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# Tenseness, Vowel Shift, and the Phonology of the Back Vowels in Modern English*

## 1. Tenseness

The feature of tenseness has had a long and complicated career in phonetics. Tenseness was first recognized as a distinct phonetic feature by A. M. Bell, the founder of modern phonetics, in his *Visible Speech* (1867). Bell used this feature to distinguish vowels such as those in German *Biene* 'bee', *See* 'sea', *gut* 'good', and *Sohn* 'son' from those in *bitte* 'please', *fest* 'firm', *Hund* 'dog', and *Sonne* 'sun'. He labelled the former "narrow", and the latter "wide". These terms describe the degree of maximal constriction in the vocal tract: the constriction is narrow in the first set of vowels and wide in the second set. In German and in many English dialects as well, tenseness is frequently correlated with vowel length: the long vowels being tense and the short vowels lax. In addition, there are also correlations between tenseness and tongue height: many but not all tense vowels show greater tongue height than their lax cognates. As a result of these multiple correlations, phoneticians have had difficulty keeping tenseness distinct from other phonetic features, a situation that was remarked upon already by E. Sievers in his *Grundzüge der Phonetik,* the basic text for phoneticians for a half century after its publication in 1875:

> One must guard against confusing the concepts "tense" (or "narrow") and "lax" (or "wide") with those which are designated by the traditional expressions "close" and "open". The latter express only the fact that a given vowel has greater or lesser mouth width than some other vowel, but without taking into consideration the very different articulatory processes which produce differences in the mouth width in each case; specifically without considering whether a given mouth width is due to greater or lesser raising of the tongue, rather than to greater or lesser tension in the tongue, or to a mixture of the two. A vowel may, therefore, be "more open" than another because it has lesser tongue height, or because it has less tension, and conversely in the case of "close" vowels. . . Where the grammarian operates with "close" or "more close" and "open" and "more open" vowels, the phonetician must state precisely in each case what is meant by this equivocal expression. (p. 100).

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The confusion persists to the present, and I regret to have to confess that I have contributed to it. As confession of one's sins is good for the soul, I shall briefly sketch the error that I now believe myself to have been guilty of and indicate how it might be remedied. When one examines the X-ray pictures of tense and lax vowels, the most obvious difference that one notices in them is the position of the tongue root: tense vowels characteristically have an advanced tongue root, whereas lax vowels have a more retracted tongue root. This fact was brought out with particular clarity in the X-ray pictures published by P. Ladefoged (1964) and was then discussed in an interesting paper by J. Stewart (1969). Much influenced by these publications, Stevens and I published a note in which we suggested that tenseness should be equated with *Advanced Tongue Root* (Halle and Stevens (1969)). These proposals were reviewed in an important paper by Wood (1975). Wood studied the relationship between articulation and acoustic output, and showed conclusively that the differences in formant frequencies could not be accounted for by the observed differences in pharynx volume produced by advancing the tongue root; instead, the formant frequency differences can be accounted for by differences in the maximal narrowing to be found in the vocal tract. This investigation thus supported Bell's original suggestion as well as an earlier proposal of Jakobson's (see Jakobson and Halle (1956, 43)), which (like many other suggestions due to Jakobson) was taken over in Chomsky and Halle (1968; hereafter, SPE); namely, that the tense sound is produced with a vocal tract configuration that deviates more from a uniform tube than the one involved in the production of its lax counterpart; for the greater the constriction, the greater the deviation from a tube of uniform cross-section.

The proposal that tenseness is correlated with degree of constriction also solves a problem that could not be resolved within a framework where tenseness was correlated with advanced tongue root; namely, the possibility of the existence of both tense and lax low vowels. Since low vowels are all produced with a constricted pharynx that can only be implemented by maximal retraction of the tongue, Stevens and I suggested that low vowels were all [−Advanced Tongue Root], i.e. lax. Keyser (1973) showed that the contrast between tense and low was phonetically neutralized among low vowels in a great many American English dialects. The literature, however, contains clear instances in which low vowels contrast as tense and lax. We find tense and lax low vowels in various West African languages, where tenseness harmony is extended to low vowels; Ladefoged (1964, 37) notes that "Nzima, Kyerepong and some forms of Twi . . . had two complete sets of five vowel qualities." Moreover, one finds contrasts in tenseness among low vowels in more familiar languages; for example, in many varieties of modern German we find two types of *a*: *Rat* 'advice' vs. *hat* 'has'. The German phonetician Viëtor (1913, 31) remarks that the German "[a] shares with other vowels the distinction of 'narrow' (tense) articulation when long, and wide (lax) articulation when short." Different dialects of American English also possess both tense and lax varieties of low vowels, although phoneticians have often failed to

