmith (1990).

37 Sainz raises questions about the Level 1 restriction on vowel shortening. She notes that "long vowels consistently shorten before coronal clusters involving stratum 1 suffixes only when the cluster is derived by the addition of either the inflectional suffixes *-t/-d*... or the noun-forming suffix *-th* (e.g., heal/health...)." (p. 184). Citing Ross, she notes the possibility that shortening is "a lexically conditioned rule which applies to the presuffixal vowel in certain words prior to the assignment of stress" (ibid). Since domains, such as "Level 1," are in any case defined in terms of the morphemes contained within them, the question really boils down to one of how many "lexical" domains there are. Is the Level 1 domain for stress rules defined by the same set of affixes which define the domains for vowel shortening, or for the deletion rules to be discussed below? Are all lexical domains nonoverlapping, and part of a large set of properly nested domains? We leave these issues unresolved.

38 But see the discussion of the Derived Environment Constraint and word-level rules in section 4.3.

39 Szpyra (1989) challenges the cyclic analysis of Coronal Palatization, presenting data which demonstrate that the rule appears to apply in certain nonderived environments, while it exceptionally fails to apply in other derived environments. She argues that the domain restriction of Coronal Palatalization does not follow from the SCC, but might involve more direct reference to morphological structure.

40 More recent analyses (Kenstowicz and Rubach 1987; Szpyra 1992) distinguish yers from other vowels on the basis of their prosodic status (such as their specification for a vowel skeletal position), rather than ascribing an abstract [-tense] feature to the yers. The yer □ ø alternation then results from general conditions on syllabification. While these proposals involve different rules to account for yer Lowering, the question of cyclic domains and cyclicity remains.

41 This discussion summarizes Szpyra (1989, pp. 203-224).

42 Rubach notes that the institutions of native speakers with regard to the syllabification of certain clusters are not clear, but in general, the contrast between those clusters which give rise to Devoicing and those which do not derivable from the surface syllabification.

43 Given the lexical restrictions on Sonorant Desyllabification, it must be considered a lexical noncyclic rule, as opposed to a post-lexical noncyclic rule, although Rubach does not discuss this issue.

44 In all of the examples, the cyclic domain is a well-formed morphological constituent.

45 The Arabic system is reanalyzed without problematic rule interaction in Cole (1990).

46 See Myers 1991 for discussion of persistent rules.

47 In a similar fashion, interactive processes building syllable and metrical structures play an important role in the treatment of Latin vowel quantity alternations presented in Mester (in press).

48 Optimization in harmonic phonology is proposed in work by Alan Prince and Paul Smolensky, as cited by Archangeli and Pulleyblank (in press) and Mester (in press); see also Prince (1990). A related dynamic approach to phonology is proposed in Goldsmith (1991b). Rule interaction can also be modeled nonderivationally in terms of conflict resolution strategies as in Cole (1992a), or encoded in the architecture of the phonology-to-phonetics mapping, as in Lakoff (1993) and Wheeler and Touretzky (1993).

49 Arguments for a morphologically-based Derived Environment Constraint are given by Hammond (1991), on the basis of considerations of morphological acquisition.

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