

Segmental Phonology of Modern English

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# Segmental Phonology of Modern English

In this article we examine the problems in the segmental phonology of modern English partly covered in chapter 4 of Chomsky and Halle (1968) (henceforth SPE). Our reasons for coming back to these problems at this time are threefold. First, although there have been a number of attempts to revise the SPE proposals, among which Halle (1977), L. Levin (1980), and especially Rubach (1981; 1984) can be viewed as direct antecedents of the treatment presented below, the segmental phonology of English has attracted somewhat less attention than other issues raised in SPE. Second, with the emergence of the theory of Lexical Phonology, many of the problems have assumed a new and different appearance, making a thorough review desirable. Third, a large body of fresh facts has come to our attention, and these facts demand new solutions and theories.

A major result of SPE was to bring out the central role that Vowel Shift plays in the phonology of modern English. We present new evidence for Vowel Shift in the Appendix, where we analyze the stem vowel ablaut in the inflection of English "strong" verbs. As noted by both Rubach (1981; 1984) and Kiparsky (1983a), Vowel Shift poses a number of problems that concern basic conventions on rule application in the new theory of Lexical Phonology. It has been our experience that one of the best ways of coming to grips with such theoretical issues is by confronting the theory with a rich body of empirical data. We hope, therefore, to contribute something toward the solution of these problems by our discussion, within the framework of Lexical Phonology, of the main facts of English segmental phonology, surely one of the most thoroughly studied domains. And it is with a sketch of this theory that we begin this discussion.

## 1. Lexical Phonology

### 1.1. *The General Outline*

The theory of Lexical Phonology has been developed in a series of studies by Pesetsky (1979), Mohanan (1982), Kiparsky (1982a,b; 1983a,b), Pulleyblank (1983), and others. Since Lexical Phonology is still very much in the process of development, we cannot refer the reader to an exposition of the theory that would represent a reasonable consensus among those who have been actively working on it. We therefore sketch the main outlines of the theory as we understand it and propose modifications on the basis of our study of the segmental phonology of English.

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Lexical Phonology adopts from Siegel (1974) and Allen (1978) the idea that the lexicon consists of ordered *strata* (or *levels*) and that each morphological affixation process takes place at a particular stratum. In English, for example, all class I affixes (like *-ic*, *-ion*, *-ity*, and *in-*, which are associated with the + boundary in SPE) attach at stratum 1, whereas class II affixes (like *-ness*, adjectival *-ed*, *-hood*, and *un-*, which are associated with the # boundary in SPE) attach at stratum 2. An immediate consequence of this is that although class II affixes may be attached to stems containing either class I or class II affixes, class I affixes may not be attached to stems containing affixes of class II. Thus, for example, whereas both *grammaticality* and *grammaticalness* are well-formed English words, only *guardedness* but not *\*guardedity* is well-formed, because the stratum 2 suffix *-ed* cannot be followed by the stratum 1 suffix *-ity*.

We propose that in addition to these two strata, English morphology must recognize three more. Compound formation takes place at stratum 3, whereas regular inflections such as those of the plural and the past tense and participles of verbs are suffixed at stratum 4. This ordering accounts immediately for the fact that regular inflections can be added to words of all kinds—unsuffixed, suffixed, and compound—whereas once the inflection is added, no further suffixes may be adjoined, nor can the “inflected” word be the left-hand member of a compound (except under special circumstances).

In addition to “lexical” strata such as these four proposed for English, there is a fifth: the postlexical stratum, where words are concatenated into phrases and larger syntactic entities. Languages may differ in the number of strata they recognize, but there appear always to be at least two strata, one lexical and the other postlexical, unless the language has no morphology whatever.

The rules of phonology interact with the strata of the morphology in that phonological rules are assigned specific morphological strata as their domain, and a given phonological rule applies only at the stratum that is assigned to it.

(1) *Principles of Domain Assignment*

- a. In the absence of counterevidence, assign the smallest number of strata as the domain of a rule.
- b. In the absence of counterevidence, assign the highest possible stratum as the domain of a rule (where “lowest” = stratum 1).

Given these assumptions, in the unmarked case all phonological rules apply at the postlexical stratum (1b) and only at that stratum (1a). We do not know at present whether there in fact exist languages where all phonological rules are restricted to the postlexical stratum as their domain.<sup>1</sup>

In English, phonological rules apply variously at all five strata, and there are a number of rules that apply at more than one stratum. Among the rules that apply at stratum 1 are the vowel shortening and vowel lengthening rules. Thus, Trisyllabic Short-

<sup>1</sup> Principles (1a,b) are of course not the only ones conceivable. Alternatively, one might think of the following principles: (a) In the absence of counterevidence, assign the maximum number of strata as the domain of a rule. (b) In the absence of counterevidence, assign the lowest stratum as the domain of the rule.

ening applies to *divinity* and *serenity* since these are formed with a class I suffix that is added at stratum 1. Trisyllabic Shortening does not apply to *maidenhood*, *likelihood* or to *timeliness*, *coziness* because the suffixes *-hood* and *-ness* are added at stratum 2 and this rule applies only at stratum 1.

The rule of Flapping (*divinity* → *divini[D]y*, *writer* → *wri[D]er*) applies at the postlexical stratum. It therefore applies anywhere in the phonological phrase, within words as well as across word boundary: *I'll see you [D]omorrow*. And, as we will show, there are other phonological rules whose domains are strata intermediate between 1 and 5 (postlexical).

### 1.2. Stem-final Tensing

To illustrate the above principles, we will consider the rule of Stem-final Tensing that operates in most English dialects. Stem-final Tensing (SPE, 74) tenses nonlow vowels without simultaneously diphthongizing and lengthening them. It accounts for the fact that in these dialects the word-final vowel in *city* is tense, whereas the word-medial vowel is lax. Though tense, this vowel is not long. As a result, the tense short vowel in *cities* [sitiz] contrasts with the tense long diphthongal vowel in *theses* [θiysi:z].<sup>2</sup>

In Lexical Phonology, boundary markers are not sequential entities on a par with speech sounds, as they were in various versions of structuralist phonology and also in SPE. Instead, boundary markers merely indicate the beginning and end of constituents in the string and are therefore notated here by means of double square brackets [ ] to contrast with the regular square brackets [ ] that enclose distinctive feature complexes. Using this notation, we write the Stem-final Tensing rule as follows:

#### (2) Stem-final Tensing

$$\left[ \begin{array}{c} \text{V} \\ \text{-low} \end{array} \right] \rightarrow [+ \text{tense}] / \text{ — } ]$$

In an informal survey we conducted of stem-final tensing, we found that it receives four distinct dialectal treatments. Our main findings are summarized as follows:

#### (3) Dialectal variations in stem-final tensing

Environment	Example	Underlying	Dialect			
			A	B	C	D
Word-final	city	i	i	iy	i	i
Before inflection	cities	i	i	iy	i	i
Stem-finally in compounds	city hall	i	i	iy	i	i
Before <i>-ness</i> , <i>-hood</i> , etc. <sup>3</sup>	happiness	i	i	i	i	i

<sup>2</sup> The only dictionary that we know that represents this three-way contrast systematically is Proctor (1978).

<sup>3</sup> This statement applies to all stress-neutral suffixes except *-ful* and *-ly*. All the speakers we have checked with have *beaut[i]ful* and *happ[i]ly*. Two of our informants reported hearing [i] in these positions from their elderly relatives. Note that vowel reduction (V → ə) applies to short *lax* vowels only: the tense vowel [i] does not reduce. Thus, in dialects A–C we find [hæpəli] but not \*[hæpənəs].

The simplest case is that of dialect D, in which rule (2) does not apply to /ɪ/. In dialect A, all forms are subject to the rule. Dialects B and C are more complex, because they make a distinction between the first three cases of (3) and the last.

Given the SPE theory of boundaries, the examples would be represented as follows:

- (4) a. city           ##sɪtɪ##  
 b. cities           ##sɪtɪ#z##  
 c. city hall       ##sɪtɪ##hɔl##  
 d. happiness     ##hæpɪ#nɛs##

These representations make it impossible to account for the facts of dialects B and C, for they do not distinguish (4b) from (4d); that is, they do not distinguish inflectional suffixes from derivational suffixes associated with the # boundary. It would of course be a trivial matter to postulate two types of # boundaries, of which one would appear before inflectional suffixes and the other before derivational suffixes. However, this proliferation of boundary types would provide no insight into the issues, for it would be available to deal with any problem where the SPE boundary notation failed to make the appropriate distinctions. What clearly is needed is a solution that does not depend on different types of boundaries. Lexical Phonology provides such a solution.

We have observed that the suffix *-ness* is adjoined at stratum 2. In view of this, at stratum 1 the two morphemes composing a word such as *happiness* are treated as two independent units—that is, without reference to the fact that they are next to one another. We express this fact graphically as in (5), by omitting the external brackets of the word and introducing extra space between the morphemes:

- (5) Stratum 1: [[hæpɪ] [nɛs]]<sup>4</sup>

None of the phonological rules of stratum 1 applies to the two morphemes in (5). The first step in stratum 2 is the adjunction of the suffix *-ness* to the stem *happy* to form the noun *happiness*, as shown in (6):

- (6) Stratum 2: [[[hæpɪ] [nɛs]]]

If we stipulate the domain of Stem-final Tensing to be stratum 2, the final vowel in *happy* will be tensed, yielding the output attested in dialects A and B of (3) (ignoring lengthening for the moment). The form [[sɪtɪ], to which no morphological operation applies at stratum 2, is also an input to the rule, yielding [[sɪtɪ]. It is to the output of this rule ([[sɪtɪ]) that compounding and inflectional affixation apply, yielding [[[sɪtɪ]hɔl]] and [[[sɪtɪ]z]], respectively. To obtain the facts of dialect C, where the stem-final vowel of *happy* in *happiness* remains lax, we stipulate that for this dialect the domain of Stem-final Tensing is stratum 3, thereby preventing it from applying at stratum 2. At the end of stratum

<sup>4</sup> Since we see no reason to distinguish between compounding and affixation in terms of bracketing, we shall represent both affixes and stems with brackets around them: [[[man] [ɪy]], [[[man] [made]]]. A theory that distinguishes between them in terms of bracketing (e.g. [[[man]]y] vs. [[[man]]made]]) is clearly less restrictive. (See, however, Mohanan and Mohanan (1984).)

2—the stratum at which the suffix *-ness* was adjoined to the stem *happy* to form the noun *happiness*—the brackets delimiting the two constituents of the noun are erased pursuant to a special convention given below in (8), and the word appears as the unbroken sequence of phonemes shown in (7):

(7) [hæpɪnes]

The convention responsible for this modification in the representation reads as follows:

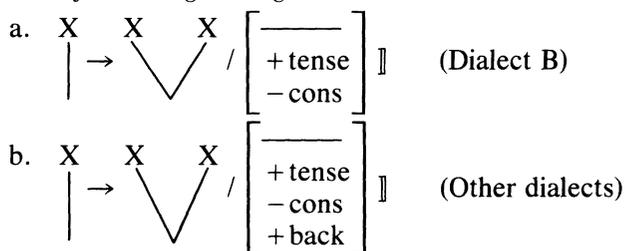
(8) *Bracket Erasure Convention* (BEC)

After the application of all rules at a stratum, the brackets between the morphemes are deleted, so that reference to the constituent morphemes becomes impossible at subsequent strata.<sup>5</sup>

It is obvious that Stem-final Tensing will not apply to (7), since no vowel precedes a constituent bracket. Thus, by assigning Stem-final Tensing to stratum 3 we capture the pronunciation of *happiness* in dialect C.

The length contrasts that are a special feature of dialect B parallel precisely the tenseness contrasts in dialect C. We express this formally by postulating that in dialect B, a rule of Stem-final Lengthening applies at stratum 3, which lengthens stem-final tense vowels. It must be noted that although the lengthening of [ɪ] is found only in some dialects, the lengthening of [u] is found in all dialects. Thus, Proctor (1978) gives long [u:] in *value* and *residue* (vs. short [ʊ] in *valuable* and *residual*), but short tense [i] in *valley*. We formulate Stem-final Lengthening as follows:<sup>6</sup>

(9) *Stem-final Lengthening*



Since Stem-final Lengthening has stratum 3 as its domain, it will not apply in words such as *happiness*, that is, before class II suffixes. To account for the fact that in dialect B the [i] in *happiness* is tense, we assume that in this dialect, as in dialect A, all words are subject to Stem-final Tensing, which has stratum 2 as its domain.

As an example, we give the derivation of the forms in (3) in dialect C:

<sup>5</sup> This convention is stated in Mohanan (1982) as follows:

(i) Erase the internal brackets at the end of a stratum.

See SPE (p. 20) and Pesetsky (1979) for the original proposal, which erases internal brackets at the end of every *cycle*. See Pesetsky (1983) and Kiparsky (1983a) for apparent violations of this principle.

<sup>6</sup> For discussion of the notation in (9), see section 2.1.



- b. \*railroad station
- \*railroads station
- \*houses-hunt

We capture this fact by allowing inflections to be suffixed in stratum 4, whereas compounding, as noted above, takes place in stratum 3.

In light of the preceding, we must recognize two distinct *-ing* suffixes. The inflectional, participial *-ing* is suffixed in stratum 4 and the derivational, nominalizing *-ing* is added in stratum 2.

The suffixes *-er* and *-est*, forming the comparative and superlative of adjectives, appear to be inflectional suffixes and should therefore be added in stratum 4. This decision, however, seems to run afoul of the phonetic facts, as shown by the derivations below.

Prior to stratum 4, where *-ing* and *-est* are suffixed, *long*, *longing* (part.), *longest* will appear as follows,

- (14) [[long]]  
       [[[long]] [[ing]]]  
       [[[long]] [[est]]]

where the extra spaces separating the morphemes express the fact that suffixation has not yet taken place. Rules (11) and (12) apply to these forms in stratum 2, with the following effects:

- (15) [[[loŋ]]]  
       [[[loŋ]] [[ɪŋ]]]  
       [[[loŋ]] [[est]]]

The suffixation and bracket erasure of stratum 4, followed by the postlexical rules, will complete the derivation. Since English phonology does not include a rule reinserting a [g] after nasals, it is clear that the above derivation will produce an output for *longest* that incorrectly will contain no [g]. As pointed out to us by P. Kiparsky, the correct output for the adjectives *long*, *strong*, and *young* can be obtained by the relatively straightforward expedient of exceptionally suffixing *-est* in stratum 1. If that is done, the superlative form will undergo bracket erasure in stratum 1 and emerge at the beginning of stratum 2 as

- (16) [[longest]]

to which only Nasal Assimilation but not *g*-Deletion is applicable, as required by the facts.

In sum, we shall assume that the suffixes *-er* and *-est* are normally added in stratum 4, like all other inflections. In the case of the adjectives *long*, *strong*, *young*, however, *-er* and *-est* are exceptionally added in stratum 1. A modicum of support for this exceptional treatment is provided by the past tense suffix /t/ in verbs such as *kept*, *left*,

*meant*. As will be discussed in the Appendix, the past tense /t/ suffix is added in stratum 1, whereas the regular past tense suffix is added in stratum 4. This treatment thus parallels the solution just proposed for the adjectives.

#### 1.4. *The Loop*

It is well known that stratum 2 affixation and compounding provide inputs to each other (see Selkirk (1982), Kiparsky (1982a)): [[[neighborhood] [gang]], [re[[air][condition]]]]. These two processes therefore cannot be distinguished in terms of morphological distribution, unlike stratum 1 and stratum 2 affixations. In order to account for this distribution, Mohanan (1982) proposes a “loop” between strata 2 and 3:

- (17) Stratum 1: Class I derivation, irregular inflection  
 Stratum 2: Class II derivation  
 Stratum 3: Compounding  
 Stratum 4: Regular inflection

The loop is a device that allows a stratum distinction for the purposes of phonology, without imposing a corresponding distinction in morphological distribution. This device is well motivated for languages like Malayalam in which two kinds of compounds are distinguished in terms of structure, meaning, and phonology, but not in terms of morphological distribution.

Unlike the present study, Kiparsky (1982a) accounts for the distributional facts of class II derivation and compounding in English by assuming that they belong to the same stratum (see also Selkirk (1982), where equivalent assumptions are made). The facts of stem-final tensing, however, show that we require the stratum ordering in (17). In particular, as detailed above (see (3)), in dialect C Stem-final Tensing must be assigned to a stratum that follows the one on which *-ness* is suffixed. If, as proposed by Kiparsky, compound formation is to take place on the same stratum as class II affixation, we should expect that in dialect C Stem-final Tensing will be inapplicable not only before the *-ness* suffix but also in compounds such as *city hall*. Since this is not the case (see (3)), we must assume that compound formation takes place at stratum 3 and class II affixation at stratum 2. To account for the fact that compounds undergo class II affixation, we then have recourse to the “loop” in (17). Without this option there does not seem to be any plausible way to account for the facts of dialect B.