describe the contrasts in these terms. Perhaps the best known of these are the two varieties of [æ] found in a great many American dialects. Trager (1930), who appears to have been the first to have studied their distribution, described one of the two vowels as "a short, unrounded, low, front, lax oral vowel" and the other as "the corresponding long, tense, slightly higher front vowel." (Below we shall typographically distinguish low tense vowels from low lax vowels by supplying the former with a subscript *t* and the latter with a subscript *l*). According to Trager, lax [æ$_l$] appears before word-final voiceless stops and [l], whereas the tense [æ$_t$] appears before other word-final consonants:

(1) [æ$_l$]: tap, pat, rack, patch, pal
[æ$_t$]: tab, pad, tag, badge, ham, man, staff, salve, path, pass, jazz, cash

A distinction between two kinds of low, back, unrounded vowels has been well known at least since Bloomfield (1933) cited the contrasts in (2):

(2) father—bother, calm—Tom, rajah—Roger

It appears that tense and lax rounded back vowels are not to be found in a single American dialect. The lax [ɔ$_l$] is found in Eastern New England dialects in words such as

(3) caught law lost cot top cob

which in most other American dialects are implemented in part with tense [ɔ$_t$], in part with long [ɑ$_l$]. The standard Southern British pronunciation (RP) does include both tense [ɔ$_t$] and lax [ɔ$_l$], as noted by many authorities from Sweet (1906) to Kurath and McDavid (1961, 7). Examples of contrasting pairs are shown in (4):

(4) RP: caught—cot laud—nod dawn—don

Having illustrated the appearance of phonetically both tense and lax low vowels in various dialects of contemporary English, I turn to a discussion of the role that these contrasts might play in the phonology of the language.

## 2. Vowel Shift

Vowel Shift has traditionally been regarded as the crucial watershed separating Middle English from Modern English. It was one of the major claims of SPE that this historical process, which is first attested in Southern British dialects in the early sixteenth century, is an active component of the majority of dialects that are spoken today. The arguments that were adduced in support of this claim were of an indirect sort: Chomsky and I tried to show that a variety of phonological alternations could be stated in a relatively simple manner only if Vowel Shift were included as a rule in the synchronic phonology of the modern language. In the last few years a number of challenges to this view have appeared. Since these challenges have failed to deal with the critical core of

our proposal, but have focussed on largely irrelevant side issues, I shall review here the main facts that support our proposition.

It was observed in SPE that there are numerous contexts in English where the following alternations are found:

| | | | | |
|---|---|---|---|---|
| (5) | āy - i | divine—divinity | crucify—crucifixion | satire—satiric |
| | īy - e | serene—serenity | intervene—intervention | hygiene—hygienic |
| | ēy - æ | sane—sanity | abstain—abstention | volcano—volcanic |
| | āw - ʌ | profound—profundity | — | — |
| | ōw - ā | verbose—verbosity | — | cone—conic |
| | ūw - ʌ | — | reduce—reduction | — |

The main point to observe about these alternations, which are clearly part of the synchronic phonology of contemporary English, is that they can be captured only with the help of a very complicated rule that has the effect of turning each of the long tense diphthongs in the left columns in (5) into the specific lax monophthong found in the column to its right.

A part of the same alternations are found in other cases such as those in (6).

| | | | | |
|---|---|---|---|---|
| (6) | ə - æ - ēy | marginal—marginality—marginalia | | |
| | ə - - īy | manager | — | managerial |
| | ə - ā - ōw | harmony—harmonic—harmonious | | |

Since the environments in which the processes in (6) take place are totally distinct from those in which the processes in (5) are found, they cannot be combined into a single rule. However, it is a fact that the processes in (5) and (6) have important similarities—in all of them, a given monophthong alternates with a specific long tense diphthong. In SPE we proposed factoring out the part that these rules had in common into two separate rules—the so-called Vowel Shift rule and the Diphthongization rule, both of which apply only to tense, long vowels. Then the special facts in the two sets—the shortening and laxing of the vowels in (5) and their lengthening and tensing in (6)—can be given in the fairly simple rules that roughly have the form (7):

$$\text{(7) a. } V \longrightarrow [-\text{long}, -\text{tense}] \,/\, \_\_\; C_0 \begin{Bmatrix} V\ C\ V \\ C\ C \\ ic \end{Bmatrix}$$

$$\text{b. } V \longrightarrow [+\text{long}, +\text{tense}] \,/\, \begin{bmatrix} \_\_\_\_ \\ -\text{high} \end{bmatrix} \text{CiV}$$

