Topics in Phonological Theory

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The Problem of the Abstractness of Underlying Representations

Assuming that phonological alternations are (in some cases, at least) appropriately characterized by postulating a single underlying representation (henceforth UR) from which each phonetic representation (henceforth PR) of that morpheme can be predicted by rule, the following fundamental question naturally arises: How direct is the relationship between an UR and a PR derived from it? In other words, to what extent may these two representations differ from one another?

It is widely accepted that URs utilize the same categorization of speech sounds as PRs: That is, morphemes are stored in the lexicon in terms of the same phonetic parameters (features) as appear in characterizations of their phonetic structure. This results in a fairly direct relationship between an underlying form and its surface form: in both cases the units making up the representations are viewed as a collection of specifications with respect to a certain set of phonetic features. Furthermore, generative phonologists generally assume that the UR of a morpheme is also the PR of that morpheme, if no rule applies to modify the UR. Theoretically, then, it is possible for a UR to be identical to a PR derived from it.

However, an examination of the work of generative phonologists reveals that in most, if not all, instances a UR and its PR are not identical. This lack of identity is the consequence of two essential factors. First, there is considerable redundancy in the sounds of a language; not all of the phonetic properties of

a PR are independently selected, and as a consequence those properties that are not independently selected can be viewed as rule-governed and thus not to be included in lexical representations (such representations being regarded as the repository of what is idiosyncratic and unpredictable about the phonological behavior of a morpheme). Second, sounds are very often affected by the contexts in which they are placed; since morphemes can occur in different contexts, they are often required to modify their basic shape.

Since a UR and a PR derived from it are generally not identical, we return to the question: To what extent may they diverge? This question is basically the same as that posed by Paul Kiparsky in his paper "How Abstract is Phonology?" (1968). It is a fundamental question, and one that we cannot answer as yet. Before examining the question in detail, however, some preliminary remarks about what counts as "evidence" for a given phonological analysis are required.

Given a body of linguistic data, we wish to discover which analysis (or set of analyses, should it happen that different speakers arrive at different analyses of the same data) out of all the logically possible analyses best represents the internalized knowledge of native speakers of the language. The most direct means of establishing that a certain analysis is correct for a given speaker of the language is to show that the behavior of this speaker cannot be accounted for in a plausible fashion without assuming that his internalized grammar includes the basic features of the analysis in question. For instance, to establish that a particular pattern of morphophonemic alternation is the result of a rule rather than simply a matter of memorization on the speaker's part, we would look for evidence that the speaker goes beyond the data that he has actually encountered (and thus could have memorized) to apply the rule in situations that the speaker has not previously encountered. We will refer to such behavioral data as "external" evidence.

Various kinds of external evidence have been adduced in recent years to support particular analyses of a speaker's knowledge of the pronunciation of his language: (1) the combination of familiar elements in novel (not previously encountered by the speaker) word-forms, where the pronunciation of the entire combination cannot be explained simply in terms of the speaker's memorization of the pronunciation of the elements themselves; (2) slips of the tongue, where the resulting pronunciation cannot be explained simply as a rearrangement of elements in the intended pronunciation; (3) the phenomenon of a "foreign accent," where a speaker extends a rule of his own language to the pronunciation of another language that he is attempting to speak; (4) language games (usually involving the transposition of syllables, the insertion of sounds, the deletion of sounds, etc.), where pronunciations in the "secret language" cannot always be explained entirely in terms of a manipulation of the overt phonological shape of words in the ordinary language; (5) language change—in particular, cases where sense can be made out of a historical change of x to y only if one assumes that speakers assigned a particular interpretation (analysis) to x and

to the system of which x was a part. (Some examples of the use of external evidence will be provided later in this chapter.)

Unfortunately, when we examine a particular phonological problem in a particular language, it is often the case that the external evidence available does not serve to establish the exact character of the analysis that speakers have internalized. For example, there may be external evidence that a certain alternation in the pronunciation of morphemes is rule-governed, but no external evidence that points to the exact form of the rule or the underlying representations on which the rule operates. Relevant external evidence is often difficult, if not impossible, to find. Under these circumstances it is natural that linguists would like to have recourse to other types of evidence to support their analyses of linguistic data. More specifically, they would like to be able to determine from the linguistic data itself the appropriate analysis. This is not an unreasonable goal. After all, language learners must arrive at an analysis based on an examination of a body of data alone. The language learner does not appeal to the kinds of external evidence cited earlier. He examines the data he is exposed to and uses certain principles (the nature of which we must discover) to arrive at an analysis. If we can learn what general principles the language learner utilizes in his grammar construction, then we can make use of these same principles in choosing an appropriate linguistic description. Let us refer to these principles as "internal" evidence.

In order to determine the principles speakers utilize in their grammar construction (what counts as internal evidence for speakers), obviously we must examine a certain number of examples of grammars that speakers have constructed and try to determine what considerations in the data led to the adoption of the grammars that were in fact selected. In order to know which grammars speakers have arrived at (and which ones they have rejected), we must have the relevant external evidence. There is no other evidence that we can use; we cannot use internal evidence, for our goal is to discover what in fact counts as internal evidence.

If we can amass sufficient external evidence to determine in a range of cases what sorts of analyses speakers have arrived at, then we can attempt to deduce from these examples what considerations about the data might be responsible for leading to the adoption of these grammars. The "relevant" considerations will constitute the internal evidence that speakers make use of in grammar construction. Once we have discovered the general principles that govern the choice of a grammar (and how speakers react to situations where these principles are in conflict), then we can make use of these principles (i.e., internal evidence) in deciding on an analysis in situations where external evidence is either unavailable or insufficient. If we can identify the relevant kinds of internal evidence, then we can conclude that an analysis (or set of analyses) that is supported by this evidence is correct, even in the absence of external evidence.

Although linguists have always made use of various kinds of internal evidence in justifying phonological descriptions, they have rarely attempted to justify

the use of this internal evidence by demonstrating that external evidence leads the linguist to choose analyses that are in fact precisely those that the internal evidence supports. Thus the conclusions that linguists arrive at on the basis of this internal evidence are only as strong as the internal evidence itself. The various kinds of internal evidence that linguists appeal to cannot be fully accepted until they can actually be shown to play a role in the grammar-construction of speakers.