1.4.1. *Brackets vs. Boundary Markers (Junctures)*. We have noted that Lexical Phonology does not employ boundary markers of the SPE type, which are sequential units without phonetic content.<sup>8</sup> In place of the three kinds of SPE boundary—+, #, ##—Lexical Phonology recognizes, for English, five strata to which phonological rules may be assigned. We have already explained that the distinction between + and # corre-

<sup>8</sup> For arguments against the use of distinct boundary symbols in phonology, see Rotenberg (1978), Pesetsky (1979), Selkirk (1980), and Mohanan (1982).

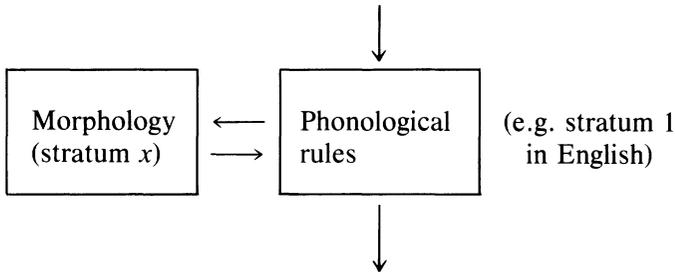


*l*-Resyllabification applies at stratum 4 because it affects not only compounds but also *V + ing* forms such as *dea[l]ing*, *whee[l]ing*, etc. *l*-Resyllabification applies before and thus bleeds *l*-Velarization, which applies at the postlexical stratum. Across words in phrases (which are concatenated at the postlexical stratum) there is no resyllabification of *l* in English.

### 1.5. Cyclic and Noncyclic Strata

1.5.1. *English*. There is abundant evidence that the rules of word stress, which apply at stratum 1, apply cyclically. As noted above, the cyclicity of rule application in Lexical Phonology is not a stipulation on individual rules. Rather, it is a stipulation on the stratum, or on the way morphology interacts with phonology. By saying that stratum 1 in English is a cyclic stratum, we intend that the relevant phonological rules apply to every morphological constituent in the stratum—to the basic stem (see however section 1.5.2), as well as to every constituent created by morphological processes—immediately after the application of each morphological process. After the phonological rules have applied, the result is again a potential input to morphology. This relation between morphology and phonology is represented as follows:

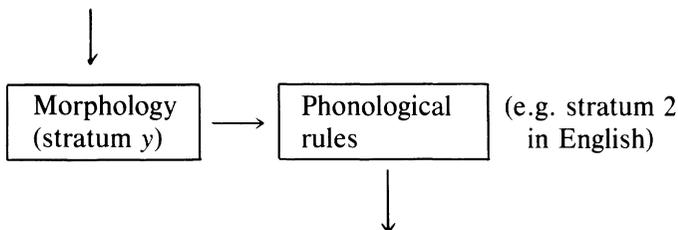
#### (22) Cyclic Stratum



An example of phonological rules applying before affixation as in (22) is provided by the English stress rules:  $[[\text{theatre}]] \rightarrow [[\text{théâtre}]] \rightarrow [[[\text{théâtre}]][\text{ic}]] \rightarrow [[[\text{theâtre}]][\text{ic}]] \rightarrow [[\text{théátric}]] \rightarrow [[[\text{théátric}]][\text{al}]] \rightarrow \dots$

In addition to cyclic strata there are *noncyclic strata* in which all the morphological processes apply en bloc followed by the phonological rules of that stratum.

#### (23) Noncyclic Stratum



Given that at least some strata have to be cyclic, the null hypothesis would be that all lexical strata in all languages are cyclic. This is the assumption found in Mohanan (1982) and Kiparsky (1982a,b). In light of the facts of stem-final tensing given in (3), however, this appears to be too strong a position. Recall that in dialect B, the rule of Stem-final Tensing does not apply when followed by the suffixes *-ful* and *-ly* (see footnote 3), even though these are class II affixes and Stem-final Tensing normally applies at stratum 2 in dialect B. The exceptionality of these two affixes can be encoded in the grammar by formulating the rule as follows:

$$(24) \left[ \begin{array}{l} - \text{cons} \\ - \text{low} \end{array} \right] \rightarrow [ + \text{tense} ] / \text{---} ] \text{ except before } -ly, -ful$$

|  
R

It is clear that rule (24) can apply only after the affixation at stratum 2. If rule application at stratum 2 were cyclic, the results would be contrary to the facts:

(25)	[[hæpi]]	[[li]]	Underlying
	[[hæpi]]	[[li]]	Rule (24)
	[[[hæpi]] [[li]]]		Affixation
	—		Rule (24)
	*hæpili		Output

It is important, therefore, that phonological rules be allowed to apply at stratum 2 only *after* all morphological processes, as in (23), rather than before the morphological processes, as in (22). We achieve this by stipulating that stratum 2 is noncyclic.

A conceivable alternative is to treat *-ful* and *-ly* as class I suffixes. This solution will not work, however, because these suffixes never affect stress and cannot be followed by class I affixes: \**beautifullity*.

Another alternative is to revise (2) as (26) so that the structural description is not met until after the suffixation:

$$(26) V \rightarrow [ + \text{tense} ] / \text{---} ] X, \text{ where } X \neq \emptyset$$

Rule (26) is incorrect, however; it would prevent tensing in forms like *city hall*, *cities*, and *city*, for in none of these cases is the word-final vowel followed by a nonnull string at stratum 2.

One might next think of changing the domain of rule (26) from stratum 2 to all strata between 2 and the postlexical stratum, so that the structural description is met for *happiness* at stratum 2, *city hall* at stratum 3, *cities* at stratum 4, and *The city lives* at the postlexical stratum. This proposal does not work, since the last vowel in phrases like *We love this city* would not undergo the revised rule, whereas in fact the /*ʌ*/ is tensed, even though it is not followed by a nonnull string. Therefore, we conclude that none of these alternatives is correct and that stratum 2 is noncyclic.

Yet another alternative would be to have the following rules in the grammar:

- (27) a.  $i \rightarrow i / \text{ \_\_\_\_ } ]$  (rule (2))  
 b.  $i \rightarrow i / \text{ \_\_\_\_ } ]$  *-ful, -ly*

Under this solution, the rules can apply cyclically, yielding  $[[hæpi]] \rightarrow [[hæpi]] \rightarrow [[[hæpi]]li]] \rightarrow [[[hæpi]]li]]$ . We must reject this solution, however, because it is more complicated than the alternative above where only rule (24) had to be postulated. Rule (27a) is comparable in complexity to (24); hence, rule (27b) adds to the complexity of the solution. The added complexity is needed not to characterize the facts, but only to satisfy the theoretical requirement that lexical rules must be cyclic. Once that requirement is abandoned, nothing prevents adoption of the simpler solution consisting of rule (24) alone.

1.5.2. *The Lexical Phonology of Vedic Stress.* If lexical strata may be either cyclic or noncyclic and the same rule may apply at more than one stratum, we would expect to find rules that apply cyclically at one stratum and noncyclically at another. An especially instructive example of the effects of stratum-ordered phonological rules is provided by Vedic stress, as discussed in Kiparsky (1982b).

Like many Indo-European languages (see Kiparsky and Halle (1977)), Vedic Sanskrit distinguishes between unaccented and accented (including preaccenting) morphemes. A word containing  $n$  morphemes may therefore contain anywhere from zero to  $n$  accented syllables. On the surface, however, each word appears with only a single stressed syllable, whose location is determined by the Basic Accentuation Principle:<sup>9</sup>

(28) *Basic Accentuation Principle (BAP)*

A word is stressed on the leftmost accented syllable or, in the absence of an accent, on the leftmost syllable.

We view *accent* as a diacritic feature that attracts stress. Specifically, we postulate that the effect of the BAP is to assign both stress and accent to the leftmost (accented) syllable in a word, at the same time eliminating accents from all other syllables in the word. We illustrate these points with examples of dative singular forms (accented vowels are underlined):

- (29) duhitar + e → duhitré<sup>10</sup> ‘daughter’ (cf. *dūhitar* ‘vocative’)  
 bhrātar + e → bhrātre ‘brother’  
 marut + e → marúte ‘wind’

In addition to classing morphemes into unaccented and accented, Vedic Sanskrit groups morphemes into what Kiparsky has termed *dominant* and *recessive*. The dominant morphemes contrast with recessive morphemes (of which the dative singular *e* is an example) by triggering rule (30):

(30) *Accent Deletion*

Delete stress and accent on nonfinal morphemes.

<sup>9</sup> For a more sophisticated statement of the BAP, see Halle and Vergnaud (forthcoming).

<sup>10</sup> The deletion of the stem-final /a/ in the first two examples is due to a special rule that is not germane to the issues under discussion.

Dominant suffixes may be adjoined to stems containing dominant suffixes, but they may not be adjoined to stems containing recessive suffixes. In light of the preceding discussion this implies that dominant suffixes are added on an earlier stratum than recessive suffixes. The facts of greatest interest from the present vantage point are those concerning stress placement in words with dominant suffixes. As expected in view of (30), words with accented dominant suffixes surface with stress on the last accented dominant suffix. Thus, the noun-forming suffix *-in*, which is dominant and accented, always surfaces with stress regardless of whether the stem to which it is added is accented and regardless of whether it is followed by an accented recessive suffix.

- (31)  $\text{rath} + \underline{\text{in}} + \underline{\text{e}} \rightarrow \text{rathíne}$  ‘charioteer’ (dat. sg.)  
 $\text{mitr} + \underline{\text{in}} + \underline{\text{e}} \rightarrow \text{mitríne}$  ‘befriended’ (dat. sg.)

Words with unaccented dominant morphemes, on the other hand, surface with stress on the initial syllable regardless of whether the stem is inherently accented and regardless of whether a following recessive suffix is accented:

- (32) a.  $[[\text{sar} + \text{as}]] + \text{vat} + \bar{\text{i}} + \text{vant} \rightarrow \text{sárasvatívant}$   
 ‘accompanied by Sarasvati’, where *-as* is dominant and unaccented and *-vant* and *-i* are recessive  
 b.  $[[\text{prati} + \text{cyav} + \bar{\text{i}}\text{yas}]] + \text{i} \rightarrow \text{práticyavīyasi}$   
 where the comparative suffix *-īyas-* is dominant and unaccented and *-i* is recessive

Finally, when a word contains both accented and unaccented dominant suffixes, it is the rightmost (last) of these that determines the place of the word stress. If the last dominant suffix is accented, it also has the word stress. If the last dominant suffix is unaccented, word stress goes on the initial syllable:

- (33) a.  $[[\text{kār} + \underline{\text{ay}} + \text{itum}]] \rightarrow \text{kārayitum}$   
 ‘in order to cause to make’, where *-itum* is dominant and unaccented and *-ay-* is dominant and accented  
 b.  $[[\text{ci} + \text{kār} + \underline{\text{ay}} + \text{iṣa}]] + \text{ti} \rightarrow \text{cīkārayiṣati}$   
 ‘wants to cause to make’, where *-ay-* is dominant and accented and *-iṣa-* is dominant and unaccented

The facts just reviewed can be handled most easily by assuming that there are two lexical strata in Vedic. Dominant suffixes are adjoined to stems in stratum 1, whereas recessive suffixes are adjoined in stratum 2. Accent Deletion has stratum 1 as its domain, whereas the BAP has both stratum 1 and stratum 2 as its domain. Finally, we postulate that stratum 1 is cyclic—that is, that the phonological rules in this stratum are applied in accordance with (22)—whereas stratum 2 is noncyclic—that is, its phonological rules are applied in accordance with (23).

We illustrate the preceding with the schematized derivations in (34), where S represents stems, D dominant suffixes, R recessive suffixes, and the underline, the diacritic mark *accented*.

(34)	a.	b.	c.
	[[[S][D][D]]]	[[[S][D][D]]]	[[[S][R][R]]]
<i>Stratum 1</i>			
	[S]	[S]	[S]
Accent Deletion	—	—	—
BAP	—	—	—
Affixation	[[[S][D]]]	[[[S][D]]]	—
Accent Deletion	[[[S][D]]]	—	—
BAP	[[[S][D̄]]]	[[[S][D̄]]]	—
Affixation	[[[S][D̄][D]]]	[[[S][D̄][D]]]	—
Accent Deletion	[[[S][D][D]]]	[[[S][D][D]]]	—
BAP	[[[S][D][D̄]]]	[[[S][D][D̄]]]	—
BEC	[[SDD̄]]	[[SDD̄]]	—
<hr/>			
<i>Stratum 2</i>			
Affixation	—	—	[[[S][R][R]]]
BAP	—	—	[[[S̄][R][R]]]
BEC	—	—	[[S̄RR]]
<i>Output</i>	[[SDD̄]]	[[SDD̄]]	[[S̄RR]]

It has been observed repeatedly, since Kiparsky (1973) first drew attention to it, that cyclic rules apply only in “derived” environments, and that they do not apply in “nonderived” environments. This limitation on the application of cyclic rules is illustrated in the first three lines of the derivations in (34). It is worth noting in this connection that underived stems do constitute well-formed words in Vedic. Such words are not stressless, as the following vocative forms show, for example:

- (35) *dúhitar* ‘daughter’  
*bhrátar* ‘brother’  
*marút* ‘wind’

They are stressed by the BAP in stratum 2, which is noncyclic and is therefore not restricted to “derived environments.”

Observe that word stress rules in English apply to underived forms at stratum 1, as shown by words like *nightingale*, *America*, *agenda*. This indicates that word stress rules in English are not subject to strict cyclicity. In contrast, the stress rules in Sanskrit are subject to strict cyclicity. This contrast follows from the fact that stress in Sanskrit is structure-changing, since morphemes are specified in their lexical representation as accented or unaccented, whereas those in English are not.<sup>11</sup>

Kiparsky (1982b) presents a somewhat different treatment of the facts under discussion here. This difference derives basically from the assumption made by Kiparsky,

<sup>11</sup> See the distinction between structure-building and structure-changing operations in section 2.5.



morphemes, between dominant and recessive morphemes, and between different strata of affixation. It appears to us, therefore, that the added complexities are the result of Kiparsky's failure to recognize the correspondence between cyclic vs. noncyclic and dominant vs. recessive affixes.

## 2. The Segmental Phonology of English

### 2.1. English Vowels: The General Picture

Example (38) shows the surface contrasts among the stressed vowel nuclei in English. The pronunciations are based on Kenyon and Knott (1944) for American English (GA) and Jones (1977) and Proctor (1978) for British English (RP). The notation is ours.

(38) *Surface vowels*<sup>12</sup>

	[+ back]		
	[− back]	[− round]	[+ round]
[ + high − low ]	i : bit		u : put
	iy : beat		uw : boot
	i : happy		
[ − high − low ]	ε : bet	ʌ : but	o : baud (in RP)
	ey : bait		ow : boat
[ − high + low ]	æ : bat	a : bomb (in GA)	ɔ : bomb (in RP)
		a <sub>t</sub> : balm	ɔ <sub>t</sub> : baud (in GA)
		a <sub>t</sub> y : bite	ɔ <sub>t</sub> y : boy
		a <sub>t</sub> w : bow	

In determining the underlying representation of the short vowels in GA, we follow the pattern in (38) except for the nonhigh rounded vowels, as shown in (39).

(39) *Underlying representations of short vowels*

	[+ back]		
	[− back]	[− round]	[+ round]
[ + high − low ]	bit		put
	/ɪ/		/ʊ/
[ − high − low ]	bet	but	baud
	/ε/	/ʌ/	/o/
[ − high + low ]	bat	balm	bomb
	/æ/	/a/	/ɔ/

<sup>12</sup> [i, u, ε, o, ʌ, æ, ɔ, a] represent lax vowels; [i, u, e, o, ɔ<sub>t</sub>, a<sub>t</sub>] represent tense vowels.

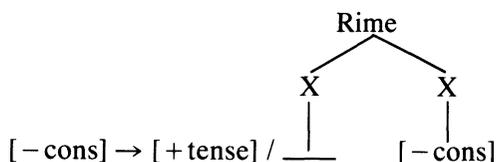
In addition to the features [high], [low], [back], and [round], we need a length distinction to contrast pairs like *bit* and *beat*. We follow the practice in autosegmental phonology (McCarthy (1979), Halle and Vergnaud (1980), Steriade (1982), and others) and represent phonological strings as three-dimensional objects consisting of a core skeleton composed of (timing) slots whose phonological contents are given by distinctive feature complexes that are located on one or more separate melody tiers and are linked to the slots of the skeleton. In this representation a short vowel is linked to a single skeleton slot, whereas a long vowel is linked to two consecutive slots. This is illustrated in (40), where the distinctive feature complexes on the melody tier are given by the standard phonetic symbols and the skeleton slots are represented by X:

(40) Skeleton:	X	X	X	X	X	X	X
					/ \		
Melody:	b	i	t	b	i	t	

We follow here the suggestion of J. Levin (1983) and do not distinguish timing slots linked to vowels from those linked to consonants. Our timing slots are therefore all labeled with the single symbol X. We do not justify this choice here since none of the matters discussed below hinges on it.