A second argument is adduced from a consideration of the facts of Velar Softening, which is the result of a process totally separate from the lengthening and shortening rules just reviewed. The process of Velar Softening consists of the replacement of *k* by

*s* and *g* by *ǰ*, as exemplified by such pairs as those in (8):

(8) critic—criticize fungus—fungi
medicate—medicine analog—analogical
matrix—matrices syrinx [gs]—syringes
reduction—reducent intellect [gt]—intelligentsia

What interests us here is the environment in which Velar Softening takes place. The environment in purely phonetic terms is quite odd: Velar Softening would appear to be triggered by a following [āy, ĭ, īy, ĕ]; or, in feature terms, before any front high vowel, before a lax mid vowel, and before the diphthong [āy]. The environment becomes much more transparent as soon as we recall that, if the language is subject to Vowel Shift, then the diphthongs [āy, īy] are surface manifestations of the underlying tense long vowels [ī, ē], respectively. Velar Softening can then be said to take place before [ī, ē, ĭ, ĕ], that is, before vowels that are [−back, −low]. The rule would then read as follows:

(9) $\left\{\begin{matrix} k \rightarrow s \\ g \rightarrow \check{j} \end{matrix}\right\} / \_\_\_\_ [-low, -back, +syl]$

Further support for the above version of Velar Softening comes from the special class of prefixed words of the type illustrated in (10):

(10) a. consign—resign b. incite—recite
consist—resist incipient—recipient
consult—result concede—recede
consent—resent concession—procession

We see in (10a) that if the prefix ends with a vowel, root-initial /s/ is voiced. There is, however, a clear class of exceptions to the *s*-voicing rule, those illustrated in (10b). One can either consider these as irregular cases about which nothing further can be said, or one can try to find a subregularity that accounts for the differences between (10a) and (10b). The subregularity is that the words in (10b) are subject to Velar Softening, whereas the words in (10a) contain an underlying /s/ that is voiced after prefixes ending with a vowel. If the voicing rule is ordered before Velar Softening, the surface facts illustrated in (10b) are readily accounted for.

Since the environments in which Velar Softening takes place can thus be stated in a reasonably simple manner only if English vowels are assumed to undergo Vowel Shift, the facts just reviewed must be taken as supporting the view that Vowel Shift is a rule of the phonology of Modern English.

A third interesting argument is provided by the vowel alternations found in English verbs illustrated in (11):

(11) a. lie—lay; eat—ate; choose—chose
drink—drank; sing—sang; begin—began; swim—swam; sit—sat

b. find—found; bind—bound; break—broke; wear—wore
dig—dug; shrink—shrunk
c. write—wrote; rise—rose; speak—spoke; freeze—froze
get—got; tread—trod

The words in (11a) exhibit the following surface alternations: [āy - ēy], [īy - ēy], [ūw - ōw], [i - æ]. While there are, no doubt, some common features to be abstracted here—e.g. the second alternant among the long diphthongs is a mid vowel—the true generalization becomes apparent only when we represent the vowels in their underlying form; that is, when we abstract away the effects of Vowel Shift. We then have the alternations [ī - ǣ], [ē - ǣ], [ō - ɔ̄], [i - æ]: that is, in the past tense forms the stem vowel is [+low].

The alternations in (11b) are of a different kind: here in the past tense form the underlying vowel is [+back], if the process is to be expressed in terms of the underlying representations rather than in terms of surface vowels. The alternations in (11c) can now be captured quite readily; in the past tense the stem vowel undergoes both lowering and backing. In other words, among the allomorphy rules of English there are the two rules (12a) and (12b):

(12) a. $V \rightarrow [+low, -high]$
b. $V \rightarrow [+back]$

The verbs in (11a) undergo (12a) in the past tense; those in (11b) undergo (12b), while those in (11c) are subject to both rules.

We thus have three quite distinct processes in English that can be expressed quite simply if it is assumed that the processes affect vowels that subsequently will undergo Vowel Shift. If Vowel Shift is not assumed to be a synchronic rule of the language, the characterization of these processes becomes hopelessly complex.