Various types of internal evidence have been invoked in the justification of phonological descriptions, most of which revolve around such notions as "generality," "economy," and "naturalness." In fact, many such examples can be found both in this chapter and in later chapters, for we shall continue to employ many of the traditional arguments to support proposed analyses. We do this recognizing that the analyses we propose are only as well-motivated as these arguments. We follow this course of action simply because we have little choice. While there is considerable external evidence that demonstrates that many aspects of the phonetic structure of languages are rule-governed, we have exceedingly little external evidence that goes beyond this to show the precise nature of the rules and the underlying representations that the rules presuppose. In the case of most of the examples discussed in this book, we simply lack adequate external evidence and are thus forced to appeal to internal evidence, despite the fact that this evidence itself needs justification.

It seems to us that it is possible to give at least some external evidence that tentatively establishes the relevance of the traditional kinds of internal evidence. But external evidence also exists that supports the relevance of certain other principles, not traditionally used in generative phonology at least (e.g., Vennemann, 1974, attempts to use evidence from linguistic change to support the principle that speakers identify the underlying form of a morpheme with the form of the morpheme that occurs in morphologically unmarked contexts). It may well be that all of these principles have some validity. The most critical problem is to determine the relative importance of these various considerations in situations where they conflict with one another. Until the relative importance of all the types of internal evidence can be established, we are obliged to take all of them into consideration.

Let us return at this point to the question of the abstractness of underlying representations: To what extent may the UR of a morpheme diverge from its associated PRs? An answer to this question would aid us in finding an answer to the question: What is an appropriate analysis of any given set of data? And an answer to the latter would essentially be a statement about the nature of language. Thus any restriction on the "distance" between a UR and its PRs would contribute substantially to the characterization of the nature of language.

Two types of restriction on the pairing of underlying and surface representations can be distinguished: absolute restrictions (which no language may violate) and relative restrictions (which may be violated, but only "under duress"). Clearly, absolute restrictions would be more powerful: They would

simply eliminate from consideration many logically possible analyses of a set of data. Relative restrictions, on the other hand, could be violated—provided other considerations forced the violation. Relative restrictions would in a sense be just one among several kinds of relevant considerations employed by speakers in arriving at an analysis. Their relative strength (when in conflict with other kinds of evidence) would have to be determined.

In this chapter we will examine a number of possible restrictions that might be imposed on the grammars of individual languages and that would limit the extent to which the UR of a morpheme may depart from its associated PRs. In some cases these restrictions have been explicitly proposed by certain linguists; in other cases they have implicitly controlled actual linguistic analyses, without having been made explicit; in yet other cases the restrictions are simply logical possibilities that have not been explicitly stated nor implicitly accepted by anyone (to our knowledge). The degree to which the various restrictions discussed actually do limit the "distance" between a UR and its associated PRs varies greatly. From the more restrictive conditions it generally follows that for any given set of phonetic realizations of a morpheme there exists only a small class of possible underlying representations (in extreme cases, restrictive conditions reduce the class of possible underlying forms to one). The less restrictive conditions allow a larger set of possible URs.

As already noted, the most direct relationship between a UR and its PR is that of identity. The condition that would allow the least divergence between a UR and its PR would be one that says that URs and their associated PRs are in fact always identical. Let us call this the "identity condition" imposed on the relationship between underlying and surface forms. The identity condition denies the existence of the very distinction between underlying and surface representations. In so doing, it leaves unexplained the relationship between different phonetic realizations of the same morpheme. Furthermore, the identity condition claims that the lexical representation of a morpheme contains all of the phonetic detail of the surface form of the morpheme (even though these phonetic details may in fact be derivable by general rules), and thus in no way distinguishes between those phonetic details that are idosyncratic (unpredictable, hence contrastive) and those that are not (predictable, hence noncontrastive).

Therefore, we must abandon the identity condition if we can demonstrate that: (1) differences in the phonetic realization of the same morpheme in different contexts are (in some cases) rule-governed, and that the most appropriate formulation of these rules requires deriving the various surface forms from a single phonological representation; and (2) certain aspects of the pronunciation of a morpheme must be assigned by rule, rather than simply memorized as part of the lexicon (even in cases where that morpheme has but one surface phonetic realization).

Evidence that certain phonetic phenomena are rule-governed is rather easily provided, and generally comes from the productive extension of the rule to "new" forms, forms not previously encountered by the speaker and thus not

"memorized." Consider, for example, the following case from Chi-Mwi:ni, a Bantu language. Chi-Mwi:ni has both long and short vowels in its phonetic representations; furthermore, it is necessary to assume that both types of vowels occur as basic (underlying) elements in the language. Nevertheless, there are certain contexts where long vowels do not generally occur in phonetic representations. If one examines individual words in isolation, for instance, he does not find long vowels any further forward in the word than in the antepenultimate syllable. Examination of examples such as those in (1) suggests that there is a rule operative in the language that will shorten a vowel if it occurs in a preantepenultimate syllable in the word.

(1) *x-so:m-a* 'to read' *x-so:m-eɬ-a* 'to read to/for'
x-som-eɬ-an-a 'to read to one another'
ku-ba:ram-a 'to talk' *ku-baram-iɬ-a* 'to talk for'
ku-re:b-a 'to stop' *ku-re:b-eɬ-a* 'to stop for'
ku-reb-eɬ-an-a 'to stop for one another'

The roots /so:m/ 'read', /ba:ram/ 'talk', /re:b/ 'stop' all have long vowels that can not be predicted by rule. The long vowel of these roots is not maintained in all of their morphologically derived forms. In particular, the length of the root vowel is lost as soon as that vowel comes to be in preantepenultimate position as a consequence of the addition of suffixes. Given a root such as /so:m/, the length of the root vowel is maintained both in *x-so:m-a* and *x-so:m-eɬ-a*. In the first example, the root vowel is in the penultimate syllable of the word, and in the second example it is in the antepenultimate syllable. The length is lost, however, in *x-som-eɬ-an-a*, where the root vowel is in a preantepenultimate position. Given a root such as /ba:ram/, the long vowel is maintained only in *ku-ba:ram-a*, where it is in the antepenultimate syllable. The addition of another suffix induces vowel shortening, as in *ku-baram-iɬ-a*.