Certain surface details must be settled at this point. Long vowels in English, for example, are redundantly tense and diphthongized (e.g. [buwt], [biyt]), whereas short vowels are lax monophthongs (e.g. [bit], [bet]). The following rule accounts for the redundant tensing of long vowels.

(41) *Long Vowel Tensing*



It is, however, not the case that all underlying short vowels surface as lax. It has been well known at least since Bloomfield (1933) drew attention to it that many GA dialects exhibit a contrast between the vowels in *bomb* and *balm*, which, following Halle (1977), we take to be that of lax [a̠] vs. tense [a]. Lax [a̠] derives from underlying short /ɔ/, as shown by alternations such as those in (42):

- (42) cone~conic  
 verbose~verbosity  
 provoke~provocative

In the unsuffixed base forms the underlying vowel must be long /ɔ̃/—[+low, +back, +round]—which undergoes Vowel Shift and surfaces as the diphthong [ow] (see rules (61) and (62) below). In the suffixed words the stem vowel is shortened by special rules

(see the shortening rules (56) below). The shortened [ɔ] then surfaces as [a] by virtue of the unrounding rule (43):

(43) *ɔ-Unrounding*

$$\begin{bmatrix} +\text{low} \\ +\text{back} \end{bmatrix} \rightarrow [-\text{round}] / \begin{array}{c} \text{---} \\ | \\ \text{X} \\ | \\ \text{R} \end{array}$$

In RP *ɔ-Unrounding* is not applicable, and the words in (42) surface with short lax [ɔ].

To account for the fact that the stressed vowels in such words as *balm* (as well as *father* and *rajah*, but not *bother* and *Roger*) are phonetically tense, we need a rule tensing short /a/, which applies before *ɔ-Unrounding* and therefore does not affect underlying short /ɔ/. Before formulating this rule, we observe that in addition to /a/ short underlying /o/ as in *baud* and *Catawba* also surfaces as tense. We therefore need a rule that tenses short /a/ and /o/:

(44) *a/o-Tensing*

$$\begin{bmatrix} -\text{high} \\ +\text{back} \\ \alpha\text{low} \\ \alpha\text{round} \end{bmatrix} \rightarrow [+ \text{tense}] / \begin{array}{c} \text{---} \\ | \\ \text{X} \\ | \\ \text{R} \end{array}$$

For RP nothing further is needed, since *a/o-Tensing* yields the correct surface reflexes of the vowels under discussion (see below (46)). In GA dialects, on the other hand, short /o/ is lowered by the following rule:

(45) *o-Lowering*

$$\begin{bmatrix} -\text{high} \\ +\text{back} \\ +\text{round} \end{bmatrix} \rightarrow [+ \text{low}] / \begin{array}{c} \text{---} \\ | \\ \text{X} \\ | \\ \text{R} \end{array}$$

By ordering *ɔ-Unrounding* after *a/o-Tensing* and before *o-Lowering*, we obtain the following derivations:

(46)	balm	bomb	baud	
	a	ɔ	o	Underlying
	a <sub>t</sub>	—	o	<i>a/o-Tensing</i>
	—	a	—	<i>ɔ-Unrounding</i>
	—	—	ɔ <sub>t</sub>	<i>o-Lowering</i>

As noted earlier, RP does not make use of *ɔ-Unrounding* and *o-Lowering*, and the deri-

vation stops after the application of *a/o*-Tensing.<sup>13</sup> In GA dialects where the vowels of *bomb* and *balm* do not contrast, *ɔ*-Unrounding is ordered before *a/o*-Tensing.

The *o*-Lowering rule (45) provides an account for the GA contrasts below:

- (47) [ɔ<sub>ɪ</sub>] long            cough    broth    toss  
           haunt  
           Maundy  
       [a] tongs            doff    gothic    mosque  
           (King) Kong  
           font  
           fond

The stems surfacing with [ɔ<sub>ɪ</sub>] have underlying short /o/; those surfacing with [a] have underlying /ɔ/.<sup>14</sup>

Some GA dialects have both tense and lax [æ]. According to Trager (1930), for example, lax [æ] appears before word-final voiceless stops, and tense [æ<sub>ɪ</sub>] appears before other word-final consonants:

- (48) [æ]: tap    pat            patch    rack    pal  
       [æ<sub>ɪ</sub>]: tab    pad            badge    tag    ham, man  
           staff    path    pass    cash  
           salve            jazz

The following rule accounts for the facts in these dialects:

- (49) *æ*-Tensing  
 $\text{æ} \rightarrow [+ \text{tense}] / \begin{array}{c} \text{---} \quad \text{C} \\ | \quad | \\ \text{X} \quad \text{X} \\ \diagdown \quad \diagup \\ \text{R} \end{array}$

where C = [+ voice, - son, - cont] or [- lateral]

Halle (1977) assumed that English vowels are underlyingly specified for tenseness as well as for length. The main reason for this assumption was the fact that in certain words with low vowels, the penultimate syllable attracts stress, even though it does not undergo Vowel Shift and Diphthongization. It was suggested in SPE that both stress placement and Vowel Shift (see section 2.2) depend on the feature [tense]. The SPE Main Stress Rule thus assigned stress to a penultimate syllable if it had a tense vowel, and this vowel then was also subject to Diphthongization:

- (50) angina  
       emphysema  
       volcano  
       Angola

<sup>13</sup> Jones (1977) represents the vowel in *balm* as [a:].

<sup>14</sup> We assume that *long* has underlying /ɔ/ in RP and /o/ in GA, both surfacing as [ɔ<sub>ɪ</sub>].

There are words such as those in (51), however, where main stress falls on the penultimate syllable yet where the vowel is evidently not subject to Diphthongization:

- (51) [æ] impala, Alabama, alpaca, banana, hosanna  
 [a] Chicago, sonata, soprano, errata, cassaba  
 [ɔ:] Winnepesaukee, Catawba

To handle this fact, Halle (1977) proposed that the Main Stress Rule is sensitive to the feature of vowel length, whereas Diphthongization affects only vowels that are tense (and stressed). In Halle's account the vowels in (51) were therefore represented as long and nontense, but those in (50) were considered to be tense as well as long.

L. Levin (1980) has pointed out, however, that words such as those in (52),

- (52) vanilla antenna Mississippi  
 operetta medulla umbrella

whose penultimate nonlow vowel is short and nontense, exhibit the same "irregular" stress behavior as the words in (51), whose penultimate vowel is long and nontense. Halle's proposal evidently cannot deal with the facts in (52). In view of this we suggest that the "irregular" stress of the words in (51) and (52) is to be accounted for by stipulating that the penultimate syllable in these words is supplied with the diacritic feature *accented* by a special rule that attracts stress. (See Halle and Vergnaud (forthcoming) and Halle and Clements (1983) for details.) This solution has two desirable consequences. First, it makes it possible to eliminate the feature [ $\pm$ tense] from underlying representations. Second, by restricting assignment of the diacritic feature *accented* to the penultimate (i.e. the last metrical) syllable of a word, we explain the fact that "irregular" stress appears only on the penultimate syllable. We also capture the fact that stress in English (unlike stress in Sanskrit) is not present in lexical representations and that the stress rule of English is not "structure-changing" and therefore not subject to the Strict Cyclicity Condition ((102) below).

## 2.2. Vowel Shift

The central role of Vowel Shift in the phonology of English was discussed in detail in SPE with reference to various rules that affect the length of vowels. As illustrated in (53) and (54), respectively, there are several distinct environments where long vowels are shortened, and several in which vowels are regularly lengthened:

- |         |                      |    |                        |    |                  |
|---------|----------------------|----|------------------------|----|------------------|
| (53) a. | divine~divinity      | b. | crucify~crucifixion    | c. | satire~satiric   |
|         | serene~serenity      |    | intervene~intervention |    | kinesis~kinetic  |
|         | sane~sanity          |    | —                      |    | volcano~volcanic |
| (54) a. | —                    | b. | elegy~elegiac          |    |                  |
|         | manager~managerial   |    | —                      |    |                  |
|         | marginal~marginalia  |    | algebra~algebraic      |    |                  |
|         | Lilliput~Lilliputian |    | ambiguous~ambiguity    |    |                  |

The alternations in quantity do not leave vowel quality intact. Rather, they are accompanied both by alternations in vowel quality and by changes from monophthong to diphthong and vice versa.

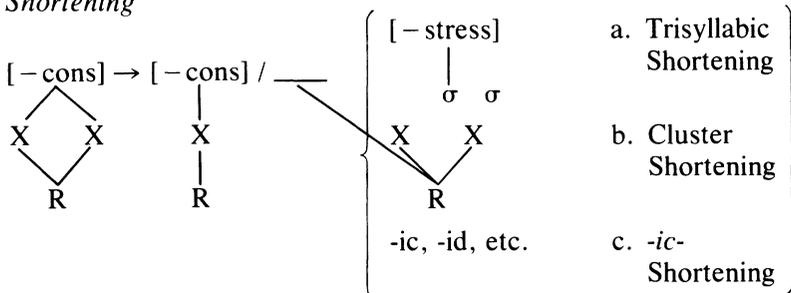
The alternations exhibited in (53) and (54) are as follows:

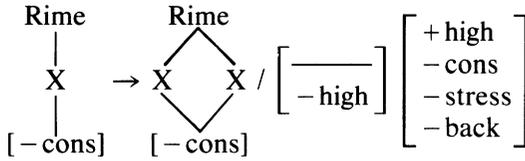
- (55) ay~ɪ  
 iy~ɛ  
 ey~æ  
 aw~ʌ  
 (y)uw~ʌ

The alternating vowels in (54) must be underlyingly short, as shown by the fact that they do not attract stress; the corresponding vowels in (53) must be underlyingly long, since they do attract stress. Therefore, the length alternations work both ways. If the examples in (53) and (54) were to be handled with the help of two rule blocks—one for (53) and one for (54)—the structural change in the respective rules would have to be quite complex. In the rule block accounting for (53) the structural change would not only have to shorten the vowel, but also have to monophthongize as well as effect complex changes in vowel quality: for example, [ay] → [ɪ] or [aw] → [ʌ]. In the rule accounting for (54) the structural change would have to include essentially the same machinery but operating in the reverse direction, that is, diphthongizing rather than monophthongizing vowel nuclei, etc. As shown in SPE, considerable formal simplification can be obtained if lengthening and shortening are separated from other changes in vowel quality as well as from diphthongization. Specifically, following SPE we assume that the grammar contains rules affecting the quality and diphthongization only of long vowels. An immediate consequence of this is that long vowels are represented in the lexicon as differing systematically from their surface reflex (and from that of their short cognates) in the features [high] and/or [low] as well as in diphthongization. Thus, long /ē/ surfaces as [iy], long /æ̃/ as [ey], long /ō/ as [uw], etc., whereas short vowels surface unchanged.

The alternations in (53) can then be expressed quite simply as changes from long to short, and those in (54) as changes from short to long. Formally, we capture this with the two rules in (56) and (57), which respectively shorten and lengthen vowels in specific environments:

(56) *Shortening*



(57) *CiV Lengthening*

*CiV* Lengthening (57) accounts for lengthening in such words as those in (58):

- |      |           |          |             |
|------|-----------|----------|-------------|
| (58) | Caucasian | Horatian | Lilliputian |
|      | custodial | colonial | remedial    |
|      | Scotia    | regalia  | Babylonia   |
|      | felonious | studious | mendacious  |

*CiV* Lengthening has a number of exceptions. Some are lexically marked stems such as those in (59):

- |      |         |            |            |            |
|------|---------|------------|------------|------------|
| (59) | Italian | Maxwellian | centennial | rebellious |
|      | special | gaseous    | precious   | patio      |

Others, as observed by Rubach (1984), are systematic exceptions. For example, there is no instance of this type of lengthening before *-ion*:

- |      |            |            |            |
|------|------------|------------|------------|
| (60) | companion  | battalion  | medallion  |
|      | confession | procession | discussion |

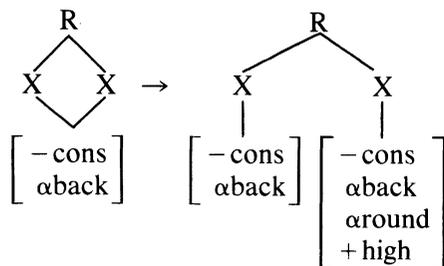
The outputs of the rules in (56) and (57), which are discussed further below, are then subject to Vowel Shift and Diphthongization. The rule of Vowel Shift (61) adopted here is basically identical to the one in Halle (1977), except that for reasons detailed above it affects vowels that are long rather than tense:

- |      |   |   |
|------|---|---|
| (61) | <i>Vowel Shift</i> <sup>15</sup>  |   |
|      | $\left[ \begin{array}{c} \alpha\text{high} \\ -\text{low} \end{array} \right] \rightarrow [-\alpha\text{high}]$ | $\left. \begin{array}{c} \left[ \text{---} \right] \\ / \quad \backslash \\ \text{X} \quad \text{X} \\ \backslash \quad / \\ \text{R} \end{array} \right\}$ |
|      | $\left[ \begin{array}{c} \beta\text{low} \\ -\text{high} \end{array} \right] \rightarrow [-\beta\text{low}]$    |   |

We deviate from SPE in not restricting Vowel Shift to stressed vowels. We have

<sup>15</sup> Our use of [ $\pm$ stress] does not imply that we consider stress a segmental feature. Rather, stress (as well as syllabicity) is a property of the hierarchical (metrical) structure.

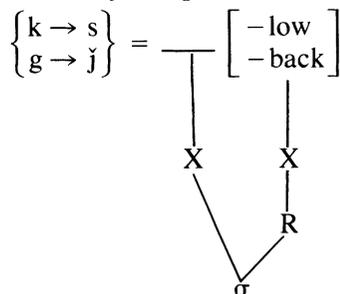
found no need for this restriction, in view of the fact that we motivate below a special treatment for such alternations as *impious*~*pious*, *various*~*variety*, *elegy*~*elegiac*, *maniac*~*maniacal*. In addition to being subject to Vowel Shift, the long vowels diphthongize, a fact expressed here by means of the following rule that inserts [y] or [w]:

(62) *Diphthongization*

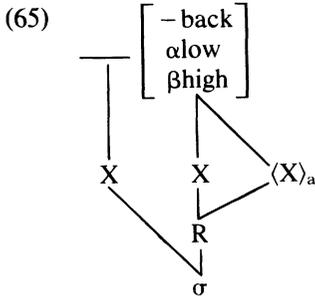
As noted in SPE (pp. 219ff.), the facts of Velar Softening as illustrated in the next example provide further support for postulating Vowel Shift as a synchronic process of contemporary English.

- (63) a. critic      critic-ize      matrix      matric-es  
           medic-ate    medic-ine
- b. fung-us      fung-i            larynx      laryng-es  
           analogue    analog-y        intellect    intellig-entsia

If Velar Softening is ordered before Vowel Shift, the context in which it applies can be stated in the relatively transparent manner given in (64),

(64) *Velar Softening*

where  $\sigma$  stands for a syllable root and R for a rime root. If Velar Softening is ordered after Vowel Shift, the statement of its environment becomes much more complex: namely, before nonback vowels which if short must be nonlow and nonhigh, and if long must be either high and nonlow or nonhigh and low. That is,



If a,    α = + or β = +  
 If ~a,   α = - and β = -

We take the preceding to be an argument for ordering Velar Softening before Vowel Shift. It follows from this that Velar Softening and Vowel Shift may have the same stratum as their domain or that Velar Softening has as its domain an earlier stratum than Vowel Shift. We will argue below that both Velar Softening and Vowel Shift have as their domain stratum 2.