Up to this point we have not discussed the precise nature of the Vowel Shift rule. In SPE, Vowel Shift was presented as being composed of two polarity switching rules, which affect vowels that agree in backness and rounding:

(13) $$\begin{bmatrix}\gamma\text{back}\\ \gamma\text{round}\end{bmatrix} \rightarrow \left\{\begin{array}{l}[-\alpha\text{high}] \,/\, \begin{bmatrix}\overline{\alpha\text{high}}\\ -\text{low}\end{bmatrix}\\ [-\beta\text{low}] \,/\, \begin{bmatrix}\overline{\beta\text{low}}\\ -\text{high}\end{bmatrix}\end{array}\right\}$$

These switching rules applied conjunctively in the following three classes of cases:

(A) Stressed tense vowels;
(B) Vowels specifically marked with the diacritic feature [+F];
(C) The high lax back vowel [ʊ].

Case (B) was postulated specifically to handle vowel alternations in verb stems such as *sit—sat, sing—sang, swim—swam*. In SPE these alternations were not

connected to any of the other vowel alternations illustrated in (11b). Since the solution proposed in (12) handles these cases together with all the other examples in (11), there is no longer any justification for including these in the Vowel Shift rule. It should be noted especially that tense vowels undergoing (12) are regularly subject to Vowel Shift. In the SPE solution such vowels have to undergo Vowel Shift twice, which is hardly a desirable situation. This is another reason for replacing SPE option (B) of the Vowel Shift rule by an allomorphy (readjustment) rule such as (12).

It will be shown below that we can also dispense with option (C) of the SPE version of the Vowel Shift rule. We are thus left with a Vowel Shift rule applying to tense vowels that are stressed and agree in backness and rounding. I would like to propose that we drop all but the first of these restrictions and let Vowel Shift apply to all tense vowels:[1]

$$(14)\quad [+\text{tense}] \rightarrow \left\{ \begin{array}{l} [-\alpha\text{high}] \,/\, \left[ \begin{array}{c} \underline{\quad\quad} \\ \alpha\text{high} \\ -\text{low} \end{array} \right] \\ [-\beta\text{low}] \,/\, \left[ \begin{array}{c} \underline{\quad\quad} \\ \beta\text{low} \\ -\text{high} \end{array} \right] \end{array} \right\}$$

The generalization of Vowel Shift to all tense vowels naturally raises questions about how to handle the various cases that led us in SPE to restrict Vowel Shift to tense vowels that are stressed and, moreover, agree in backness and rounding. First and foremost among these were the stressed vowels in words such as those in (15):

(15) Chicago rajah garage

It will be recalled that in SPE tenseness and length were completely correlated: all long vowels were assumed to be tense, and all short vowels were assumed to be lax. Therefore, the stress rule was formulated so as to take tenseness of vowels into account. The stressed vowels in (15) were assumed to be tense, but because they failed to agree in rounding and backness, they did not undergo Vowel Shift. This move, however, did not solve all problems. In particular, words of the type illustrated in (16) presented difficulties:

(16) Catawba Winnepesaukee Catawmet
impala Alabama soprano

[1] In Kurath and McDavid, for example, tense and lax vowels are designated respectively as "free" and "checked" (1961, 3–4):

> . . . the stressed vowels of English fall into two classes: (1) FREE VOWELS, as in *three, two, day, know, law, fur, high, boy, now,* which are usually upgliding diphthongs but have monophthongal allophones and diaphones . . . (2) CHECKED VOWELS, as in *crib, wood, ten, sun, bag, crop,* which are often monophthongal but have ingliding allophones and diaphones.

If all long vowels are tense and all short vowels lax, and if the stress goes on the penult only if the syllable ends with a strong cluster, then the stressed vowels in (16) must be *tense*. However, in this case we would expect these vowels to undergo Vowel Shift—but this evidently does not happen here, as shown by the contrast with the examples in (17):

(17) Manitoba Barcelona aroma
shillelagh volcano ultimatum

A solution to this problem might be to restrict the redundancy rule linking length and tenseness. Rather than linking these two features in all vowels as the SPE rule did, I propose to introduce rule (18), which admits both tense and lax varieties among long low vowels, but not elsewhere:

$$(18)\quad [\alpha\text{long}] \rightarrow [\alpha\text{tense}] \,/\, \left[ \frac{\qquad}{\left\{ \begin{matrix} -\text{low} \\ -\text{long} \end{matrix} \right\}} \right]$$

A necessary correlate of this modification is that the Stress Rule of English be made sensitive to vowel length rather than to tenseness as in SPE. If the penultimate vowels in (16) are now represented as long and lax, they will be stressed correctly; however, they will not undergo Vowel Shift, as this rule does not affect lax vowels.