Not only does Chi-Mwi:ni appear to shorten vowels in preantepenultimate positions in the word, but the rule also seems to operate in certain kinds of phrases. Note the examples in (2):

(2) *chibu:ku* 'book' *chibuku ichi* 'this book'
mu:nt^{h}u 'man' *munt^{h}u iɬó* 'the man who came'
ku-vu:nḍ-a 'to break' *ku-vunḍ-a chiluti* 'to break a small stick'

The long vowel of the noun *chibu:ku* shortens when the demonstrative *ichi* follows, since the presence of the demonstrative puts the underlying long vowel in a preantepenultimate position. Similarly, the long vowel of the verb root /vu:nḍ/ 'break' shortens when *chiluti* follows; the addition of this object noun puts the root vowel in preantepenultimate position.

The fact that a speaker of Chi-Mwi:ni will shorten preantepenultimate long vowels even in phrases that he has never heard before provides evidence that the alternations cited in (2) are the consequence of a general rule, and not simply memorized. For example, even though a speaker has (presumably) never encountered the phrase meaning 'to read a small stick', he automatically assigns the phrase the pronunciation *xsoma chiluti*, with the vowel of the root /so:m/ shortened by virtue of its preantepenultimate position. This automatic extension of vowel shortening to novel forms like *xsoma chiluti* supports the argument that the occurrence of a short vowel in such cases is rule-governed.

Let us turn now to an example where the productive extension of a rule occurs in connection with a slip of the tongue. Various linguists (Sapir, 1925 represents one especially interesting example) have analyzed the velar nasal [ŋ] in English as arising from an underlying /n/ via a rule of nasal assimilation. Slips of the tongue as in the following examples (recorded in Fromkin, 1971) support the existence of such a rule: [wɪŋks ən . . .] instead of the intended *weeks and months*. In this example, the speaker has added a nasal consonant before the final consonant cluster of *weeks* in anticipation of the nasal consonant [n] in *months*, which occurs before a word-final consonant cluster. The inserted nasal, however, is pronounced [ŋ] rather than [n], showing apparently the effect of the proposed rule of nasal assimilation.

We find an additional example of the productive extension of a rule in Bakwiri (Hombert, 1973), a language of the Duala group of Bantu languages: Vowels are nasalized when they precede clusters of a nasal plus (voiced) stop, the only nasal clusters permitted in the language. This rule accounts for the vowel nasalization in examples like *kõ̃mbà* 'to take', *kõ̃ndì* 'rice', and *ẓãŋgō* 'father'. Young Bakwiri speakers play a language game that involves moving the last syllable of a word to a position before the initial syllable of the word. Thus *mɔ́ẓɔ́* 'viper' is pronounced *ẓɔ́mɔ́* in the game. This transposition of syllables, in some cases, creates a context for vowel nasalization. When the game is applied to *mbèẓà* 'young man', for example, the result is [ẓãmbè]. The fact that the final vowel of *mbèẓà* becomes nasalized when placed before the initial *mb* cluster supports the claim that Bakwiri has a RULE of vowel nasalization that applies to VNC clusters.

Although the productive extension of a rule provides the most common source of evidence that certain aspects of pronunciation are rule-governed, other types of BEHAVIORAL evidence can be given. Let us return to the analysis of [ŋ] in English. In a word such as *bank* [bæ̃ŋk], the surface [ŋ] never alternates: [ŋ] appears in every surface realization of the morpheme. What is the evidence, then, that *this* particular occurrence of [ŋ] should be derived from an underlying /n/? Why cannot underlying /ŋ/ be postulated here? (This does not, of course, preclude the possibility that *some* surface [ŋ] sounds derive from underlying /n/.) Once again, slips of the tongue can be used to support the claim that /n/ underlies the surface [ŋ] in [bæŋk]. The evidence this time is not a product of the extension of the rule of nasal assimilation to a sequence of sounds arising from the slip of the tongue (as in the case of [wɪŋks] discussed above), but rather of the occurrence of a slip of the tongue whose form can only be understood on the basis of accepting a particular underlying representation of a given word that differs from its surface form. As a case in point, consider the following slip of the tongue reported in Fromkin (1975): [bæ̃n] *will* [peyk] instead of the

intended *bank will pay*. The speaker in this example has taken the last consonant of *bank* and added it to *pay*. Note that the resulting form is [bæ̃n], with a final *n*, and not *[bæ̃ŋ]. The appearance of *n* here can be accounted for if /n/ is, in fact, the source of [ŋ] in [bæ̃ŋk]. For once the final consonant of *bank* is transferred to *pay*, the underlying /n/ is no longer in a context to undergo nasal assimilation.

Language games can, in some cases, provide similar evidence that a certain aspect of pronunciation should be derived by rule rather than be attributed to the underlying representation of a morpheme. For instance, Sherzer (1970) suggests that the word [bíriga] 'year' in Cuna, an Amerindian language, should be derived from underlying /birga/ via a vowel epenthesis rule. Part of the evidence for such an analysis comes from the observation that stress is generally predictable in the language, occurring on the penultimate syllable. [bíriga] appears to be an exception to this rule. But if the underlying representation /birga/ is accepted, then the stress can be accounted for neatly, provided that stress is assigned prior to the application of the vowel epenthesis rule. Sherzer provides behavioral evidence in support of this analysis. He notes that the Cuna Indians play a language game that involves moving the first syllable of a word to the end of the word. For example, the Cuna word [argan] 'hand' is pronounced [ganar] in the game. When Cuna speakers use [bíriga] in the game, they say [gabir] and not* [rigabi]. The form [gabir] is explicable if the underlying representation of 'year' is /birga/. We need only assume that it is at the underlying level, rather than at the surface, that Cuna speakers rearrange the syllables of a word when playing the game. If /biriga/ were the underlying representation of 'year', there would be no explanation of how moving the first syllable to the end could lead to [gabir].