As noted above, SPE did not distinguish between tense short vowels and tense long vowels on the surface, and hence *CiV* lengthening was handled there as *CiV* tensing. In addition to *CiV* Tensing, SPE contained two other tensing rules, namely, Stem-final Tensing and Prevocalic Tensing. We have already seen that the processes of stem-final tensing (rule (24)) and stem-final lengthening (rule (9)) are distinct. These facts raise questions regarding the status of Prevocalic Tensing. The dictionary entries in Kenyon and Knott (1944) and Jones (1977), neither of which distinguishes between tense and lax short vowels, indicate that vowels are not *lengthened* in the prevocalic position:

(66)	Kenyon and Knott	Jones
a. vary	veɹɪ	veəɹɪ
b. various	veɹɪəs	veəɹɪəs
c. variation	veɹɪeʃən	veəɹɪeɪʃn
d. radiance	redɪəns	reɪdɪəns
e. radiate	redɪet	reɪdɪeɪt
f. radiation	redɪeʃən	reɪdɪeɪʃn
g. arduous	ɑɹdʒʊəs	ɑ:dʒʊəs
h. theatre	θ $\begin{Bmatrix} ɪ \\ i \end{Bmatrix}$ ətə	θɪətə
i. theatric	θætrɪk	θɪætrɪk

Key: Kenyon and Knott: *city* [sɪtɪ], *seat* [sɪt]  
 Jones: *city* [sɪtɪ], *seat* [si:t]

These data clearly show that there is no Prevocalic Lengthening corresponding to the Prevocalic Tensing of SPE. The immediate consequence would be that we need to think of a special mechanism to account for the vowel alternations in pairs like *various*~*variety*. In SPE, the /ɪ/ in *various* and *variety* underwent Prevocalic Tensing, and the vowel in

the latter in addition underwent Vowel Shift, which, in SPE, applied to tense stressed vowels. In our treatment, Vowel Shift applies to long vowels, and since the prevocalic vowels in (66) are not long, the SPE solution is not open to us. Therefore, it is necessary to attribute the vowel alternation in *various~variety*, *impious~pious*, and *maniac~maniacal* to a special rule that lengthens the stressed vowels in a number of specially marked words. In addition to lengthening, this rule will have to lower the vowel to mid in examples like *simultaneity* and *homogeneity*, which are represented with long [i] in Kenyon and Knott. In order to account for the facts given by Jones, who lists alternative pronunciations like [-ni:ti], [-ni:iti], and [-nei:ti], we will have to assume that in some dialects the lengthening rule is accompanied by changing the vowel to low ([-nei:ti]).

Though there is no prevocalic lengthening in English (except as a special rule in a few words), the entries in Proctor (1978), which distinguish between tense and lax short vowels, indicate that there is indeed a rule of prevocalic tensing that applies when [ɪ] is followed by a vowel other than schwa:

(67) a.	vɛəri	vɛəriəs	vɛəriɛɪfən
b.		reɪdiəns	reɪdiɛɪt reɪdiɛɪfən
c.		a:dʒuəs	
d.		θiətə	θiætrɪk
e.		sɪmɔlteɪniəs	sɪmɔlteɪni:ti

The [ɪ] in *vary* is tensed by Stem-final Tensing (24). There is no tensing in the words in the second column, when the [ɪ] is followed by schwa. In the third column, [ɪ] is tensed when followed by a non-schwa vowel.

It appears that this prevocalic tensing applies to [ɪ] but not to [ʊ]. Proctor (1978) gives entries like the following, in which [ʊ] does not tense:

(68)	insinuate	ɪnsɪnjuɛɪt ([j] = [y])
	insinuation	ɪnsɪnjuɛɪfən
	evaluate	ɪvæljuɛɪt
	evaluation	ɪvæljuɛɪfən

We therefore formulate Prevocalic Tensing for this dialect as follows:

(69) *Prevocalic Tensing*

$$\left[ \begin{array}{l} - \text{cons} \\ - \text{back} \end{array} \right] \rightarrow [+ \text{tense}] / \text{---} [- \text{cons}]$$

Comparison of Prevocalic Tensing (69) with Long Vowel Tensing (41) shows that the sole difference between the two rules is that the former applies to front vowels, whereas the latter is not so restricted. Put differently, any vowel is tensed before a following [-cons] segment that is tautosyllabic; moreover, front vowels are tensed also when the following [-cons] segment is heterosyllabic. (This extra restriction may well be a peculiarity of certain dialects.) We therefore express the two tensing processes with the single rule (70):

(70) *Nonfinal Tensing*

$$\left[ \begin{array}{l} - \text{cons} \\ \langle - \text{back} \rangle_a \end{array} \right] \rightarrow [+ \text{tense}] / \begin{array}{c} \text{---} \\ | \\ \text{R} \end{array} \begin{array}{c} [- \text{cons}] \\ | \\ \langle \text{R} \rangle_b \end{array}$$

If b, then a

Nonfinal Tensing will take care of the tensing in diphthongs as well as the tensing in *radiate*, *variation*, etc. The question that remains is why the prevocalic [ɪ] does not tense when followed by [ə]. We suggest that this is because schwa is an empty slot unassociated (at this stage) with any melody segment (see Archangeli (1984) for the relevant assumptions in this regard). The [ɪ] in the second column in (67) is not followed by [-cons] and hence is not subject to rule (69):

$$(71) \begin{array}{cccccccc} \text{X} & & \text{X} \\ | & \vee & | & | & & & | & | & & | & \vee & | & | & \vee & | & | \\ \text{r} & \text{æ} & \text{d} & \text{i} & & & \text{n} & \text{s} & \text{vs.} & \text{r} & \text{æ} & \text{d} & \text{i} & \text{æ} & \text{t} & \end{array}$$

Support for this solution comes from the facts of centering diphthongs ([ɪə], [ʊə], [ɛə]) in RP, derived from an underlying long vowel followed by /r/, in words like *sincere* [sɪnsɪə], *poor* [pʊə], and *bear* [beə] (Mohanán (1984)). The vowels in these diphthongs do not undergo tensing, unlike the vowels in *beat* and *boot*, since the schwa in these vowels has no melodic content. These diphthongs can be derived by the following rule, applying after Vowel Shift:

(72) *Centering Diphthong Rule*

$$\begin{array}{ccc} \text{X} & \text{X} & \text{X} \\ \vee & & | \\ [- \text{cons}] & & \text{r} \end{array} \rightarrow \begin{array}{ccc} \text{X} & \text{X} & \text{X} \\ | & & | \\ [- \text{cons}] & & \text{r} \end{array}$$

Derivations for *compare* and *comparison* in RP are given below:

$$(73) \begin{array}{ccc} \begin{array}{c} \text{X} \text{XX} \\ \vee \quad | \\ [\text{k} \text{ɔmp} \text{æ} \text{r}] \end{array} & \begin{array}{c} \text{X} \text{XX} \\ \vee \quad | \\ [[\text{k} \text{ɔmp} \text{æ} \text{r}] [\text{ɪ} \text{s} \text{ɔ} \text{n}]] \end{array} & \\ \\ \text{---} & \begin{array}{c} \text{XX} \\ | \quad | \\ [[\text{k} \text{ɔmp} \text{æ} \text{r}] [\text{ɪ} \text{s} \text{ɔ} \text{n}]] \end{array} & \text{Trisyllabic Shortening} \\ \\ \begin{array}{c} \text{X} \text{XX} \\ \vee \quad | \\ [\text{k} \text{ɔmp} \text{ɛ} \text{r}] \end{array} & \text{---} & \text{Vowel Shift} \\ \\ \begin{array}{c} \text{X} \text{XX} \\ \vee \quad | \\ [\text{k} \text{ɔmp} \text{ɛ} \text{r}] \end{array} & \text{---} & \text{Centering Diphthong} \end{array}$$

The deletion of /r/ in the rime position ([kæmpɹə] vs. [kæmpɹəɪŋ]) takes place independently.

For this account to work in examples like *theatre*~*theatrical* it is necessary to assume that reduction erases the entire segmental melody and that vowel reduction takes place at stratum 2, prior to Nonfinal Tensing.

We have not checked the facts of prevocalic tensing in GA, since Kenyon and Knott do not distinguish between tense and lax short vowels. It is possible that this rule has a more general application in GA, applying not only before full vowels in words like *theatric* but also before schwa in words like *theatre*.

Because of their obvious similarity, Nonfinal Tensing must be combined with Stem-final Tensing, as shown in (74):

(74) *Vowel Tensing*

$$\left[ \begin{array}{l} - \text{cons} \\ \langle - \text{back} \rangle_a \\ \langle - \text{low} \rangle_c \end{array} \right] \rightarrow [+ \text{tense}] / \begin{array}{c} \text{---} \\ | \\ \text{R} \end{array} \left\{ \begin{array}{l} [- \text{cons}] \\ | \\ \langle \text{R} \rangle_b \\ | \\ \langle \text{I} \rangle_d \end{array} \right\}$$

If b, then a

If c, then d

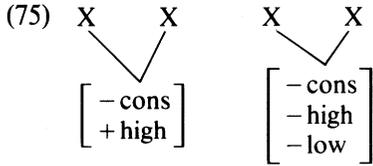
### 2.3. *The Ordering of the Rules Developed So Far*

Arguments are advanced in SPE showing that the lengthening rule in (57) must follow the shortening rules in (56). A straightforward bit of evidence for this ordering is provided by forms such as *Jordanian*, *Newtonian*, *Mendelian*, which satisfy the structural description of both Trisyllabic Shortening (56a) and CiV Lengthening (57). Since the forms surface with a long vowel, Trisyllabic Shortening must be ordered before CiV Lengthening.

It is easy to see that Trisyllabic Shortening must have stratum 1 as its domain, for it is triggered by class I affixes but not by class II affixes. Thus, we find shortening in *divinity* but not in *coziness*, *raininess*, *Quakeress*.

We have presented evidence that stratum 2 must be the domain of Nasal Assimilation (11) and *g*-Deletion (12), which must, moreover, apply in that order. Stratum 2 is also the domain of Velar Softening (64) and Vowel Shift (61). We have been unable to find evidence bearing on the relative order of the latter two rules relative to Nasal Assimilation and *g*-Deletion.

We have shown that stratum 3 is the domain of Stem-final Tensing (2) (now included in (74)) in dialects of type C and of Stem-final Lengthening (9) in dialects of type B. Stratum 4 is the domain of *l*-Resyllabification (21). Nonfinal Tensing (70) must be ordered after Diphthongization (62) since, prior to the application of the latter, the vowels in *beat*, *bait*, etc., have the following representation,



to which the former is not applicable. We know that Stem-final Tensing (24) applies at stratum 2 in the dialect represented in Proctor (1978), and if we collapse the three rules as Vowel Tensing, all of them must apply at stratum 2. It follows from this that Diphthongization applies at stratum 2.

The remaining rules apply at the postlexical stratum, in the order *a/o*-Tensing, *ɔ*-Unrounding, *o*-Lowering. The rules of *æ*-Tensing and *l*-Velarization also apply at this stratum, but their order with respect to the other rules that apply at the postlexical stratum could not be determined.

We summarize the preceding discussion in (76):

(76)	<i>Stratum 1</i>	
	( CiV Lengthening	(57)
	Shortening rules	(56)
	<i>Stratum 2</i>	
	Velar Softening	(64)
	Vowel Shift	(61)
	Nasal Assimilation	(11)
	<i>g</i> -Deletion	(12)
	Diphthongization	(62)
	Vowel Tensing	(74) (dialects A, B)
	<i>Stratum 3</i>	
	Vowel Tensing	(74) (dialect C)
	Stem-final Lengthening	(9) (dialect B)
	<i>Stratum 4</i>	
	<i>l</i> -Resyllabification	(21)
	<i>Postlexical Stratum</i>	
	<i>a/o</i> -Tensing	(44)
	<i>ɔ</i> -Unrounding	(43)
	<i>o</i> -Lowering	(45)
	<i>æ</i> -Tensing	(49)
	<i>l</i> -Velarization	(19)

## 2.4. Palatalization in English

**2.4.1. The Basic Facts.**<sup>16</sup> In many dialects of English, there is a well-known fast speech phenomenon that consists of replacing alveolar obstruents by their strident palatoalveolar

<sup>16</sup> The discussion in sections 2.4–2.7 is heavily indebted to Rubach's treatment (1981; 1984). Our conclusions differ from Rubach's in a number of important respects, which we indicate at the appropriate places.

counterparts before [y]:

- (77) miss you → [mɪʃyə]  
 got you → [gɑtʃə]  
 did you → [dɪjə]

We shall refer to this phenomenon as *palatalization*. As shown by the examples in (78), it applies only when the alveolar is followed by [y], not [i]:

- (78) miss it → \*[mɪʃɪt]  
 got it → \*[gɑtɪt]  
 did it → \*[dɪjɪt]

Word-internally, palatalization applies in all dialects and is quite regular:

- (79) rebellion    expression    supervision    confusion  
 rebellious    malicious    gaseous    officious  
 familiar    racial    spatial    official

Following SPE, we assume that the suffix -y in *presidency*, *residency*, etc., is the glide [y]. Pairs like *presidency* and *presidential* show that the y must be followed by a vowel for palatalization to apply. We formulate the rule as follows:

- (80) *Palatalization*<sup>17</sup>

$$\left[ \begin{array}{l} - \text{son} \\ + \text{cor} \end{array} \right] \rightarrow \left[ \begin{array}{l} - \text{ant} \\ + \text{strid} \end{array} \right] / \text{---} \left[ \begin{array}{l} - \text{cons} \\ + \text{high} \\ + \text{cor} \end{array} \right]$$

$\begin{array}{c} \text{X} \quad \text{X} \quad \text{R} \\ | \quad | \quad | \\ \text{---} \quad \text{---} \quad \text{---} \end{array}$

Word-internally, the [y] that triggers Palatalization drops after palatoalveolar consonants. Thus, underlying /rǣs + yǣl/ becomes [reyʃəl], not \*[reyʃyəl]. We formulate this process as follows:

- (81) *y-Deletion*

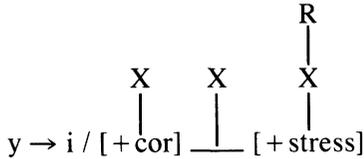
$$\left[ \begin{array}{l} - \text{syl} \\ - \text{cons} \\ + \text{high} \\ - \text{back} \end{array} \right] \rightarrow \emptyset / \left[ \begin{array}{l} + \text{cor} \\ - \text{ant} \end{array} \right] \text{---}$$

$\begin{array}{c} \text{X} \quad \text{X} \quad \text{R} \\ | \quad | \quad | \\ \text{---} \quad \text{---} \quad \text{---} \end{array}$

<sup>17</sup> Counter to SPE, we assume that [i], [ɪ], and [y] are [+coronal].

Consider next cases where *y*-Deletion does not apply, as in *presidentiality* and *artificiality*, as opposed to *presidential* and *artificial*, in which the [y] is deleted. The obvious generalization is that in *artificiality* the [y] becomes [i] before the stressed vowel and thereby escapes deletion:

(82) *y*-Vocalization



*y*-Vocalization must be assumed to be optional at least in some words; for example, *beneficiary* and *auxiliary* can be pronounced both with and without an [i] before the suffix *-ary*. Note also that when there is no [i]—that is, when *y*-Vocalization does not apply—the suffix *-ary* is in a position next to the main stress and therefore subject to destressing and reduction. Thus, the adjectival suffix *-ary* is reduced in *elementary* and *anniversary*, but carries stress in *secretary* and *customary*. The same contrast is observed in the two pronunciations of words like *beneficiary* as well: [bɛnəfɪʃəri] vs. [bɛnəfɪʃiəri].

It is obvious that *y*-Vocalization must precede *y*-Deletion and that Palatalization must precede both. Which stratum must be assigned to the rules? First, observe that *y*-Deletion must not apply at stratum 1. If it did, it would apply cyclically, yielding incorrect derivations for words like *artificiality* [. . . ʃælti]. Specifically, *y*-Deletion must not be allowed to apply in the cycle before *-ity* is attached and the conditions for *y*-Vocalization are met. Therefore, it must not apply at stratum 1. Moreover, it does not apply across words or to the stems of a compound: *misuse* [miʃywuɪs]/\*[miʃuɪws], *fish university* \*[fiʃiʊwɪvɜrsiti].<sup>18</sup> Hence, *y*-Deletion cannot apply at stratum 3 or subsequent strata, and the only domain left for its application is stratum 2.<sup>19</sup>

Since Palatalization and *y*-Vocalization apply prior to *y*-Deletion, their domains must include stratum 1 and/or stratum 2. Since there is no *y*-Vocalization across the stems of a compound (*misuse* \*[miʃiʊws]; *fish university* \*[fiʃiʊwɪvɜrsiti]), *y*-Deletion cannot apply at stratum 3 or at subsequent strata. Given the Principle of Domain Assignment (1), we conclude that *y*-Vocalization applies at stratum 2.

Since Palatalization applies before *y*-Deletion and *y*-Vocalization, it must be allowed to apply at least at stratum 2. Since it applies across words in some dialects, it must be allowed to apply at the postlexical stratum as well. By Principle of Domain Assignment (1b), we conclude that Palatalization does not apply at stratum 1, but only at stratum 2. By the Continuity of Stratum Hypothesis, we conclude that Palatalization applies at all

<sup>18</sup> There are fossilized expressions like *got you* [gəʔ] in which *y*-Deletion does seem to apply across words, but examples like *got your letter* [gəʔyɜrlɛtəɾ]/\*[. . . ɜɾ . . .], *his uniform* [hiʒyʊwɪnɜfɜm]/\*[. . . ʒw . . .] show that this is a result of treating *got you* as a single word.