### 3. Dialectal Treatment of Lax Nonhigh Back Vowels

Since modern English dialects differ significantly with regard to their treatment of nonhigh back vowels, it is clearly of interest to examine how the proposed modification in the definition of tenseness affects one's ability to capture the processes involved. The relevant examples are given in (19) under the column with the heading "key word". The rest of the table is divided into two parts: in the lefthand part I have given the distinctive feature complexes of the key vowels at the point where the Vowel Shift rule applies, and on the right, their surface manifestations in several dialects of English (the data here are taken from Kurath and McDavid (1961, 5-8), with a number of modifications of my own).[2]

[2] It has been suggested to me that the Vowel Shift rule can be further simplified by merging the two subrules in (14) into a single rule. As I know of no process that must intervene between the two subrules, I am favorably inclined toward this suggestion. However, I am somewhat puzzled by the opacity (as opposed to transparency) of the resulting rule. In any event, nothing of relevance to the issues under discussion hinges on this part of the rule.

(19)

| *Key Word* | *Long* | *Tense* | *High* | *Low* | *Back* | *Round* | EMass | WPa | RP | NYC | UNY |
|---|---|---|---|---|---|---|---|---|---|---|---|
| $\bar{ɔ}_t$ Arizona | + | + | − | + | + | + | $\bar{o}_t$w | $\bar{o}_t$w | $\bar{o}_t$w | $\bar{o}_t$w | $\bar{o}_t$w |
| $\bar{ɔ}_l$ Catawba | + | − | − | + | + | + | $\bar{ɔ}_l$ | $\bar{ɔ}_l$ | $\bar{ɔ}_t$ | $\bar{ɔ}_t$ | $\bar{ɔ}_t$ |
| $\bar{a}_l$ Chicago | + | − | − | + | + | − | $\bar{a}_l$ | $\bar{ɔ}_l$ | $\bar{a}_t$ | $\bar{a}_t$ | $\bar{a}_t$ |
| $\check{ɔ}_l$ conic | − | − | − | + | + | + | $\bar{ɔ}_l$ | $\bar{ɔ}_l$ | $\check{ɔ}_l$ | $\bar{a}_l$ | $\bar{a}_t$ |
| $\check{o}_l$ shot | − | − | − | − | + | + | $\bar{ɔ}_l$ | $\bar{ɔ}_l$ | $\check{ɔ}_l$ | $\bar{a}_l$ | $\bar{a}_t$ |
| $\check{o}_l$ lost | − | − | − | − | + | + | $\bar{ɔ}_l$ | $\bar{ɔ}_l$ | $\check{ɔ}_l$ | $\bar{ɔ}_t$ | $\bar{ɔ}_t$ |

For reasons given at the end of the preceding section, we assume that the underlying vowel in the penultimate syllable of *Arizona* is long, tense, and rounded, whereas its counterpart in *Catawba* is long, lax, and rounded, and in *Chicago* it is long, lax, and unrounded. The stressed vowel in *conic* must be short and lax as well as low, back, and rounded, for it is derived by the shortening/laxing rule (7a) from *cone*, which has the same vowel as the one in the penultimate syllable of *Arizona*. The past tense forms *shot* and *lost* are also the result of shortening/laxing (cf. *light–lit* and *keep–kept*). Since in the base forms *shoot* and *lose* the stem vowel is nonhigh, nonlow, back, and round, the same feature values are postulated in *shot* and *lost*.

We turn now to the righthand part of (19), where we find the surface manifestations of these six vowels in the different dialects. The simplest situation is the one prevailing in Eastern Massachusetts. Here we find that short, lax [o$_l$] merges with its low cognate [ɔ$_l$], and that all low vowels appear as long on the surface. These facts are captured by the two rules in (20), which are assumed to be ordered so as to apply after Vowel Shift.

(20) Eastern New England
  a. [+syl, +round, −high, −long] → [+low]
  b. [+low, +round] → [+long]

The lowering of short [o] to [ɔ] expressed formally in rule (20a) is a property of all five dialects under discussion here. In addition to this, the Western Pennsylvania dialects show the merging of long lax [$\bar{a}_l$] and [$\bar{ɔ}_l$] into [$\bar{ɔ}_l$]. We shall assume that this is achieved with the help of rule (21b) below. We note, however, that it is conceivable that no special rule is involved, but that instead in this dialect there are no long lax [$\bar{a}_l$] in underlying representations, and that words such as *Chicago* have underlying [$\bar{ɔ}_l$] in place of [$\bar{a}_l$]. In this case, the rules for the Western Pennsylvania dialect are identical with those of Eastern Massachusetts, but the dialects differ in their underlying representations.