In the preceding paragraphs we have briefly sketched several examples where various kinds of behavioral evidence (i.e., speech forms produced by speakers where the forms in question were not simply memorized, but rather involved some extension of the speaker's knowledge of his language) support the claim that some aspects of pronunciation are determined by rule, and that underlying representations distinct from surface forms need to be postulated. On the basis of such evidence, we reject the identity condition on the relationship between underlying and surface representations.

Let us consider now a somewhat weaker condition that may apply to underlying and surface representations.

(A) *The UR of a morpheme consists of all and only the invariant phonetic properties of that morpheme's various PRs.*

While (A) is not fully precise as stated, it will be sufficient for our purposes. (A) claims that by comparing the various phonetic realizations of a morpheme, its UR can be determined by eliminating those phonetic properties that do not occur in all the phonetic forms. In particular, only those segments that occur in all the forms of a morpheme belong in the UR, and only those phonetic properties of a segment that are constant in all the phonetic realizations of that

segment will be included in the UR. The UR is what is invariant in the various pronunciations of the morpheme. Notice that if this constraint on the shape of URs were valid, the UR of a morpheme would stand in a very direct relationship with its various phonetic shapes: the UR would be a subset of the phonetic properties of each of the associated PRs.

Principle (A) is an extremely restrictive constraint imposed on grammars. If one assumes that (A) can be stated more precisely, offering a unique answer to the question, "What are the invariant phonetic properties of any given set of phonetic realizations of a morpheme?", then the application of (A) automatically yields a single possible UR for any given set of PRs. A's restrictiveness lies in its requirement that the UR consist of *all* invariant properties (thus disallowing the omission of one or more invariant phonetic features) and *only* invariant properties (thus disallowing the assignment of some variant properties to the UR, as well as disallowing the assignment of properties that do not occur in any of the PRs to the UR).

An examination of the following data from the Yawelmani dialect of Yokuts, an Amerindian language spoken in California (Newman, 1944) presents an example of the application of (A).

(3)

ʔilk-al	'might sing'	*ʔilik-hin*	'sings'
logw-ol	'might pulverize'	*logiw-hin*	'pulverizes'
ʔugn-al	'might drink'	*ʔugun-hun*	'drinks'
paʔṭ-al	'might fight'	*paʔiṭ-hin*	'might fight'

The preceding data illustrate a very general pattern in Yawelmani, whereby verb roots that have the shape CVCC- before vowel-initial suffixes assume the shape CVC*i*C- before consonant-initial suffixes (the *i* vowel in the latter will be realized as *u* if the preceding vowel is a high back rounded vowel, by virtue of a very important rule of vowel harmony operative in the language). By assuming that the URs of 'sing', 'pulverize', 'drink', and 'fight' are /ʔilk/, /logw/, /ʔugn/, and /paʔṭ/, respectively, the disyllabic forms of these morphemes can be readily accounted for by postulating a phonological rule that inserts *i* in the environment C____CC. Such an analysis can be motivated on the grounds that (a) there are no cases of CCC clusters in the language, thus the proposed rule can be viewed as one that transforms underlying representations containing "unpronouncable" combinations of sounds into acceptable surface forms; and (b) there are no verb roots of the shape $CV_1CV_2(C)$-, where V_1 and V_2 are not identical; if the *i* in a form such as *paʔiṭ-hin* were underlying, then we would have to allow underlying disyllabic verbs with nonidentical vowels—but then all such verbs would have *i* as their second vowel.

(A) would require that the second vowel of *ʔilik-*, *logiw-*, etc., be omitted from the URs of these morphemes, since this vowel is not invariant in all of the phonetic realizations of these morphemes (being absent in the alternants *ʔilk-*, *logw-*, etc). (A) thus requires these verbs to have the structure CVCC- in their underlying representations; the vowel that occurs in the CVCi/uC- alternant

would have to be assigned by rule. Since this is just the sort of analysis that can be argued to be appropriate for the Yawelmani data, condition (A) in this case would require the URs of these morphemes to be just the ones that we have posited.

Although in certain cases (A) will predict the underlying form that appears to be correct on the basis of internal and/or external evidence, (A) has many weaknesses. Perhaps the most obvious one is that (A) requires all invariant properties to be assigned to the UR. There are, however, many instances where nonidiosyncratic (rule-governed) properties of the pronunciations of a single morpheme happen to be invariant as well. (A) would require these rule-governed features to be incorporated into underlying structure.

Recall, for example, vowel nasalization in Bakwiri. A vowel in this language is nasalized if it precedes a cluster of nasal plus (voiced) stop. In a morpheme such as *kõmbà* 'to take care', the first vowel of the root is nasalized in all of the pronunciations of the morpheme since it is always followed by an NC sequence. Condition (A) requires that this nasalization be included in the UR of *kõmbà*. But when the final syllable of the word moves to the beginning in the linguistic game, the pronunciation *mbákò* results. Note that the *o* is oral in this form. This can be explained if we assume that the UR of this morpheme is /kombà/ with an oral vowel and that the speech disguise rule applies to the UR before the nasalization is assigned. Such an analysis is prohibited by (A), however. Consequently, it appears that (A) is too strong.

Russian provides a second example demonstrating that (A) is too restrictive a condition. In Russian the two mid-vowels ɛ and *e* both appear in phonetic representations, but do not contrast. *e* occurs before palatalized consonants, while ɛ appears elsewhere (before nonpalatalized consonants and word finally). Furthermore, the language has a pervasive rule palatalizing consonants before front vowels, giving rise to alternations like the following.