<sup>19</sup> This result strengthens our argument for placing class II derivation and compounding in distinct strata, 2 and 3. If the two processes applied at the same stratum, there would be no stratum for the application of *y*-Deletion, since it cannot apply either at stratum 1 or in compounds.

the lexical strata (except stratum 1), as well as at the postlexical stratum in these dialects.<sup>20</sup> There are, however, many dialects in which Palatalization does not apply across words or in compounds (for example, in Jones (1977) *misuse* is [mɪsyuws], not \*[mɪʃyuws]). In these dialects, Palatalization does not apply at stratum 3 or subsequently and is therefore restricted to stratum 2.

In light of these facts, these rules must apply in the following order:

- (83) { Palatalization (80) (stratum 2-postlexical), (stratum 2 in RP)  
 y-Vocalization (82) (stratum 2)  
 y-Deletion (81) (stratum 2)

2.4.2. *Spirantization*. In the examples discussed to this point Palatalization invariably produced palatal continuants regardless of whether the source morpheme ended in a stop or a continuant. Thus, we found [ʃ] in *expression* as well as in *deletion*, even though the latter has in its underlying representation a stop rather than a continuant. It may appear, therefore, that the Palatalization rule (80) should be modified so as to produce continuants exclusively. The following examples show, however, that Palatalization does not always obliterate the distinction between stops and continuants.

- |         |             |              |            |           |
|---------|-------------|--------------|------------|-----------|
| (84) a. | Christian   | bestial      | digestion  | celestial |
| b.      | Egyptian    | reaction     | extinction | extension |
|         | exemption   | invention    | contortion | expansion |
|         | residential | torrential   | partial    |           |
|         | deletion    | decision     | confession | confusion |
| c.      | sensual     | conceptual   | gradual    | manual    |
|         | usual       | eventual     | residual   | annual    |
|         | sexual      | habitual     | individual |           |
| d.      | sensuous    | tumultuous   | arduous    | strenuous |
|         |             | tempestuous  | deciduous  | tenuous   |
|         |             | contemptuous |            | ingenuous |

The examples in (84a) show that Palatalization does not turn stops into continuants if the stop is preceded by /s/, although as shown in (84b) stops and sonorant consonants do not have this blocking effect. Even more interesting are the examples in (84c,d). Thus, we find *sen[ʃ]ual* (cf. *sense*) but *habi[č]ual* (cf. *habit*), whereas the contrast is obliterated before [y] elsewhere, for example, in *colli[ž]ion* (cf. *collide*) vs. *revi[ž]ion* (cf. *revise*). These facts prompted the suggestion in SPE that the process of turning stops into continuants (Spirantization) is distinct and separate from Palatalization, and we shall adopt this view here:

- (85) *Spirantization*

$$\left[ \begin{array}{c} - \text{son} \\ + \text{cor} \end{array} \right] \rightarrow \left[ \begin{array}{c} + \text{cont} \\ + \text{strid} \end{array} \right] / \left\{ \begin{array}{c} [+ \text{son}] \\ [- \text{cont}] \end{array} \right\} \text{ — } y$$

<sup>20</sup> This hypothesis states that the domain of a rule cannot be a set of discontinuous strata (Mohanani (1982)).

This rule, which is ordered before Palatalization, applies to coronal obstruents before [y] provided that they are not preceded by a continuant obstruent, which, in effect, means [s].<sup>21</sup>

2.4.3. *Distribution of i and y.* It was argued in SPE (pp. 225–227) that the distribution of [i] vs. [y] in forms such as those in (86) is predictable and should be captured by means of a phonological rule (SPE rule (116), p. 225):

(86) a.	Tibetan	Lutheran	Lucullan	medusan
	[i] Kantian	Lithuanian	Virgilian	Malthusian
	[y] Lilliputian	Pennsylvanian	Italian	Parisian
b.	covetous	poisonous	frivolous	
	[i]	harmonious	punctilious	
	[y] vexatious	ingenious	rebellious	
	infectious			
c.	parental	personal	circular	
	[i]	colonial	filial, familial	
	[y] torrential	ceremonial	familiar	

Phonological rules with numerous idiosyncratic exceptions and stipulations, such as those postulated in SPE, seem to us to obscure rather than illuminate the facts. Instead, we follow Rubach (1984) and postulate two distinct “connecting” morphemes [y] and [i] that are chosen by different stems concurrently with adding particular suffixes. In instances where the choice is phonologically governed (e.g. [y] is not selected after stems ending in [p] or [d]) this fact is reflected in the word formation rule governing the choice of the “connecting” morpheme.

We again deviate from SPE and do not account for the difference between *Pennsylvan[y]an* and *Lithuan[i]an* by postulating a formative boundary in the latter but not in the former, since there is no morphological, syntactic, or semantic motivation for this distinction. Note that the parallel difference between *Tunisia* and *Finlandia* would not be accounted for by means of a boundary even in SPE, since it would follow from the fact noted in SPE (and incorporated there in the word formation rules) that after [d] the “connecting” morpheme [i] is mandatory.

We may note here that the products of Velar Softening are subject to Palatalization, as illustrated in (87):

(87)	Grecian
	electrician
	crucial

<sup>21</sup> However, compare *right~righteous* with [ɛ], SPE (pp. 233f.), and section 2.5 below. Moreover, although the noun-forming suffix -y causes Palatalization and Spirantization, the adjective-forming -y in words like *trendy* and *racier* (cf. *racy*) does not. We assume that the latter suffix is underlyingly /t/.

We assume the “connecting” morpheme [y] in these cases, but the [y] does not surface because of y-Deletion, which applies after Palatalization.

2.4.4. *Palatalization and [yuw]*. It is well known that the sequence [Cy] in English is regularly followed by the vowel [uw] or its unstressed reduced reflex. Thus, although [kyuw] *Kew*, [kyut] *cute*, as well as [kwiyn] *queen*, [kwæk] *quack*, [kwam] *qualm*, [kwowt] *quote*, etc., are well-formed, \*[kyiyn], \*[kyæk], \*[kyam], \*[kyowt], etc., are not. SPE accounts for this by disallowing [Cy] underlyingly and inserting the [y] before certain vowels, which we shall provisionally denote as Q. Thus, *cute* will have the underlying representation /kQt/, and it will become [kyuwt] by the following rules:

- (88) a. *y-Insertion*  
 $\emptyset \rightarrow y / \text{---} [Q]$   
 b.  $Q \rightarrow \dots [uw]$

In British dialects, words like *duty*, *tune*, and *news* are pronounced with [Cyuw] (e.g. [dyuwti]). In many American dialects, on the other hand, these words are pronounced with [Cuw] (e.g. [duwti]). In these dialects, [yuw] is allowed after alveolar consonants only if the vowel is stressless (*tenuous*, *venue*, *value*). To account for these facts we shall assume that in the [dyuwti] dialects [y] is inserted before the vowel Q everywhere, but in the [duwti] dialect [y] is inserted after alveolar consonants only before stressless Q. The rule of y-Insertion will therefore have the following forms in the [dyuwti] and [duwti] dialects, respectively:

- (89) a.  $\emptyset \rightarrow y / \text{---} Q$   
 b.  $\emptyset \rightarrow y / \langle [+cor] \rangle_a \text{---} \left[ \begin{array}{c} Q \\ \langle -stress \rangle_b \end{array} \right]$   
 If a, then b

We are now in a position to tackle the feature composition of the vowel designated by the letter Q. Consider to this end the following words:

- (90) *argue* *issue* *statue* *venue*  
*ague* *tissue* *virtue* *menu*

Since the last vowel in these words is stressless, it should be underlyingly short and therefore will not undergo Vowel Shift. These forms will surface with [yuw] in all dialects as predicted by (9), (74), and (89). This suggests that  $Q = [+high]$ , since that is the feature value it has in the output.

Consider now the examples in (91).

- (91) a. *cube* *music* *putrid* *beauty*  
 b. *revenue* *residue* *avenue*  
*absolute* *hypotenuse* *substitute*

In the [dyuwti] dialects all forms of (91) surface with [yuw], whereas in the [duwti] dialects only the forms in (91a) but not those in (91b) surface with [yuw]. Even more important to the topic of our discussion is that in (91a) the vowel [yuw] is long and must therefore have undergone Vowel Shift. Since [yuw] is [+high], its pre-Vowel Shift source must be [−high]. In other words, the word-final vowels in (90) and (91a) cannot be identical in underlying representation, but they become identical (save for stress) because Vowel Shift applies in (91a) but not in (90). In spite of its straightforward character, this correct inference, which was first drawn in an unpublished paper by L. Levin (1980), eluded all earlier students, who like Halle (1977) apparently failed to recognize that the underlying vowels in *cube* and *argue* are different. Since the vowel under discussion surfaces as [yuw], there is good reason to assume that it is [+back]. We cannot assume that the vowel in *cube* is [−high, +back, +round] or /o/, since that would fail to distinguish it from the vowel in *cool*. The only option left is to assume that the vowel in *cube* is [−high, +back, −round], i.e. the long counterpart of [ʌ]. Immediate support for this assumption comes from forms such as those in (92),

- (92) assume~assumption  
 reduce~reduction  
 (im)pugn~repugnant

where the long [yuw]~[uw] alternates with the short [ʌ].

Having made the assumption that the vowels in (91) are long / $\bar{\lambda}$ /, we are forced to assume that the vowels in (90) are short /+/ underlyingly and that Q in the rule of y-Insertion is /+/. We must then replace Q in (89) accordingly.

(93) y-Insertion

a. [dyuwti] dialects

$$\emptyset \rightarrow y / \text{---} \left[ \begin{array}{l} + \text{high} \\ + \text{back} \\ - \text{round} \end{array} \right]$$

b. [duwti] dialects

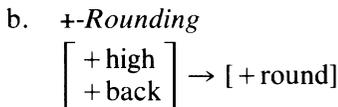
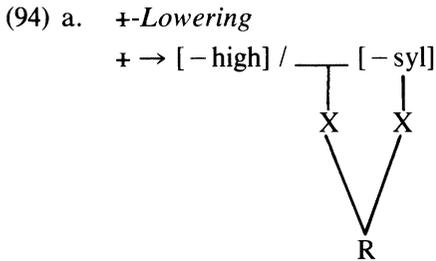
$$\emptyset \rightarrow y / \langle [+ \text{cor}] \rangle_a \text{---} \left[ \begin{array}{l} \langle - \text{stress} \rangle_b \\ + \text{high} \\ + \text{back} \\ - \text{round} \end{array} \right]$$

If a, then b

Though underlyingly short (and nontense), the final vowels in (90) are tensed by Stem-final Tensing (2) or lengthened by Stem-final Lengthening (9) in dialects of type

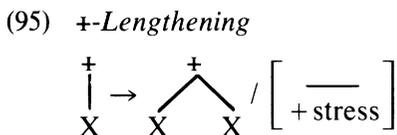
B. Since Stem-final Lengthening has been assigned stratum 3 as its domain and Vowel Shift stratum 2, lengthened vowels cannot undergo Vowel Shift.

Since we have postulated / $\Lambda$ / and / $\pm$ / as sources of surface [y $\omega$ ], we need a rule that rounds [+]. As shown by the examples in (90) as well as by such forms as *communist*, *impudent*, *credulous*, the rule rounding [+ ] cannot be restricted to long [ $\mp$ ]. It does not, however, apply to short [+ ] in closed syllables, as shown by the examples in (92); in those cases, [ $\Lambda$ ] surfaces. To account for these facts we need the rules in (94):



The rules in (94) provide a very simple account of the [aw]~[ $\Lambda$ ] alternation in such cognate pairs as *profound*~*profundity*, *abound*~*abundance*. In *profound* the underlying / $\mp$ / is subject to Vowel Shift and Diphthongization, resulting in the diphthong [aw]. In *profundity* / $\pm$ / is shortened by Trisyllabic Shortening (56a) and then subject to  $\pm$ -Lowering. The lowered vowel [ $\Lambda$ ] is, of course, not subject to  $\pm$ -Rounding.

In words like *sulphur* the underlying [+ ] cannot be long, as indicated by the stress facts. However, the vowel surfaces as long in the cognate *sulphuric*. Since there are no examples of stressed short [+ ] in English, we postulate a rule that lengthens [+ ] when stressed:



Evidence for our assumption that the [y] in [y $\omega$ ] is inserted and is not underlying (say, at the beginning of the rime) is provided by pairs like *Lilliput* and *Lilliputian* (as well as by the [y $\omega$ ]~[ $\Lambda$ ] alternation in words like *assume*~*assumption* and *reduce*~*reduction*). Observe that [y] appears only when underlying / $\Lambda$ / is lengthened and is vowel-shifted to [+]. Similarly, an underlying / $\pm$ / that is shortened and lowered to [ $\Lambda$ ] does not appear with [y]:

(96)

Lilliput	Lilliputian	sulphur	sulphuric	profound	profundity	
Λ	Λ	‡	‡	ǣ	ǣ	Underlying
—	ǣ	—	—	—	—	Lengthening
—	—	—	—	—	‡	Shortening
—	ǣ	—	—	ā	—	Vowel Shift
—	—	Λ	—	—	Λ	‡-Lowering
—	—	—	ǣ	—	—	‡-Lengthening
—	yǣ	—	yǣ	—	—	y-Insertion
—	yū	—	yū	—	—	‡-Rounding
—	yuw	—	yuw	aw	—	Diphthongiza- tion
Λ	yuw	ə	yuw	aw	Λ	Output

In (96) we have ordered ‡-Lowering before ‡-Lengthening in order to prevent Lengthening from applying to the stressed vowel in *profundity* while allowing it to apply in *sulphuric* and *credulity*. Moreover, since y-Insertion is triggered by [‡]—that is, by an unrounded back vowel and not by its rounded cognate [u]—‡-Rounding must follow y-Insertion. Finally, as shown by the examples in (84c,d), the [y] inserted by y-Insertion does not trigger Spirantization but does cause Palatalization; y-Insertion must therefore apply after Spirantization and before Palatalization.<sup>22</sup>

What are the domains of these rules? Since the inserted [y] in words like *credulous* deletes by y-Deletion, and y-Deletion applies at stratum 2, the lowest stratum at which y-Insertion can apply is stratum 2. This means in turn that all rules that precede y-Insertion in (96) must also apply at stratum 2 or stratum 1. We already know that Shortening and Lengthening (56) and (57) apply at stratum 1. Given our hypothesis about unmarked domain assignment, which requires us to assign the highest-numbered stratum

<sup>22</sup> Borowsky (1984) presents an alternative analysis of the facts of y-Insertion in terms of a solution that makes the following assumptions:

- (i) [yuw] is underlyingly a complex nucleus  $\text{ɪ} \wedge \text{u}$ .
  - (ii) [ly] is not a possible onset in English.
  - (iii) In the environment  $\text{V} \_\_\_\_\_\_ \text{V}$ , R O(nset) is resyllabified as R O.
- (iv) The  $\text{ɪ}$  of  $\text{ɪ} \wedge \text{u}$  is detached from the nucleus and is attached to the onset if permissible.

Although this proposal accounts for the contrast in pairs such as *volume* [valyəm] and *voluminous* [vəlúwmənəs], it is unacceptable because it implies contrary to fact that a word like *volume* is syllabified as [val-yəm] rather than as [va-lyəm]. We know that the former syllabification is correct because in dialects that velarize [l] in rime-final position, there is no velar [ʃ] in words such as *volume*.

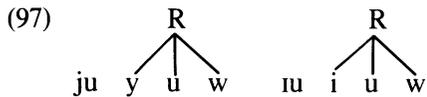
Note that words like *cod+ling* and *coddling* show that the conditioning environment for the [l]~[ʃ] alternation must be stated in terms of syllable structure, as we have done in (19), not in terms of preceding and following segments. Thus, *codling*, which is always disyllabic, is always pronounced with “clear” [l], whereas *coddling* is pronounced with “clear” [l] when it is disyllabic and with “dark” [ʃ] when trisyllabic. In the latter case, /l/ constitutes the rime and becomes [ʃ], undergoing rule (19), *l*-Velarization.

possible as the domain of a given rule (see (1)), we assume that Vowel Shift,  $\pm$ -Lengthening, and  $\pm$ -Lowering apply at stratum 2 (and only at stratum 2).<sup>23</sup>

2.4.5. *The [miuwzik] Dialect.* Kenyon and Knott (1944, xlii–xliii) observed that in

words containing long *u* there is variation between the sounds *ju*, *iu* and *u*. The same speaker often varies between *iu* and *ju*, for *iu* easily shades into *ju* as the *iu* receives less stress and thus becomes more like consonantal *j*. . . . Present knowledge does not always permit of an accurate order of frequency in the vocabulary. . . . [Therefore] all that is attempted here is to give the three (or two) current pronunciations (*duty*: 'dju<sup>t</sup>i, 'du<sup>t</sup>i, 'du<sup>t</sup>i, *blue*: blu, blu, *accuse*: ə'kjuz], ə'kiuz) without insistence on order of frequency, all the pronunciations being in cultivated American use.<sup>24</sup>

The distinction between Kenyon and Knott's *ju* and *iu* is represented here as follows,



and the appearance of [iuw] can readily be explained by a generalization of *y*-Vocalization (82). In the [iuw] dialects *y*-Vocalization applies not only after coronals but after any tautosyllabic consonant. (It does not apply to syllable-initial [y] as in *ewe*, *young*, *yellow*.)