(21) Western Pennsylvania
  a. = same as (20a)
  b. [+low, +back, −tense] → [+long, +round]

In the dialect underlying the so-called Received Pronunciation (RP) of Southern British English, all long back vowels are phonetically tense (cf. Jespersen (1928, sections 15.52, 15.82)). We capture these facts formally with the help of the rules in (22):

(22) Southern British (RP)
a. = (20a)
b. [+back, +low, +long] → [+tense]

The two remaining dialects exemplified in (19) share, in addition to the vowel merger captured by rule (20a), the fact that the vowel in words such *lost* and *long* does not merge with the vowel of *conic* or *shot* but rather with that of *Catawba*. We express this fact formally by adding the special lengthening rule (23b) (see below). Moreover, the two dialects under discussion here differ from the three preceding ones in their treatment of short vowels, which at this stage in the derivation are [−high, +back]. As in the overwhelming majority of American dialects, these vowels appear here on the surface as long unrounded vowels. For the dialect spoken in New York City (which in this respect parallels the Chicago dialect described by Bloomfield (1933, 102–104)), we need, in addition to the RP rule (22b), a rule that unrounds and lengthens all low short back vowels (see (23d)). Because of its place in the order of the rules, rule (23d) will preserve a distinction between these newly unrounded vowels and other long vowels: the latter will be tense, whereas the vowels unrounded by rule (23d) will be lax. (As a consequence, in this dialect *father* has a long tense vowel on the surface, while *bother* has a long lax vowel.)

(23) New York City
a. = (20a)
b. $[+\text{back}, +\text{low}] \rightarrow [+\text{long}] / \_\_\_\_ \begin{Bmatrix} [+\text{cont}, -\text{voiced}] \\ [+\text{nasal}, +\text{high}, +\text{back}] \end{Bmatrix}$
c. = (22b)
d. [+back, +low, −long] → [−round, +long]

This distinction between back low vowels is absent in the Upstate New York dialects, and we express it formally by reversing the order of the last two rules.

(24) Upstate New York
a. = (20a)
b. = (23b)
c. = (23d)
d. = (22b)

Before leaving this topic, I should like to remark that the rules proposed are in need of further study; they must be examined in the light of a much broader range of facts from each of the dialects than I have had an opportunity to consider. I believe,

however, that the relative simplicity of the accounts just presented—even if these might have to be revised in certain details—provides substantial evidence in favor of the suggestion that English distinguishes between two types of long low vowels, tense and lax.

## 4. Effects on Nonlow Back Vowels

We recall that Vowel Shift turns underlying tense mid vowels into high vowels and that, as modified in (14), Vowel Shift will affect unrounded as well as rounded back vowels. We now inquire how this change affects the treatment of such alternations as those in (25):

(25) reduce—reduction consume—consumption

If we assume that the underlying vowel is [ʌ], that is, [−high, −low, +back, −round], we should expect a vowel that is [+high, −low, +back, −round] or [ɨ] as the surface manifestation of the (Vowel Shifted) tense vowel. Since the attested surface variant is [ū], we need only add the highly plausible rule (26) to complete the account of the alternations in (25).

(26) [+syl, +back, +high] → [+round]

Before continuing, I should remark explicitly that, much as in SPE, I assume here that the diphthongal quality of the tense long vowel is accounted for by a diphthongization rule (cf. SPE, 183ff.). Unlike SPE, however, I assume that this rule is ordered after Vowel Shift. Since Diphthongization inserts a [w] glide after back vowels and a [y] glide after front vowels, it can be ordered anywhere, as long as it precedes rules that affect the feature *back* in tense vowels. The only rule relevant here is the one turning the vowel-shifted reflex of [ī] into [ā], and this rule can be ordered very late (cf. SPE, 216). I follow SPE also in its account of the insertion of the [y] that appears before some reflexes of [ʌ]. Like SPE, I assume that this rule of *y*-Preposing is ordered before Vowel Shift. Since underlyingly these vowels are [−high] (rather than [+high], as assumed in SPE), we must adjust the rule accordingly. I deviate from SPE also with regard to the context in which *y*-Preposing takes place. Rather than assume that [y] is preposed before the tensed variant of [ʌ], I propose that [y] is preposed whenever [ʌ] is tense or in an open syllable:

$$(27)\quad \phi \rightarrow \text{y} \;/\; \underline{\quad} \begin{bmatrix} +\text{syl} \\ -\text{high} \\ -\text{low} \\ +\text{back} \\ -\text{round} \\ \langle +\text{tense} \rangle_a \end{bmatrix} \langle [-\text{syl}]\ [+\text{syl}] \rangle_b$$