(4)

l'ɛs	'forest'	*o-l'es'-ɛ*	'about the forest'
m'ɛst-o	'place'	*o-m'es't'-ɛ*	'about the place'
b'ɛl-yj	'white'	*b'el'-it'*	'to whiten'

The proper analysis of these data posits ɛ as underlying, since its associated rule is phonetically more plausible than the rule that would be required if *e* were underlying; in addition, underlying ɛ would parallel the open quality of *o* [ɔ], the other mid-vowel phoneme of Russian. The *e* variant is generated by a rule that raises ɛ before palatalized consonants, which are articulated by raising the body of the tongue to the hard palate.

(5) $$\varepsilon \longrightarrow e / \_\_ C'$$

There are, however, many morphemes whose final consonant is always palatalized, showing that the opposition between C and C′ is contrastive in Russian. If a front mid-vowel precedes this consonant, then it is articulated as *e* in all occurrences of the morpheme. Some examples follow.

(6)

t'ep'er'	'now'	*z'd'es'*	'here'
ol'en'	'deer'	*o-ol'en'-ɛ*	'about the deer'
z'v'er'	'beast'	*o-z'v'er'-ɛ*	'about the beast'

Principle (A), if accepted as a condition on grammars, would require us to assign to these morphemes an underlying *e* root vowel, despite the fact that its occurrence is completely predictable in terms of the rule we have formulated as (5). Linguists who have analyzed Russian have considered the *e* in these words to be a phonetic variant of the underlying /ɛ/ phoneme and have consequently adopted an analysis that violates (A).

These counterexamples to (A) might be circumvented by modifying the principle as follows:

(A′) *The UR of a morpheme consists of only (but not necessarily all) invariant phonetic properties of the phonetic realizations of the morpheme; invariant properties of morphemes that are predictable by rule may be omitted.*

(A′) has severe difficulties, however. Note the following data from Yawelmani.

(7)

ʔaml-al	'might help'	*ʔa:mil-hin*	'helps'
moyn-ol	'might become tired'	*mo:yin-hin*	'becomes tired'
ṣalk'-al	'might wake up'	*ṣa:lik'-hin*	'wakes up'

These examples appear to contain instances of the rule of vowel insertion (epenthesis) discussed earlier, whereby the vowel *i* is inserted in the environment C____CC. If this rule is to be invoked to account for the $\emptyset \sim i$ alternations in (7), then the verb roots meaning 'help', 'become tired', and 'wake up' must have the underlying shape CVCC-.

In addition to the $\emptyset \sim i$ alternation, a vowel-length alternation can also be observed in this data. The root vowel is short when followed by a consonant cluster, but long when the epenthetic *i* vowel separates the members of the consonant cluster. There is considerable evidence that Yawelmani contains a rule of vowel shortening that shortens long vowels that occur in the context

$$\_\_C\begin{Bmatrix}\#\\C\end{Bmatrix}.$$

The data in (8) illustrate the application of this rule.

(8)

ṣa:p-al	'might burn'	*ṣap-hin*	'burns'
do:s-ol	'might report'	*dos-hin*	'reports'
me:k'-en	'will swallow'	*mek'-k'a*	'swallow!'
c'o:m-ut	'was destroyed'	*c'om-k'a*	'destroy!'

If the verb root 'burn' is taken to be underlying /ṣa:p/, the proposed rule of vowel shortening will correctly predict that the root vowel will appear in a

shortened form when a consonant-initial suffix is added. A rule that shortens vowels in the environment

$$\_\_C\begin{Bmatrix}\#\\C\end{Bmatrix}$$

is consistent with the observation that the sequences V:C# and V:CC generally do not occur in Yawelmani surface forms. If, on the other hand, the underlying form of the verb root 'burn' is /ṣap/, then we have to postulate a rule that would lengthen the root vowel when a vowel-initial suffix is added. Numerous examples in the language contradict such a rule.

(9)

xat-al	'might eat'	*xat-xa*	'let's eat'
xil-en	'will tangle'	*xil-hin*	'tangles'
bok'-en	'will find'	*bok'-xo*	'let's find'
hud-al	'might recognize'	*hud-mu*	'having recognized'

Accepting, then, that Yawelmani has a rule of vowel shortening, this rule would seem to be responsible for the vowel-length alternation observed in examples like *ʔaml-al*/ *ʔa:mil-hin*. In order to invoke the rule of vowel shortening to explain the data in (7), the roots must have the underlying shape CV:CC-. The derivation of *ʔaml-al* and *ʔa:mil-hin* would then be as follows:

(10)

/ʔa:ml-al/	/ʔa:ml-hin/	
inapplicable	*ʔa:mil-hin*	vowel insertion
ʔaml-al	inapplicable	vowel shortening

Notice that vowel insertion is crucially ordered to apply before vowel shortening in this analysis. If vowel shortening were to apply first, /ʔa:ml-hin/ would be incorrectly changed to **ʔaml-hin*; then vowel insertion would apply yielding **ʔamil-hin*.

Therefore, the underlying form of the roots in (7) must be CV:CC- rather than CVCC- for two reasons. First, if CVCC- represented the basic form of these roots, then the long vowel in the CV:CiC- variant would have to be derived by a rule of vowel lengthening and could not be explained in terms of an independently motivated rule. As we have seen, an underlying CV:CC- structure accounts for the vowel length alternation between the variants CVCC- and CV:CiC- in terms of the rule of vowel shortening, which is needed in the grammar in any case. Secondly, if CVCC- were taken as the underlying structure, any rule that would be postulated to derive the long vowel in the CV:CiC- variant would be contradicted by data such as the following:

(11)

ʔilk-al	'might sing'	*ʔilik-hin*	'sings'
pa'ṭ-al	'might fight'	*pa'iṭ-hin*	'fights'
logw-ol	'might pulverize'	*logiw-hin*	'pulverizes'

If/moyn-hin/results in *mo:yin-hin*, why doesn't/logw-hin/result in **lo:giw-hin*? There is no ready explanation. On the other hand, if the underlying form of

'become tired' is /mo:yn/ and that of 'pulverize' is /logw/, the difference between these two roots is easily explained by means of our vowel insertion and vowel shortening rules.