2.4.6. *Credulous and Credulity.* There appear to be in English dialects three distinct treatments of pairs such as *credulous*~*credulity*, *residual*~*residue*, *perpetual*~*perpetuity*:

(98)

	Dialect I	Dialect II	Dialect III <sup>25</sup>
credulous	dyu	ǰu	ǰu
credulity	dyuw	diuw	duw

<sup>23</sup> Rubach (1984) opts for a somewhat more concrete treatment of the facts discussed in this section. Rubach does not accept L. Levin's (1980) proposal that is central to our analysis. As a result, he is forced to adopt in its essentials the analysis proposed in Halle (1977) that requires two distinct rules of /y/-insertion, one applying before the long mid vowel /ʌ/ and the other before the high back vowel, which in Halle (1977) was assumed to be /+/, but which in Rubach's account is /u/. (In Rubach's article the former rule is called *J-preposing* (22) and the latter *J-insertion* (29).) It seems to us that this treatment fails to draw the correct inference from the fact that [y] is inserted in one case before a long mid vowel and in the other case before a short high vowel. As noted above, it is L. Levin's (1980) recognition of the significance of this fact that motivates the treatment in this section.

There are a number of disadvantages to the analysis championed by Rubach. First, as already remarked, it requires two /y/-insertion rules (one cyclic and the other noncyclic), whereas our analysis requires only one. Second, Rubach's analysis needs to restrict Vowel Shift so that it will not apply to long /u/. This complication is unnecessary given our treatment. Third, Rubach must assume that the [y] in words such as *populate*, *copula* is present in the underlying representation, for, as he observes in fn. 15, "there is no way to derive the glide" in these cases. His treatment is thus unable to formally reflect the fact that in English the appearance of [y] before [u] is totally predictable.

<sup>24</sup> Notice that Kenyon and Knott give only *blu* and *bluu*, but not \**blju*, whereas all three forms *u*, *iu*, *ju* appear after *d*, *t*, and *n*. This gap is quite systematic: in positions followed by primary stress there are no citations of the form *lju* corresponding to *luu*.

<sup>25</sup> In all dialects, stressed [+] is lengthened as required by (95) even though subject to Trisyllabic Shortening.

Dialect I is perhaps the easiest to handle. Since the inserted [y] does not cause Palatalization in this dialect and does not undergo y-Vocalization, these two rules must be ordered before y-Insertion. Since both Palatalization and y-Insertion are assigned to stratum 2, the following ordering of the rules emerges in dialect I:

(99) *Dialect I*

Palatalization	(stratum 2)	(80)
y-Vocalization	(stratum 2)	(82)
y-Deletion	(stratum 2)	(81)
y-Insertion	(stratum 2)	(93a)

In the other two dialects, inserted [y] causes Palatalization; however, this occurs only when the [+] is unstressed. In dialect II, therefore, the inserted [y] undergoes y-Vocalization before stressed vowels by the generalized y-Vocalization rule (82), as discussed in section 2.4.5. If y-Vocalization is ordered before Palatalization, all facts are accounted for. The rule order for dialect II is therefore as follows:

(100) *Dialect II*

y-Insertion	(stratum 2)	(93a)
y-Vocalization	(stratum 2)	((82) generalized as in section 2.4.5)
Palatalization	(stratum 2)	(80)
y-Deletion	(stratum 2)	(81)

Dialect III differs from dialects I and II in that it is subject to the restricted version of y-Insertion given in (93b). Moreover, in dialect III y-Vocalization takes place only after coronals, as stated in (82). The rule order for this dialect is as follows:

(101) *Dialect III*

y-Insertion	(stratum 2)	(93b)
Palatalization	(stratum 2)	(80)
y-Vocalization	(stratum 2)	(82)
y-Deletion	(stratum 2)	(81)

### 2.5. *The Strict Cyclicity Condition*

Kiparsky (1982a) proposes that lexical rule applications in Lexical Phonology obey the condition of "strict cyclicity," which we restate as follows:

(102) *Strict Cyclicity Condition (SCC)*

Lexical rule applications cannot change structure in environments not derived in their cycle. (Derived environment = environment created by the concatenation of two morphemes, or by the application of an earlier rule in the same cycle.)<sup>26</sup>

<sup>26</sup> For various versions of this condition, see Kiparsky (1968; 1973), Mascaró (1976), and Halle (1978). In Kiparsky (1983b) this condition has been weakened so as not to apply at the last stratum. Moreover, the use of underspecification obscures the predictions somewhat.

The SCC prevents the application of, say, Trisyllabic Shortening in *nightingale*, because the environment for the rule is not derived and Trisyllabic Shortening is a lexical rule. It does not, however, block the application of stress assignment, syllable structure assignment, etc., to underived forms (e.g. word stress in *nightingale*), because these are structure-building operations and not structure-changing ones. Once stress, tone, syllable structure, etc., have been assigned, however, the SCC prevents changing them in underived environments. Similarly, assuming that underlying representations in English do not have the feature [tense], the SCC does not block the tensing of the stem-final vowel in *happiness* (Stem-final Tensing (2)), since this rule does not change a feature, but adds it.

As it happens, however, our analysis of English contains several violations of the SCC. A typical case is the rule of Vowel Shift (61). Vowel Shift precedes y-Insertion (93), which precedes y-Deletion (81). We have shown that y-Deletion must apply at stratum 2, since it does not apply across the stems of compounds. Since Vowel Shift precedes y-Deletion, Vowel Shift must apply at stratum 2.<sup>27</sup> It applies, however, to forms not derived at stratum 2 (*divine*, *serene*, etc.), thereby violating the SCC.

Other rules that intervene between Vowel Shift and y-Deletion, applying at stratum 2, raise the same issue. For instance, *r*-Lowering and y-Insertion change structure in underived environments. *g*-Deletion (rule (12)) applies in words like *long* in an underived environment. Velar Softening (64) changes underlying [kēv] in *receive* to [sēv] in an underived environment. Velar Softening must be assumed to apply in the lexicon, since it refers to morphological features like [+linate]. It also applies in *magician* but not in compounds such as *magic eye* or *electric eel*, which forces us to assume that it applies at stratum 2.<sup>28</sup>

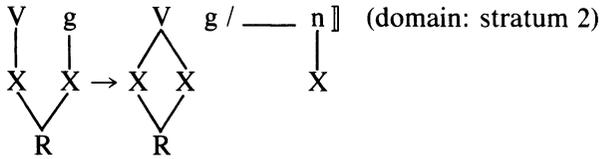
There are many other examples of similar rules in English. Consider the following alternations:

- |          |        |           |           |           |
|----------|--------|-----------|-----------|-----------|
| (103) a. | sign   | signature | signing   | (n~gn)    |
|          | b.     | malign    | malignant | maligning |
| (104) a. | solemn | solemnity |           | (m~mn)    |
|          | b.     | damn      | damnation | damning   |
| (105) a. | bomb   | bombard   | bombing   | (m~mb)    |
|          | b.     | iamb      | iambic    |           |

These alternations can be accounted for by assuming underlying representations like /sign/, /solemn/, and /bomb/, with rules that delete [g], [n], and [b]:

<sup>27</sup> Vowel Shift cannot apply at stratum 1, since this domain assignment would make the rule apply cyclically, yielding incorrect results like \*[divayniti] instead of [divɪniti].

<sup>28</sup> Under the assumption that Palatalization applies at stratum 2, y-Deletion does not pose any problem for the SCC, since its input is derived at stratum 2. If, on the other hand, Palatalization applied cyclically (at stratum 2), y-Deletion would change the structure of a form not derived at stratum 2 and would violate the SCC.

(106) a. *Prenasal g-Deletion*b. *n-Deletion*

$$n \rightarrow \emptyset / [+nasal] \text{---}] \quad (\text{domain: stratum 2})$$
c. *Noncoronal Deletion* ((12) revised)<sup>29</sup>

$$\left[ \begin{array}{l} -\text{son} \\ +\text{voice} \\ -\text{cor} \end{array} \right] \rightarrow \emptyset / [+nasal] \text{---}] \quad (\text{domain: stratum 2})$$

These rules apply at stratum 2, changing structure in underived environments.

Note that in (106a) *g*-deletion is simultaneous with compensatory lengthening. Moreover, this rule feeds Vowel Shift ([sign] → [sɪ:n] → [sain]). It is crucial, therefore, that it should apply at stratum 2 (assignment at stratum 1 being ruled out on the grounds that the rule does not apply before class I suffixes).

Faced with examples of the kind given in (103)–(105), one might be tempted to conclude that the SCC must be abandoned. One might propose that the reason why Trisyllabic Shortening does not apply in *nightingale*, for example, is simply that it is a lexical exception, on a par with lexical exceptions like *obesity*, which the SCC does not take care of anyway. This move to abandon the SCC appears too hasty to us, however, for the literature offers numerous examples that strongly support the need for it (see Kiparsky (1982a) and the references cited there). A revealing case is that of Icelandic *u*-umlaut, discussed in Kiparsky (1984). This rule changes [a] to [ö] before [u], deriving *hör + um* from [har + um]. *akur* does not undergo the rule, since the environment is not a derived one. The [a] in this word cannot be stipulated to be a lexical exception to umlaut, for the same vowel undergoes the rule when the environment is derived, as in /*akur + um*/ → [akr + um] → [ökrum]. Given that examples of this kind demonstrate the need for the SCC, how can we explain the violations in English noted above? In other words, is there a principled distinction between lexical rule applications that obey the SCC and those that do not?

On examining the examples that violate the SCC, we find that all of them have stratum 2 as their domain, which can hardly be an accident.<sup>30</sup> We already know that stratum 2, unlike strata 1 and 3, is a noncyclic stratum (section 1.5.1). This suggests that the violation has something to do with the fact that stratum 2 is noncyclic. Indeed,

<sup>29</sup> Forms like *resign*, *resignation*, and *resigning* show that these deletion rules cannot be treated as allomorphic rules. The suffixes *-ation* and *-ing* are attached to the verb *resign*, since *re-* is not attached to nouns.

Philip Lesourd has pointed out to us that the pronunciation of *iamb* as [ayæmb] is an exception to (106c).

<sup>30</sup> Similar violations of the SCC have been observed in Malayalam by Mohanan and Mohanan (1984), who point out that there is no motivation to assume that any of the lexical strata in the language are cyclic.

Mascaró (1976) presents the SCC as a condition on the proper application of cyclic rules. Within the framework we have developed, cyclicity is not a property of rules, but of strata, since a rule may apply cyclically in a cyclic stratum and noncyclically in a non-cyclic stratum. However, we can reformulate Mascaró's condition as a condition on cyclic strata:

(107) *Strict Cyclicity Condition* (revised)

Rules applying in a cyclic stratum cannot change structure in environments not derived in their cycle.

## 2.6. *-ion and s-Voicing*

It was assumed in SPE that the noun suffix *-ion* is bisyllabic in its underlying representation. More recent work, notably Rubach (1984), has shown this to be incorrect. First, as noted in SPE (p. 226), there are only two words in the language where *-ion* is bisyllabic (*ganglion*, *quaternion*), and it is questionable whether these are formed with the same suffix as the rest. The other two reasons for the SPE analysis seem equally open to question. These reasons were (a) that before *-ion* the word stress invariably falls on the preceding syllable and (b) that in the syllable before *-ion* the high vowel is invariably shortened (e.g. *revise*~*revision*, *decide*~*decision*). In SPE this shortening was attributed to Trisyllabic Shortening, but as we shall see, this raises as many problems as it solves. Moreover, in light of recent work on English (see Hayes (1980) and Halle and Vergnaud (forthcoming)), postulating a bisyllabic suffix is no longer the only, or even the preferred, means for assigning stress to the presuffixal vowel.

In SPE forms such as the following

- (108) devotion  
deletion  
integration

first underwent Trisyllabic Shortening (56a) and then *CiV* Lengthening (57). If we assume with Rubach (1984) that *-ion* is underlyingly represented as [yon], neither of these rules will apply to the words in (108). This has no effect on the output, however, since the stem vowels in (108) are underlyingly long.

As noted already, it was also assumed in SPE that Trisyllabic Shortening was responsible for the shortened stem vowels in the following words:

- (109) revision  
decision  
precision

However, if *-ion* begins with [y], as proposed above, then Trisyllabic Shortening cannot be invoked here. Instead, we must follow Rubach (1984) in accounting for these forms by means of *i*-Shortening:



A rule of stratum 1 turns [t,d] into [s] before suffixes such as *-ive*:

- (113) permissive    extensive  
           exclusive    evasive  
           explosive

Before other suffixes, however, we find [s]~[z] alternations, as predicted by *s*-Voicing: [z] if preceded by a long vowel, [s] otherwise.

- (114) a. permissible    defensible    responsible  
           divisible      feasible      plausible  
       b. compulsory    accessory    promissory  
           advisory      delusory    derisory

To account for the absence of *s*-Voicing in such words as the following,

- (115) facial  
           fallacious  
           rapacious

we need only assume that they are marked as exceptions to *s*-Voicing.

Also relevant to the present discussion is the [s]~[z] alternation in (116a) vs. its absence in (116b):

- (116) a. resign~consign    resist~consist    reserve~conserve  
       b. recede~concede    receive~conceive    recite~excite

We can account for (116b) in the fashion proposed in SPE by postulating that these verb stems begin with a velar that undergoes Velar Softening. Moreover, following Rubach, we can account for the voicing alternation in (116a) by assuming that the stems begin with underlying [s], which is then voiced by *s*-Voicing. The only complication arising from this account is that we must set up a long vowel in the prefix in *resign*, as suggested by Rubach, and account for the reduction of /ē/ in *re-* by extensions of the rules that provide for vowel reduction in other prefixes of this class of verbs (cf. *conserve*, *transpire*, etc.).

Note finally that as suggested in SPE the present account also explains the contrasting alternations in (117):

- (117) a. resist~assist  
           design~assign  
       b. recede~accede  
           decelerate~accelerate  
       c. conge<sup>st</sup>~suggest

We shall assume that the prefix in, say, *accede* is represented with a floating skeleton slot:

- (118) æ  
       |  
       X X

As a result, none of the forms in (117) satisfies the conditions of *s*-Voicing. Moreover, in the last three forms the velar that is in the onset of a syllable, but not the one that is part of a rime, is subject to Velar Softening (64). This fact violates the restriction proposed by Steriade (1982, 60) according to which a “unit on the melodic core which is shared between skeleton positions should be inaccessible to rules whose structural descriptions are met by only one of the linked matrices.” We shall therefore not impose this restriction here. We have no suggestions at present for dealing with the facts that Steriade cites to support this restriction.

### 2.7. Ordered List of Rules

In (119) we list the rules we have proposed, their ordering, and their domain assignment:

- (119)
- Stratum 1*
    - Stress rules
    - CiV Lengthening (57)
    - s*-Voicing (111)
    - Shortening rules (56) and (110)
  - Stratum 2*
    - Velar Softening (64)
    - Nasal Assimilation (11)
    - Prenasal *g*-Deletion (106a)
    - n*-Deletion (106b)
    - Noncoronal Deletion (106c)
    - Vowel Shift (61)
    - ɹ*-Lowering (94a)
    - ɹ*-Lengthening (95)
    - Spirantization (85)
    - y*-Insertion (93)
    - Palatalization (80) (stratum 2 through postlexical stratum)
    - y*-Vocalization (82)
    - y*-Deletion (81)
    - Centering Diphthong Rule (72)
    - Diphthongization (62)
    - Vowel Reduction
    - Vowel Tensing (74) (dialects A, B)
  - Stratum 3*
    - Vowel Tensing (2) (dialect C)
    - Stem-final Lengthening (9) (dialect B)
  - Stratum 4*
    - l*-Resyllabification (21)

*Postlexical Stratum*

±-Rounding (94b)

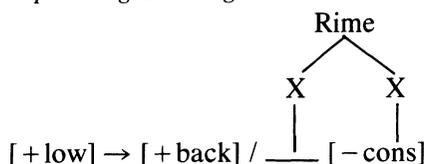
{ *a*/*o*-Tensing (44)  
 { *ɔ*-Unrounding (43)  
 { *o*-Lowering (45)  
 æ-Tensing (49)  
*l*-Velarization (19)

The rules in (119) constitute a substantial fraction of the phonological rules of English. It is by means of these rules that the repertory of vowels (38) that are encountered in English utterances are derived from the underlying vowels of the language, given in (120).