Condition: $a \vee b$

Thus *y*-Preposing takes place in the contexts illustrated in (28):

| | | | | | |
|---|---|---|---|---|---|
| (28) a. | Berm*u*da | f*u*gue | c*u*cumber | reb*u*ke | am*u*se |
| b. | ambig*u*ous | perpet*u*al | contin*u*ant | val*u*e | individ*u*ate |
| c. | ang*u*lar | cop*u*la | imp*u*dent | mod*u*lar | tab*u*late |

We observe with regard to (28a) that because of forms such as *rebuke* *y*-Preposing (27) cannot be limited to the environment where [ʌ] is in an open syllable. We are unable to represent this verb as /rē + bʌke/ because, as shown by *reduce*, word-final /e/ induces Velar Softening. On the other hand, we are prevented from limiting *y*-Preposing to the environment before tense [ʌ̄] because of the examples in (28c). Here, *y*-Preposing applies before lax [ʌ], which, as shown in (29) below, does not diphthongize and appears on the surface as [yə]. The appearance of [yūw] in all examples in (28b) is a consequence of the independently motivated rule that lengthens and tenses vowels in prevocalic position (see SPE, 181). As shown in (29), the rules just discussed yield the correct output for all three types of example in (28):

| (29) | Berm[ʌ́]da | ambíg[ʌ]ous | áng[ʌ]lar |
|---|---|---|---|
| Prevocalic Tensing | ——— | ʌ̄ | ——— |
| *y*-Preposing (27) | yʌ́ | yʌ̄ | yʌ |
| Vowel Shift (14) | yɨ́ | yɨ̄ | ——— |
| High Rounding (26) | yṹ | yū | ——— |
| Diphthongization | yṹw | yūw | ——— |
| Vowel Reduction | — | ——— | yə |
| Output | [yṹw] | [yūw] | [yə] |

The proposed extension of Vowel Shift allows us to treat the stressed vowel in *ambiguity* in exactly parallel fashion to its unstressed cognate in *ambiguous*. In this respect, this solution differs from the one in SPE. The advantage, however, is clearly on the side of the solution given here, since it allows us to dispense with the two special rules, one tensing and the other laxing the vowels under discussion (cf. SPE rule (52), p. 195; and rule (59), p. 197). Moreover, this solution allows us to dispense with the ad hoc rule mentioned in SPE (192, fn. 18), designed to handle such pairs as *simultaneous* vs. *simultaneity*, for in the present treatment these are completely regular. The alternations exemplified by *vary—variety* and *trochee—trochaic*, however, are exceptional under the present account; we shall assume that *vary* and *trochaic* are idiosyncratically marked as exceptions to Vowel Shift. This cost is to be balanced against the obvious advantage of being able to eliminate the special tensing and laxing rules for unrounded back vowels required in the SPE treatment (rules (52) and (59), pp. 195–197).[3]

The treatment proposed here has yet another advantage over that of SPE in that it

[3] The proposed treatment of [ʌ] obviates the need for the special subcase (C) of the Vowel Shift rule that is part of the SPE treatment of these vowels.

more nearly satisfies Postal's Naturalness Condition, for it postulates underlying representations that are more directly related to their surface reflexes than does SPE. The precise manner in which this condition should be implemented has been the subject of some debate, and there is at present no consensus on this question. The remarks that follow would appear to have some bearing on how this issue might be resolved.

The type of alternation illustrated in (30) is relatively infrequent in English; I give here all the examples known to me:

(30) profound—profundity; pronounce—pronunciation; (similarly announce, denounce, etc.); South—Southern; abound—abundant, flower—flourish, tower—turret

If we now represent the long variant as underlyingly [+high, +back, −round, +tense, +long], then the modified Vowel Shift rule introduced here will, together with the Diphthongization rule, yield the correct surface reflex [ā$_t$w]. The cost of this solution is the special rule (31), needed to deal with the short lax variant.