In summary, the available language-internal evidence points in the direction of postulating URs in the form of /ʔa:ml/, /mo:yn/, and /ṣa:lk'/ for the verbs in (7), which allow the alternations observed in the data to be subsumed under two independently motivated phonological rules. Any other analysis will require an additional rule or rules to account for these examples.

Now, consider what condition (A′) says about the Yawelmani data. The initial vowel in such PRs as *ʔaml-* and *ʔa:mil-* is neither invariably short nor invariably long. Since (A′) requires that only invariant phonetic properties be included in the UR of a morpheme, the UR of 'help' cannot be /ʔa:ml/—since vowel length is not present in all the surface forms of this root. Neither can the UR be /ʔaml/, where *a* stands for a *short* vowel—since the vowel of this root is not short in all its surface occurrences. The only representation permitted by (A′) is /ʔAml/, where A stands for a vowel that is not specified as either long or short.

Given the UR /ʔAml/, a rule will be required that will render this vowel long in an example like *ʔa:mil-hin*. But the rule that would accomplish this would have to *fail* to lengthen the first vowel of *pa'iṭ-hin*. If this is to be done, the vowel-lengthening rule must somehow apply only to vowels that are unspecified in UR for length. In other words, the analysis required by (A′) would involve a crucial contrast between an underlying short vowel (as in /pa't/) and a vowel unspecified for length (as in /ʔAml/). The required rule of vowel lengthening would apply to unspecified vowels, but not to short vowels.

The analysis required by (A′) thus substitutes a contrast between unspecified and short vowels for the long/short contrast involved in the analysis that posits CV:CC- roots underlyingly in (7) and CVCC- roots underlyingly in (11). What is the basis for choosing between these two approaches?

The analysis required by (A′) strikes us as objectionable. It claims, essentially, that phonological rules discriminate between segments that are 'unspecified' for some phonetic property and segments that are 'specified'. If this were in fact true, for any given phonetic property (vowel length, for instance), one would expect to find three distinct patterns of behavior: the pattern exhibited by those sounds that are positively specified for the relevant property in UR, the pattern exhibited by those sounds that are negatively specified, and finally the pattern exhibited by those sounds that are unspecified. This does not appear to be the case. In general, one finds only TWO patterns of behavior: in the present example, that of *ʔa:mil-hin* /*ʔaml-al* and that of *pa'iṭ-hin*/ *pa'ṭ-al*.

Postulating a contrast between A/*a* rather than between *a:*/*a* represents a case where a nonphonetic contrast (unspecified versus specified) is substituted for a phonetic contrast (long versus short), but without any justification from the phonetic reality per se.

The situation for (A′) becomes even more complex if we consider the following data from Pengo (Burrow 1970). (In the following transcriptions, *j* stands for a voiced palatal affricate.)

(12)

(2nd) singular imperative	(3rd) singular past	gerund	gloss
tu:b-a	*tu:p-t-an*	*tu:b-ji*	'blow'
tog-a	*tok-t-an*	*tog-ji*	'step on'
ŋa:k-a	*ŋa:k-t-an*	*ŋa:g-ji*	'offer worship'
hi:p-a	*hi:p-t-an*	*hi:b-ji*	'sweep'

The root 'blow' appears in two shapes, *tu:b-* and *tu:p-*. (A′) requires that the voicing of the final consonant not be indicated in the underlying form, since voicing is variable for this segment. The root 'sweep' also appears in two forms, *hi:p-* and *hi:b-*. Likewise, (A′) requires that the voicing of the final consonant of this root also be unspecified in the UR. Thus, we will have underlying representations for 'blow' and 'sweep' where both morphemes end in a labial stop unspecified for voicing. The proper value for voicing of these stops in preobstruent position will be given by a general rule of voicing assimilation. Observe, however, that a rule assigning voice to the final segment of 'blow' but voicelessness to the final segment of 'sweep' will be required when these morphemes appear in prevocalic position. But there is no way of predicting from the underlying form of these roots which one will end in a voiced consonant and which one in a voiceless one. If we maintain (A′), then we must claim that the differential behavior of 'blow' and 'sweep' with respect to the voicing or lack of voicing of the root-final consonant is not attributable to the phonetic makeup of these roots. Since it is likewise impossible to find a grammatical basis for this differential behavior, we must consider the difference to be a matter of an arbitrary, nonphonetic property. It would be necessary to divide the lexicon into two types of consonant-final roots: One type will be assigned the feature VOICE before a vowel-initial root suffix, the other will be assigned the feature VOICELESS.

A theory of phonology not adhering to (A′) would characterize the differential behavior of 'blow' and 'sweep' by claiming that the former is underlying /tu:b-/ and the latter /hi:p-/. The voicing-assimilation rule needed for any analysis of these examples requires both roots to end in a voiceless consonant when followed by *-t-* and a voiced consonant when followed by *-ji*. The fact that /tu:b-/ ends in [b] and /hi:p-/ ends in a [p] before a vowel would not derive from a rule, but from the underlying character of the root-final consonant.

(A′) thus requires an arbitrary, nonphonetic contrast to distinguish 'blow' and 'sweep', whereas the alternative view posits a contrast between underlying voiced and voiceless consonants. Notice that although one function of (A′) is to require a very direct relationship between a UR and its associated PRs,

in this case it requires that the contrast *tu:**b**-a*/*hi:**p**-a* be accounted for by a totally arbitrary division of the lexicon, even though the surface phonetic contrast is in fact one of voicing. Principle (A′) requires that a surface phonetic contrast be replaced by a nonphonetic contrast with no independent justification, thus leading to considerable abstractness.

We can adduce some other considerations against the analysis resulting from (A′). Note the following data from Pengo.

(13)

pa:g-a	'strike!'	*ba:g*	'luck'
pez-a	'lift!'	*besa*	'instrument for leveling ground'
ku:k-a	'call!'	*gu:h-a*	'swallow!'