(120) *Underlying vowels*

	[ - back - round ]		[ + back - round ]		[ + back + round ]	
	[ + long ]	[ - long ]	[ + long ]	[ - long ]	[ + long ]	[ - long ]
[ + high - low ]	divine	din	pro- found	venue profun- dity	—	pull
[ - high - low ]	serene	den	cube	study	shoot	shot
[ - high + low ]	sane	pat	—	balm	cone	bomb

A gap in the rules in (119) becomes obvious on examining the treatment of underlying long nonback /i/ in stressed syllables, as in *divine*, *pint*, *mice*. This vowel is subject to Vowel Shift, which transforms it into its low counterpart /æ/: The rules of Diphthongization and Long Vowel Tensing apply next, generating the diphthong [æy]. Although this represents the pronunciation in some GA dialects, many dialects have in this diphthong a nucleus that is identical with that deriving from the underlying long back vowel [ɨ], as in *profound*. To account for this merger, we postulate a rule that is ordered after Diphthongization in the postlexical stratum and that backs all low vowels in diphthongs:

(121) *Diphthong Backing*

The introduction of Diphthong Backing provides a means for filling yet another gap in our treatment of the English vowel system. We have said nothing so far about the diphthong in such words as *join*, *point*, *noise*. Since the nucleus in these diphthongs is a low vowel on the surface, it must derive from an underlying long high vowel. In view of the fact that English utilizes the features *back* and *high* distinctively in its vowel system, there are four candidates to consider. We have already preempted the slots for the unrounded high vowels: long /ī/ represents surface [a<sub>ɪ</sub>y], and long /ī̄/ represents surface [a<sub>ɪ̄</sub>w]. This leaves the two rounded vowels: back /u/ and front /ü/.

A point in favor of such a proposal is that it provides a straightforward account for the alternations *adjoin*~*adjunction*, *destroy*~*destruction*. A stratum 1 rule unrounding (and backing) the stem vowel in derived nominals is all that is needed. Since the stem syllables are closed, Cluster Shortening (56b) and *ɹ*-Lowering (94a) would then apply and yield the correct output.

If we assumed /u/ to be the underlying vowel, Vowel Shift and Diphthongization would produce the output [ɔw]. To obtain the correct surface diphthong, we would then have to add to the phonology a rule fronting the glide [w] in the diphthong under discussion. (It seems unnecessary to have the rule also unround the glide, since the glide is normally rounded and the traditional representation of the diphthong with an unrounded glide reflects the absence in English of a phonetic contrast between rounded and unrounded front glides, rather than phonetic reality.)

Alternatively, we could postulate that the underlying vowel is the front /ü/. Vowel Shift, Diphthongization, and Diphthong Backing would then produce the correct surface diphthong [ɔy]. Though this alternative would thus seem somewhat more straightforward, it would require a special weakening of the principles that determine the feature complexes in the system of underlying vowels, since the system would now have to include instances of the somewhat marked category of rounded front vowels. As we are not clear about the basis on which to choose between the two alternatives, we leave the issue unresolved here.<sup>32</sup>

## 2.8. Summary and Conclusions

The theory of Lexical Phonology developed and substantiated here differs in a number of respects from previous proposals. The most striking result seems to us to be the discovery that not all lexical strata are cyclic: for both English and Sanskrit it is necessary to recognize cyclic as well as noncyclic lexical strata. It can be assumed that in the absence of counterevidence the language learner constructs a grammar in which every lexical stratum is cyclic. Alternatively, it might be assumed that in the absence of counterevidence, the language learner constructs a grammar in which every lexical stratum is noncyclic. The choice between these alternatives is at present open.

A consequence of recognizing the existence of noncyclic lexical strata is that there

<sup>32</sup> For additional details, see Fidelholtz and Browne (1971).

should be rules that violate strict cyclicity when they are applied at noncyclic lexical strata. This possibility is instantiated by a whole series of English rules (all those that apply at stratum 2) as well as by the rules of Sanskrit that assign stress at the stratum where recessive affixes are introduced. Another consequence is that a given rule may apply both cyclically (when applying in a cyclic stratum) and noncyclically (when applying in a noncyclic stratum). The Sanskrit Basic Accentuation Principle (BAP) provides an example of such dual functioning.

A subsidiary result is that in the phonology of English it is necessary to recognize four lexical strata of rule application. This result is at variance with the suggestion found in earlier formulations of Lexical Phonology that there are only two domains of rule application, class I affixation on the one hand and class II affixation (compounding and inflection) on the other.

The facts reviewed above validate the distinction between structure-building and structure-changing rules. The latter obey strict cyclicity, whereas the former may violate strict cyclicity even when applying in a cyclic stratum. It is from this vantage point that the stress rules of Sanskrit and English differ most strikingly. Whereas in Sanskrit the existence of underlyingly specified accents makes the stress rules structure-changing, in English—where accents are supplied by rule on the last metrical syllable of the string if that syllable has a branching rime (see Halle and Clements (1983, 22) and Halle and Vergnaud (forthcoming))—the stress rules are structure-building and therefore not subject to strict cyclicity. Note that in Sanskrit, words without underlying accents surface with stress even when they are underived. This is because the BAP applies on both a cyclic and a noncyclic stratum. This result opens up the possibility that there may be a language in which stress rules are structure-changing as in Sanskrit, but are not permitted to apply on a noncyclic stratum. In such a language underived words without underlyingly specified accents will carry no stress. We have been unable to discover such a language, but it is our belief that one should in fact exist.

The proposal that a following stratum may loop back to a preceding stratum is confirmed by the English data. The facts of Stem-final Tensing (2) show that class II affixation must precede compounding; however, class II affixes can be added to compounds and hence compounding must also be an input to class II affixation. This can only be achieved by ordering the stratum of class II affixation prior to the stratum of compounding and allowing a loop from the latter to the former stratum. Note that looping is a morphological device: we do not allow a form to loop from stratum  $n + 1$  to stratum  $n$  without undergoing any morphological process at stratum  $n$ .

On a more narrowly empirical plane, our study confirms the central role of Vowel Shift in the phonology of English. Vowel Shift has been shown to interact with various kinds of lengthening and shortening rules, including Compensatory Lengthening (106a) and  $\mp$ -Lengthening (95), as well as with Velar Softening (64) and  $\mp$ -Rounding (94b). Additional evidence for the role of Vowel Shift is found in the ablaut rules of the “strong” verbs discussed in the Appendix. Though this evidence does not constitute proof that Vowel Shift is part of the synchronic phonology of modern English, the facts adduced

are of a complexity and variety that would make it extremely difficult to propose an alternative treatment without Vowel Shift.

This study confirms the separation of the feature of tenseness from that of length. There are several processes that affect tenseness and length of vowels separately. Unlike Halle (1977) we argue that only vowel length (but not tenseness) is distinctive in underlying representations of English.

The treatment of the stressed nuclei in such words as *Lilliputian* and *sulphuric* supports L. Levin's (1980) ingenious proposal that underlyingly the former contains /ʌ/ and the latter /ɜ/. We feel that the evidence presented for this proposal is so convincing as to render it uncontroversial.

The more than thirty rules of English discussed in the preceding pages constitute a substantial proportion of the segmental phonology of the language. In testing theoretical proposals, exposure to a massive body of data exhibiting intricate interactions is of great importance since it is only in the face of such massive amounts of data that readily invented ad hoc alternatives can be ruled out. We hope that our presentation provides a firmer foundation for future discussions of both phonological theory and the phonology of English.

### Appendix: The Inflection of the English "Strong" Verbs

The inflection of the approximately 200 English "strong" verbs is based upon a special set of rules. These rules of verb inflection constitute a continuum of productivity and generality that extends from affixation of the *-ed* suffix in *decide*~*decided* to total suppletion in *go*~*went*. In the latter case we shall assume that the grammar contains a statement to the effect that the past tense of *go* is *went*. In the former case, however, the grammar contains no statement that the past tense of *decide* is *decided*, but instead a statement that in the past tense the suffix *-ed* is attached to the stem. In this instance the grammar will contain no special marking for the verb to undergo this process of affixation. In an intermediate class of cases exemplified by verbs like *sing*~*sang* or *bind*~*bound* the changes affect only a specific number of verbs. To deal with such cases, the grammar will not contain a plethora of statements such as "the past tense of *sing* is *sang*, the past tense of *bind* is *bound*," etc. Rather, it will contain a few rules, each of which determines the stem vowels of a list of verbs specifically marked to undergo the rule in question. It is with rules of this restricted type of productivity that we are concerned here.

The basic data for our study were taken from Bloch (1947), which contains an exhaustive list of the "strong" verbs of contemporary English. The "strong" verbs fall into three classes: verbs that affix /t/ or /d/ in stratum 1, verbs that are subject to the ablaut rules, and a handful of verbs that are subject to both ablaut and suffixation. Bloch's list includes 55 verbs that take the suffix /n/ in the perfect participle. Since /n/-suffixation is unrelated to the issues of stem ablaut that are of primary interest here, we do not take it into account systematically in the discussion below. We have, moreover, excluded

from consideration here the modals *can*, *shall*, *will*, *must*, *may*, the auxiliaries *be*, *have*, *do*, and the main verbs *go*, *make*, *stand*.

### A.1. t/d-Suffixation

The following verbs generate their past tense and perfect participle form by suffixing /t/ in stratum 1.

- (122) a. bereave~bereft, cleave, creep, deal, dream, feel, keep, kneel, lean, leap, leave, mean, sleep, sweep, weep  
 b. bend~bent, build, lend, rend  
 c. bite~bit, light, meet  
 d. lose~lost  
 e. seek~sought, wreak, beseech, teach

The treatment of the 15 verbs in (122a) is completely straightforward. Since /t/ is affixed in stratum 1, the verbs are subject to Cluster Shortening (56b). All the verbs have long /ē/ as their stem vowel, which after shortening surfaces as lax [ɛ].

The forms in (122) are subject to the general constraint in English that adjacent obstruents in the same syllable should agree in voice (e.g. *wide~width*, *five~fifth*, *twelve~twelfth*). This rule, which is also responsible for the voicing assimilation in the regular past tense (*packed*, *raced*, etc.) and the plural/genitive/present tense (*cats*, *Jack's*, *packs*) may be stated as follows:

#### (123) Voicing Assimilation

$$[-\text{son}] \rightarrow [-\text{voice}] \% \text{ — } \begin{array}{c} \wedge \\ [-\text{voice}] \end{array}$$

In (122b) the application of rule (123) derives the sequence . . . [tt], which is degeminated (after the shortening rules in stratum 1) by the rule that prohibits identical adjacent consonants in the same syllable in English:

#### (124) Degemination

$$\begin{array}{ccc} & \wedge & \\ & \text{X} & \text{X} \\ & | & | \\ [\alpha\text{F}] & & [\alpha\text{F}] \end{array} \rightarrow \begin{array}{c} \text{X} \\ | \\ [\alpha\text{F}] \end{array}$$

Rule (123) follows the rule of Epenthesis ([[pet]d] → [[pɛtəd]]), which obviously does not apply to those forms suffixed with *t* at stratum 1 ([[bend]t] → \*[bendət]). We can ensure the correct results by assuming that (a) Voicing Assimilation applies at all lexical strata as well as the postlexical stratum (e.g. *Jack is here* → *Jac[ks] here*), and (b) Epenthesis is restricted to stratum 4 and the postlexical stratum. Evidence about the domain of Degemination is absent, and therefore we shall assume that it applies at the postlexical stratum. The verbs in (122c) also affix /t/ in the past tense and perfect participle. They are then subject to Cluster Shortening and Degemination, in that order. In the past tense

and perfect participle the stem-final consonant is devoiced by rule (123). The verb *lose*~*lost* (122d) presents no particular problems. The long /ō/ surfaces as [uw] in the present tense, and the short /o/ of the past tense and perfect participle, which is the result of Cluster Shortening, is turned into [ɔ̄] by *a/o*-Tensing (44) and *o*-Lowering (45) (see (46) in the text), and stem-final /z/ is devoiced by rule (123). In RP, the past tense and participle form is actualized as [lɔst], which requires that the stem vowel be specially marked as subject to the rule of Lowering Ablaut (128) below.

In GA dialects the stems in (122e) have the same stem vowel in the past tense and perfect participle as the stem in *lost* (122d), and they are also subject to *t/d*-Suffixation, which in turn triggers Cluster Shortening. However, they are subject to a number of additional processes. We note first that all stems in (122e) end with a nonanterior (i.e. palatal or velar) obstruent, which, however, does not surface before the /t/ suffix. Moreover, although the present tense forms have a front vowel, the past tense and perfect participle have the back vowel [ɔ̄]. We obtain backness in the past tense and perfect participle by assuming that in the verbs in (122e) /t/-affixation is accompanied by Backing Ablaut (131). As a result, the underlying /ē/ is turned into /ō/ in the past tense and perfect participle. If the /ō/ were shortened, the attested surface form would be derived in exactly the same manner as that of *lost*. Our problem, then, is to find a motivation for subjecting these stems to shortening.

We could, of course, mark the forms as being subject to a special Shortening Ablaut rule. (We shall see below (cf. (133)) that this is the only possible solution in the case of certain verbs.) Alternatively, we might look for a minimal modification in the underlying representation of the verbs *and* of the rules already postulated that would produce the attested surface forms. It seems to us that the latter alternative must be chosen over the former because it is by far the less arbitrary. Although any form can be made subject to any rule, provided only that the form satisfy the input conditions of the rule, it is by no means easy to assign to a form a representation such that a set of independently motivated rules will produce the prescribed output.

It was observed in SPE that [h] surfaces in English only in syllable onsets but never in syllable codas, and it was suggested (pp. 233–234) that [h] be assumed to be underlyingly the velar continuant /x/, which becomes a glide in onset position and deletes elsewhere. In the forms in (122e) we need to delete the stem-final nonanterior obstruents before the /t/ suffix. A plausible means to this end is the rule of *x*-Formation (125), which turns nonanterior obstruents before the /t/ suffix into velar continuants [x]:

(125) *x*-Formation (stratum 1)

$$\begin{bmatrix} - \text{son} \\ - \text{ant} \end{bmatrix} \rightarrow \begin{bmatrix} + \text{cont} \\ - \text{cor} \\ + \text{high} \\ - \text{voice} \end{bmatrix} / \text{---} \text{ ]t]$$

The *x*-Deletion rule of SPE mentioned above will then delete the /x/, ensuring the correct output. This derivation has a further desirable consequence: by the simple means of

ordering the SPE rule of *x*-Deletion after Cluster Shortening (56b), we also account for the fact that the underlyingly long stem vowel is shortened in the past tense and perfect participle.<sup>33</sup>

The verbs in (126) all add the suffix /d/ in stratum 1:

- (126) a. hear~heard  
 b. hide~hid, slide, bleed, breed, feed, lead, plead, read  
 c. sell~sold, tell~told

All these forms are subject to Cluster Shortening and to Degemination. The forms *sold*, *told* are subject, in addition, to Backing Ablaut (131) and *o*-Lengthening (144), which are discussed below.

## A.2. Ablaut

The first groups of verbs to be examined here are the following:

- (127) a. sit~sat, spit, bid, drink, begin, ring, shrink, sing, sink, spring, stink, swim  
 b. eat~ate, lie~lay  
 c. choose~chose

The stem vowel in the past tense (and in some cases also in the perfect participle) of the verbs in (127) is [+low, –high]. This is self-evident in (127a), where the low vowel [æ] appears on the surface. It is somewhat less transparent in (127b) and (127c), where the surface vowel is subject to Vowel Shift. The forms in (127) justify postulating the Lowering Ablaut rule:

- (128) *Lowering Ablaut* (stratum 2)

$$V \rightarrow \left[ \begin{array}{c} +\text{low} \\ -\text{high} \end{array} \right]$$

For reasons detailed at the end of this appendix, we assume that (128) is a phonological rule that applies at stratum 2, which, like *t/d*-Suffixation, is triggered in forming the past tense and perfect participle of a lexically marked class of verbs. Since Lowering Ablaut feeds Vowel Shift, which also has stratum 2 as its domain, Lowering Ablaut must be ordered before Vowel Shift.