(31) [+back, −round, −long] → [−high]

This rule must be ordered after the *y*-Preposing rule (27) so as to prevent the latter from applying before the nonhigh reflexes of [ɨ].

Because of the paucity of examples in which [āw] alternates with [ʌ], it might be suggested that rule (31) is unnecessary and that alternations be handled by means of a lexical redundancy rule that turns underlying tense [ɨ̄] into lax [ʌ] directly. The facts given in (32) suggest that this cannot be done.

(32) find—found bind—bound dig—dug fling—flung

We noted above (see (11)–(12)) that these are instances in which an allomorphy rule is responsible for backing the stem vowels in the past tense. Rule (12b) has the effect of turning [i] → [ɨ]. If [i] is tense, it will then undergo Vowel Shift and Diphthongization, yielding the required [aw]. If [i] is lax, rule (12b) will turn it into [ɨ], which then undergoes lowering to [ʌ] by rule (31). If (31) were not part of the grammar, rule (12b) would have to be complicated anyway in order to account for the examples in (33):

(33) wake—woke break—broke write—wrote speak—spoke

If rule (12b) applied to these forms, we should obtain unrounded back vowels in the past tense. This was the correct result for the examples in (32), but it is incorrect here. It is clear that the difference is correlated with vowel height. In the case of high vowels, rule (12b) holds; for nonhigh vowels it must be modified as in (34):

(34) $\begin{bmatrix} V \\ -\alpha\text{high} \end{bmatrix} \rightarrow \begin{bmatrix} +\text{back} \\ \alpha\text{round} \end{bmatrix}$

An additional consequence of this modification is that it requires that rule (12a)

must be ordered before (34) (<12b). If correct, this result implies that, like phonological rules, allomorphy rules are ordered.

We have now accounted for all back vowels except for the short [ʊ] and the diphthong [ɔ̄y]. The [ʊ] vowel can be represented with its surface features in underlying representations. The only rules that will apply to it are the tenseness distribution rule (14) and the rule rounding high back vowels (31). Both rules will apply vacuously to this segment. It should be noted that lax [ʊ] does not participate in any morphophonemic alternations.

The diphthong [ɔ̄y] is not nearly so simple a matter. As shown in (35), in the system of underlying vowels required by the analysis developed here, there are two systematic gaps: the short [u] has no long counterpart, and long [ā$_l$] has no short counterpart:

(35)

| | | | | | |
|---|---|---|---|---|---|
| ī | ɨ̄ | | i | ɨ | u |
| ē | ʌ̄ | ō | e | ʌ | o |
| ǣ$_t$ ǣ$_l$ | ā$_l$ | ɔ̄$_t$ ɔ̄$_l$ | æ | | ɔ |

Since [ɔ̄y] is a diphthong with a long vowel as nucleus, its underlying representation should be a long vowel. This suggests that we explore the possibility of representing [ɔ̄y] as underlying long [ū]. Since this vowel would be subject to Vowel Shift, we should end up with low tense [ɔ̄$_t$]. Hence, to generate the correct surface vowel, either we need a glide switching rule turning [w] to [y] after [ɔ̄$_t$], or we need to complicate Diphthongization so as to produce this result directly. The suggestion that [ɔ̄y] is the surface reflex of a long high back vowel gains a modicum of support from the observation made by Fidelholtz and Browne (1971) that after this syllabic nucleus velars and labials are unusual. In this respect [ɔ̄y] resembles [āw], which is the surface reflex of the other long back high vowel in the language.

The few surface alternations in which [ɔ̄y] is involved (see (36)) do not provide strong evidence in favor of the suggestion made here (cf. Hoard (1972)).

(36) a. join—junction—juncture
destroy—destruction

b. choice—choose
voice—vocal

Neither do they argue strongly against this proposal. To obtain the short reflexes in (36a), we should have to complicate the laxing rule so that it would unround [ū] at the same time as shortening it. This phenomenon may be even a bit more general, extending also to [−low, +back]. To obtain the examples in (36b), we would only need to make the vowels [+high] in the nouns. Neither of these two extensions of the word-formation component appears particularly implausible. Because of the scarcity of examples, however, it is impossible to feel especially confident on this point.[4]

[4] The idea that such vowel alternations as those in *resume – resumption* are to be handled by assuming as underlying an unrounded back mid vowel was proposed by Paul Kiparsky in his phonology lectures at MIT in the fall term of 1975.

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