While /pa:g-/ has an initial voiceless consonant in all of its manifestations, /ba:g-/ has an invariant voiced consonant in root-initial position. Such data could be handled within the framework of (A′) by assuming an underlying contrast between voiceless /p/ in *pa:g-a* and voiced /b/ in *ba:g*. But this would involve claiming that voicing is relevant in root-initial, but not in root-final position. However, we would have a rule that introduces a voicing contrast in root-final position, where the rule in question would be triggered by an arbitrary division of the lexicon into roots requiring voicing and roots requiring voicelessness. Clearly, such a rule is merely a roundabout way of introducing a voicing contrast in root-final position that is precisely parallel to the voicing contrast found in underlying root-initial position. In fact, if one were to adopt such an analysis, a logical extension of it would be to claim that both *pa:g-a* and *ba:g* begin with an underlying /P/, a labial stop unspecified for voicing. A rule is needed in any case to specify the /P/ of /tu:P-/ as voiced and the /P/ of /hi:P-/ as voiceless in prevocalic position. Why not let the same rules account for the difference in voicing in the initial consonants of *pa:g-a* and *ba:g*? All that would be required would be to divide the lexicon into two kinds of root-initial consonants, one type undergoing voicing prevocalically, and the other not.

In other words, if we were to follow the logic of (A′) all phonetic properties could be eliminated from the underlying form and we could depend solely upon a nonphonetic system of classifying the phonetic behavior of morphemes. Thus, the condition (A′), while superficially requiring a direct relationship between underlying and phonetic representations, would in fact permit totally abstract underlying forms (a network of nonphonetic subcategorizations) just in order to account for data like those from Pengo. Most phonologists have rejected such analyses for an obvious reason. Phonetic contrast is clearly a crucial aspect of language structure: It is the device that permits utterances to be distinguished and thus makes communication possible. But an approach that leads to reanalyzing phonetic contrasts (such as roots ending in voiced versus voiceless consonants) as nonphonetic contrasts (such as roots whose final consonants are subject to a rule assigning voice prevocalically versus roots whose final consonants are subject to a rule assigning voicelessness

prevocalically) states that surface phonetic contrasts are derived from underlying nonphonetic contrasts, with no evidence at all from the sound patterning of language to justify this position.

Principle (A′) encounters more severe difficulties in an example such as the following from Tonkawa, an Amerindian language formerly spoken in Texas (Hoijer, 1933). In this language verbal roots display extensive morphophonemic alternations. The following examples are entirely typical.

(14)

A	B	C	D	gloss
notx	*ntox*	*notxo*	*ntoxo*	'hoe'
netl	*ntal*	*netle*	*ntale*	'lick'
picn	*pcen*	*picna*	*pcena*	'cut'

Although these verb roots have a constant consonantal structure (*n-t-x-*, *n-t-l-*, *p-c-n-*), their vocalic structure is highly variable. It is possible, however, to reduce this variability to general rules. Notice, for example, that in the columns labeled A and B there is no vowel in root-final position, whereas in the columns labeled C and D there is a vowel in final position. The A and B forms occur when followed by a vowel-initial suffix, while the C and D forms occur when a consonant-initial suffix follows. It would therefore be possible to account for this particular alternation by stating that the final vowel in the C and D forms belongs to the underlying structure of the verb root, and that this final vowel is deleted when a vowel follows. Furthermore, note that a vowel occurs between the first and second consonant of the verb root in the A and C forms, but no vowel occurs between the second and third consonant. In contrast, the B and D forms reveal no vowel between the first and second consonants of the verb root, but have a vowel between the second and third consonant. The A and C forms occur when the root is word-initial or preceded by a consonant-final prefix. The B and D forms occur after prefixes ending in a vowel. In other words, the alternations follow a quite regular pattern. It is important to point out, however, that while it is possible to predict when a vowel will be pronounced and when it will not be, it is *not* possible to predict *which* vowel will occur. Taking 'cut' as an example, we have no way of determining whether the vowel *e* will occur between the first and second consonant, or whether *a* will occur between the second and third consonant, or whether *a* will follow the third consonant. The choice of vowel in each position is an idiosyncratic property of the verb root.

Given URs such as /notoxo/, /netale/, and /picena/, we can readily account for alternations found in (14). In case a vowel-initial suffix follows, the last vowel of these representations would be deleted. The second vowel would be lost in the case where the root is in the environment

$$\begin{Bmatrix} C \\ \# \end{Bmatrix} \text{——},$$

and the first vowel would be lost when the root is in the environment V——.

How would (A′) handle the Tonkawa data? According to (A′), no sound may appear in the UR of a morpheme unless it appears in all the phonetic realizations of that morpheme. Consequently (A′) would not allow any vowel to occur in the URs of 'hoe', 'lick', and 'cut', since none of the vowels that occur in the PRs of these morphemes occur in all of the PRs of the morpheme. The URs would thus have to be /ntx/ for 'hoe', /ntl/ for 'lick', and /pcn/ for 'cut'. But given such URs, there are no general phonological principles that could account for the surface phonetic patterning of these morphemes. It is idiosyncratic that /ntx/ 'hoe' has the vowel /o/ between /n/ and /t/ in *notx-*, whereas /ntl/ 'lick' has the vowel /e/ in this position. There are no phonological processes to which these facts can be attributed. If underlying representations are assumed to be the repository of those phonetic properties that cannot be attributed to the application of phonological rules, then the URs of 'hoe', 'lick', and 'cut' must contain not only an indication of the consonantal structure of these morphemes, but also a specification of the vowels that intervene between these consonants. The absence of some of these vowels in the various allomorphs is predictable by general rules. (A′) does not permit this, however; it requires that the vowels be inserted on the basis of nonphonetic information that would have to be associated with each morpheme. Instead of accounting for the contrast between *notx-* and *netl-* by including /o/ between /n/ and /t/ in the UR of 'hoe', but /e/ between /n/ and /t/ in the UR of 'lick', (A′) posits the URs /ntx/ and /ntl/. A rule is then needed that would insert a vowel between the first two consonants of an unprefixed root or after a consonant-final prefix (these are the contexts in which the CVCC(V)-alternant occurs); such a rule is possible because there are no roots with an initial consonant cluster in these contexts. But the quality of the vowel inserted by the rule would have to be an idiosyncratic property of each root. Nonphonetic information would thus have to be associated with each root morpheme in order to determine the quality of the inserted vowel. Thus, once again (A′) requires replacing a phonetic contrast (/notoxo/ versus /netale/) with a nonphonetic contrast (/ntx/ plus some nonphonetic information determining that /o/ will be inserted between the initial two consonants in the appropriate circumstances, as opposed to /ntl/ plus some nonphonetic information determining that /e/ will be inserted between the first two consonants, etc.). Again we find no reason for ignoring the surface phonetic contrast (/o/ versus /e/) in favor of the nonphonetic contrast.