A different ablaut rule is needed for the verbs in the next two sets of examples:

- (129) a. cling~clung, dig, fling, shrink, sling, slink, spin, spring, stick, sting, string, win, wring; (perfect participle only) drink, begin, ring, sing, sink, spring, swim, stink  
 b. bind~bound, find, grind, wind  
 (130) a. break~broke, stave, wake; get, tread  
 b. bear~bore, swear, tear, wear

<sup>33</sup> The present tense stem *catch* is discussed under (149) below.

The rule must have the following form:

$$(131) \textit{ Backing Ablaut (stratum 2)}$$

$$\left[ \begin{array}{c} \text{V} \\ \langle -\text{high} \rangle_a \end{array} \right] \rightarrow \left[ \begin{array}{c} +\text{back} \\ \langle +\text{round} \rangle_b \end{array} \right]$$

If a, then b

Since (like Lowering Ablaut) Backing Ablaut feeds Vowel Shift, it too must be ordered before Vowel Shift in stratum 2.

The verbs in (129a) have as their base vowel short /i/; those in (129b) have long /ī/. Backing by (131) produces short [ɪ] and long [ī̄], respectively. The former is subject to *ɪ*-Lowering, since all verb stems in (129) are closed syllables. We thus obtain [ʌ], which is the correct surface vowel. The long [ī̄], being stressed in all verbs in (129b), is subject to Vowel Shift and Diphthongization, which produce the correct surface diphthong [aw].

The verbs in (130a) are treated in parallel fashion. There is, however, a significant difference between these verbs and those in (129a,b). In order to produce the correct surface form, Backing Ablaut must not only back the vowels as in (129a,b) but also round them. We have captured this subregularity by making the assignment of rounding by Backing Ablaut contingent upon vowel height: nonhigh vowels are rounded, high vowels remain unrounded.<sup>34</sup> In view of this, Lowering Ablaut must obviously be ordered before Backing Ablaut.

The treatment of the verbs in (130b)—*bore, swore, tore, wore*—is intimately connected with the intricate question of the behavior of vowels in syllables ending with the liquid /r/, which we are unable to discuss here. We note, however, that dialects that have the alternation [ɛ]~[ɔ] in these verbs can readily be accounted for with the help of the rules developed to this point. We need only postulate that these verbs are subject to Backing Ablaut. Since the underlying vowel is [−high, −low], this will produce /o/ in the past tense, from which the surface low vowel [ɔ<sub>1</sub>] is derived by means of *a/o*-Tensing and *o*-Lowering.

Consider now the alternations in the following set of verbs:

- (132) a. shoot~shot  
 b. flee~fled  
 c. shoe~shod  
 d. see~saw

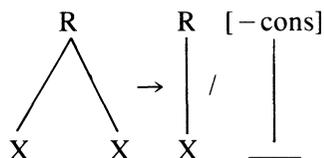
To obtain the past tense form of *shoot*, we proceed exactly as we did in the case of *meet*~*met* and the other verbs in (122c). *t/d*-Suffixation, Cluster Shortening, and De-

<sup>34</sup> This rule can be further simplified if the proposals in Archangeli (1984) concerning underspecification of phonemes are utilized.

gemination then take care of the rest. In the present instance, however, this would produce the form /ʃot/, which in view of *a/o*-Tensing and *o*-Lowering would surface as the incorrect [ʃot̚] (rhyming with *taught*). To obtain the correct surface form, we need to postulate that in the verb *shoot* *t/d*-Suffixation is accompanied by Lowering Ablaut.

The past tense and perfect participle *fled* is formed by means of *t/d*-Suffixation. In this case that process is accompanied by shortening, which, however, cannot plausibly be attributed to a deleted velar continuant as was done in (122e). We must therefore postulate a third ablaut rule:

(133) *Shortening Ablaut* (stratum 2)



To obtain *shod* (132c), we proceed exactly as in the case of *fled*, except that for the reasons given above in the discussion of *shot*, *shod* must also be subject to Lowering Ablaut.

To account for the past tense *saw* (132d), we indicate that this form is not subject to *t/d*-Suffixation. It is subject instead to Backing Ablaut and Shortening Ablaut, which together produce the string /so/. In GA this sequence is subject to *a/o*-Tensing and *o*-Lowering and therefore surfaces as [sot̚].

Consider next the verbs in (134):

- (134) a. bring~brought, think~thought  
 b. buy~bought, fight~fought

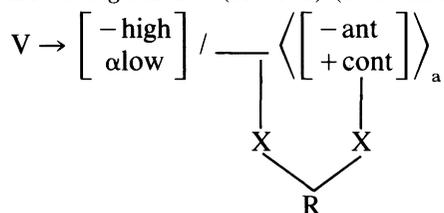
It is obvious that *brought* and *thought* should be derived in the same manner as *sought* and the other forms in (122e). However, there are two problems. First, the present tense forms *bring*, *think* have a nasal that must be elided in the past tense and perfect participle. To do this, we postulate the rule of Nasal Deletion:

(135) *Nasal Deletion* (stratum 1)

$$[+ \text{nasal}] \rightarrow \emptyset / \text{---} \left[ \begin{array}{l} - \text{ant} \\ + \text{cons} \end{array} \right] \text{ t}$$

If the past tense and participial forms were further to be subject to *x*-Formation, Lowering Ablaut, and Backing Ablaut, as well as to the SPE rule of *x*-Deletion, they would appear as /brɔt̚/, /θɔt̚/, which by virtue of the GA rule of *ɔ*-Unrounding would surface incorrectly as [brat̚], [θat̚]. To obtain the correct output we must revise Lowering Ablaut so that before a voiceless continuant, in particular a velar continuant, it generates a nonlow vowel rather than a low one.

## (136) Lowering Ablaut (revised) (stratum 2)



If a, then  $\alpha = -$

If  $\sim a$ , then  $\alpha = +$

The forms *bought* and *fought* can now be dealt with rather easily. Both are subject to *t/d*-Suffixation in the past tense and perfect participle. They are also subject to Lowering Ablaut and Backing Ablaut. If we assume further that these stems end with the velar continuant /x/, their past tense and perfect participle forms are derived by the rules developed to this point in a fashion parallel to that illustrated in the case of *brought* and *thought*. The only difference is that in *bought* and *fought* Cluster Shortening applies nonvacuously.

No problem arises with regard to the present tense form of *buy*, which is represented underlyingly as /bīx/. The situation is only slightly more complicated in the case of the present tense form *fight*, which is represented underlyingly as

(137) /fīxt/

At first sight it might appear that this form must undergo Cluster Shortening, resulting in the incorrect output [fit]. Cluster Shortening is assigned to stratum 1, which, it will be recalled, is cyclic. In a cyclic stratum, however, rules apply only in derived environments (see the Strict Cyclicity Condition (102)), and (137) is not a derived environment. By contrast, the past tense and perfect participle forms generated by *t/d*-Suffixation constitute derived environments, as in (138),

(138) fīxt + t

where both Cluster Shortening and *t/d*-Deletion will apply.<sup>35</sup>

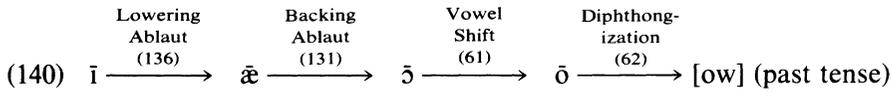
The perfect participles in (139) are accounted for by marking them as being subject to Shortening Ablaut:

(139) driven~drive, ridden, risen, shriven, smitten, stricken, stridden, striven, thriven, written

We cannot attribute shortening here to Cluster Shortening because before the participial suffix *-en* this rule does not apply, as shown by such forms as *broken*, *taken*, *frozen*. The past tense forms of the verbs in (139) and the participle *flown* have the stem vowel [ow], which derives from the long low back rounded /ɔ/. We can obtain this result by

<sup>35</sup> It was suggested in SPE that /i/ is lengthened before /x/. If this is correct, *buy* and *fight* may be represented underlyingly with a short vowel. In this case Cluster Shortening would not be involved in accounting for the past tense/perfect participle stems.

marking the forms in question as being subject to two ablaut rules, Lowering Ablaut (136) and Backing Ablaut (131).



This same dual marking will account for the past tense and perfect participle stem of the verbs in (141):

- (141) a. cleave~clove, freeze, heave, speak, steal, weave  
 b. bide~bode, dive, shine, stride

Marking the past tense stems as being subject to both Backing Ablaut and Shortening Ablaut will account for the following alternations:

- (142) fly~flew  
 strike~struck

These alternations may at first appear somewhat opaque. We assume that the stems are entered with long /i/. In the past tense, Backing Ablaut and Shortening Ablaut together will produce short [+]. It should be recalled, however, that stressed [+] in an open syllable is subject to *+*-Rounding and *+*-Lengthening, and in a closed syllable to *+*-Lowering. Thus, *flew* is subject to *+*-Rounding and *+*-Lengthening, and *struck* to *+*-Lowering, and the two forms are regular consequences of independently motivated rules.

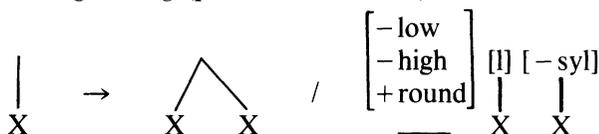
The next case, *fall*,

- (143) fall~fallen~fell

presents a special problem, in that here the low back vowel [ɔ<sub>l</sub>] in the present tense and perfect participle alternates with a nonlow front vowel in the past tense, just the reverse of the situation encountered above that the ablaut rules were designed to handle. Instead of postulating additional ablaut rules, we propose to deal with the *fall*~*fell* alternation by entering the past tense stem *fell* as the underlying form in the lexicon and marking the present tense and perfect participle as being subject to Backing Ablaut. This will generate the vowel [o], from which *a/o*-Tensing and *o*-Lowering produce the correct surface form.

As noted above, the perfect participle and past tense forms *sold*, *told* (126c) must be assumed to have short [o] as their stem vowel. To account for the fact that this vowel surfaces as [ow], we assume that when followed by [l] + consonant, [o] is subject to the following rule:

- (144) *o*-Lengthening (postlexical stratum)



If this rule is ordered before *o*-Lowering and Diphthongization but after Vowel Shift, the correct surface vowel [ow] will be generated.

The verb *hold*

(145) hold~held

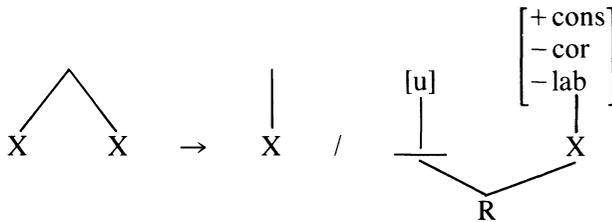
can be dealt with in the same way. The lexical entry contains short /e/ as the stem vowel. It is also marked as subject to Backing Ablaut in the present tense. The resultant [o] is lengthened by *o*-Lengthening, yielding [ow] by Diphthongization.

A more abstract solution is required by the following verbs:

(146) forsake~forsook, shake, take

We propose that in underlying representation the stem vowel is long /ē/, and that the stem is marked to undergo Lowering Ablaut in the present tense and perfect participle, and Backing Ablaut in the past tense. After Vowel Shift, this procedure would yield long [ū] as the stem vowel. We assume that the shortened [u] encountered on the surface is due to a special rule that shortens [u] before velar consonants:

(147) *u*-Shortening (stratum 2)



*u*-Shortening applies in stratum 2 after Vowel Shift and has a few idiosyncratic exceptions:

(148) spook, kook

We account for the forms in the next set in a similar fashion:

- (149) a. run~ran  
 b. come~came  
 c. give~gave  
 d. slay~slew  
 e. catch~caught

In (149a) we postulate short /i/ as the lexical stem vowel. The stem vowel is then marked as subject in the present tense and perfect participle to Backing Ablaut (and is lowered to [ʌ] by *ɜ*-Lowering). In the past tense, the stem is marked as subject to Lowering Ablaut. In (149b), *come~came*, we postulate long /ī/ as the underlying stem vowel and mark the stem as subject in the present tense and perfect participle to Backing Ablaut and Shortening Ablaut, and in the past tense to Lowering Ablaut. In (149c), *give~gave*,

we postulate long /ī/ as the lexical stem vowel and mark it as subject in the present tense and perfect participle to Shortening Ablaut, and in the past tense to Lowering Ablaut. In (149d), *slay~slew*, we again postulate long /ī/ as the lexical stem vowel and mark the stem in the present tense and perfect participle as subject to Lowering Ablaut, and in the past tense to Backing Ablaut and Shortening Ablaut. In (149e), *catch~caught*, we postulate short /e/ as the underlying vowel. The past tense and perfect participle are then derived in the manner of the verbs in (122e) such as *sought*. To account for [æ] in the present tense stem of *catch*, we mark this stem as subject to Lowering Ablaut.

The alternation in (150)

(150) say~said

is dealt with readily by postulating long /ē/ as the lexical stem vowel. The stem is then marked as subject to Lowering Ablaut in the present tense, and in the past tense and perfect participle to *t/d*-Suffixation and Shortening Ablaut.

The most complex derivations are required by the following verbs:

- (151) a. blow~blew, crow, grow, know, throw  
b. draw~drew

It is obvious that in the past tense the stem vowel must be short /ɜ/ (cf. (142)), whereas in the other forms it must be the long low rounded back vowel /ɔ/ in (151a) and the short mid vowel /o/ in (151b) (cf. (46)). For the verbs in (151a) we postulate that the lexical entry has long /ī/ as its stem vowel. In the past tense the stem vowel is marked as subject to Shortening Ablaut and Backing Ablaut. Elsewhere the stem vowel is marked as subject to Lowering Ablaut and Backing Ablaut. This solution involves a certain redundancy: although represented lexically as a front vowel, the stem vowel of all forms in (151) is subject to Backing Ablaut. We need to proceed in this roundabout fashion, however, in order to ensure the proper output of Lowering Ablaut. Whether this redundancy is a minor infelicity of our solution or indicative of a more serious flaw remains to be determined.

We could proceed in a parallel fashion in the case of (151b), *draw~drew*. We would postulate short /i/ as the vowel in the lexical representation of this stem and indicate that it is subject to Backing Ablaut in the past tense and to Backing Ablaut and Lowering Ablaut elsewhere. If this procedure were followed, the stem vowel would be short /ɜ/ in the past tense, short /ɔ/ elsewhere. Short /ɔ/ would be subject to ɔ-Unrounding, resulting in the incorrect surface form [dra<sub>ɪ</sub>ax] instead of the required [dɾɔ]. The correct output is readily obtained from an underlying /dro/ (cf. (46)). Our problem, therefore, is to constrain the application of Lowering Ablaut so that it yields here a nonlow rather than a low vowel. It will be recalled that Lowering Ablaut produces exactly this result in cases where the stem vowel is followed by the velar continuant /x/; that is, we would obtain the correct output if the lexical representation of the stem were /drix/. Because of *x*-Deletion (SPE, 244), the postulated /x/ would not surface. Its effect here is indirect: it modifies the output of Lowering Ablaut. For this proposal to work, it is necessary to

order *x*-Deletion before *ɹ*-Lowering, because the latter rule must be prevented from applying in the derivation of the present tense/perfect participle stem. That means that *x*-Deletion must be assigned stratum 2 as its domain. The alternative to this abstract solution is to add a special rule accounting for the alternation in (151b)—that is, to complicate the rules in order to satisfy theoretical preconceptions concerning the degree of abstractness permitted in underlying representations.

The three ablaut rules discussed above—Lowering Ablaut, Backing Ablaut, and Shortening Ablaut—have all been assigned stratum 2 as their domain. We must now justify this decision. Since the ablaut rules must precede Vowel Shift, which has stratum 2 as its domain, the only options available are stratum 1 and stratum 2. We have opted for the latter, because the ablaut rules, which are structure-changing, apply to unsuffixed and apparently underived forms. Since stratum 1 is subject to the Strict Cyclicity Condition, the facts just cited require that the ablaut rules be assigned to stratum 2. It might be argued that the past tense form *sang*, though unsuffixed, is not underived. This would permit us to assign stratum 1 as the domain of Lowering Ablaut. This argument, however, is difficult to sustain in light of such examples as *blow* or *run*, which clearly are underived forms, yet on the analysis proposed above are instances of Lowering Ablaut.

Below we give an ordered list of the rules introduced in this section.

(152) *Stratum 1*

Nasal Deletion (135)

*x*-Formation (125)

*Stratum 2*

Lowering Ablaut (136)

Backing Ablaut (131)

Shortening Ablaut (133)

*x*-Deletion (SPE)

*u*-Shortening (147)

*Postlexical Stratum*

*o*-Lengthening (144)

Voicing Assimilation (123)

Degemination (124)

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