One direction in which one might move in attempting to relax the constraints imposed by (A′), while at the same time severely restricting the possible URs for a morpheme, is to permit variant (alternating) features such as the voicing of Pengo obstruents to occur in the UR of a morpheme, but to establish at the same time criteria that will determine which value for the alternating feature is to be included in the UR and which value is to be assigned by rule. The criteria that we are about to discuss all assume that the UR of any morpheme is identical to one of the morpheme's PRs (excluding those features of the PR that are entirely predictable and thus do not have to be included in

URs at all—e.g., aspiration in English). These criteria differ with respect to WHICH PR is identified as the basis for establishing the UR.

Let us begin by considering the condition on grammars expressed as (B).

(B) *The UR of a morpheme includes those variant (alternating) and invariant phonetic properties that are idiosyncratic (unpredictable). But it may include only those variant properties that occur in the PR that appears in isolation (or as close to isolation as the grammar of the language permits).*

A principle such as (B) seems to be implicitly assumed by many pedagogically based language descriptions, where one frequently finds the pronunciation of morphologically complex forms (the plural of a noun, for instance) described in terms of a change in the morphologically simpler form (the singular form of a noun, for instance). Two considerations seem to motivate (B). First, the UR of a morpheme is often obscured when that morpheme is conjoined to another, due to morphophonemic changes. If a morpheme can be examined in isolation, the obscuring effect can be eliminated and the underlying form revealed. Second, the unaffixed or minimally affixed form of a root often appears in a more basic semantic context (singular as opposed to plural, present tense as opposed to past, nominative as opposed to oblique cases, and so on), and there is a tendency to identify the UR of a morpheme with the alternant appearing in a more basic semantic context, perhaps on the grounds that this context is more frequent, especially during the initial stages of language learning.

(B) encounters substantial difficulties, however, because numerous phonological processes are induced by word-initial and word-final position. Consequently, an isolated form of a morpheme does not necessarily escape being affected by phonological rules and thus does not necessarily reveal the underlying form of a morpheme.

Consider the extremely well-motivated rule of word-final devoicing of obstruents in Russian. The noun roots in (15) below alternate, ending either in an unvoiced obstruent (in the nominative singular forms) or a voiced obstruent (in the dative singular and nominative plural forms).*

(15)

nominative singular	dative singular	nominative plural	gloss
xlep	*xlebu*	*xleba*	'bread'
sat	*sadu*	*sady*	'garden'
zakas	*zakazu*	*zakazy*	'order'
storoš	*storožu*	*storoža*	'guard'
rok	*rogu*	*roga*	'horn'

Given data of this type, one could either take the nom. sg. form as basic and

* These transcriptions ignore the effects of an automatic rule that changes unstressed *e* and *o* to *i* and *a*, respectively.

posit a rule that voices obstruents before vowel-initial suffixes, or take the dat. sg./nom. pl. form of the root as basic and posit a rule of final devoicing. The final devoicing approach is strongly supported by the fact that words do not end in voiced obstruents in Russian pronunciation. Furthermore, numerous examples like the following would falsify a rule that would voice obstruents before vowel-initial suffixes.

(16)

nominative singular	dative singular	nominative plural	gloss
čerep	*čerepu*	*čerepa*	'skull'
cvet	*cvetu*	*cveta*	'color'
les	*lesu*	*lesa*	'forest'
duš	*dušu*	*dušy*	'shower'
bok	*boku*	*boka*	'side'

The root-final obstruents in these examples all remain voiceless even when followed by a vowel-initial suffix. Under the final devoicing analysis, the final underlying voiceless obstruents of the roots in (16) would simply remain and not alternate. According to the analysis of Russian that posits a rule voicing obstruents before vowel-initial suffixes to account for the data in (15), all of the roots in (16) would have to be regarded as exceptions. The analysis of Russian that postulates a word-final devoicing rule clearly provides the most appropriate analysis of the data (and, of course, is the analysis that linguists have generally accepted).

Let us consider now how (B) requires us to analyze the Russian data. The noun roots in (15) have an alternating final consonant. The phonetic property involved (namely, voicing of obstruents) is not a predictable feature of Russian pronunciation (it is not possible to predict that the root final consonant of *sadu* is *d* while the root final consonant of *cvetu* is *t*). Consequently, the URs of the roots in (15) must be specified for voicing. (B) requires that the underlying value for an alternating feature must be that value that occurs in the isolated form of the morpheme. In the case of the roots in (15), that form is the nom. sg. (B) thus posits URs such as /xlep/, /sat/, /zakas/, and so on. But if these URs are accepted, the alternation in voicing observed in (15) would have to be accounted for by a rule that voices obstruents before vowel-initial suffixes. We have seen, however, that such an analysis is inconsistent with the large number of nouns like those in (16). In order to maintain (B), all such nouns would have to be marked as exceptions to the rule of voicing before vowel-initial suffixes. (B) requires replacing a perfectly straightforward phonetic contrast (roots ending in underlying voiced obstruents as opposed to roots ending in voiceless obstruents) with a nonphonetic contrast (roots that regularly undergo voicing as opposed to roots that exceptionally fail to undergo the rule).

Lardil, a language of Northern Australia provides a more extreme example of the sort of problem that (B) encounters. According to the analysis of Lardil

proposed by Hale (1971), "The object of a nonimperative verb is inflected for accusative case and, simultaneously, for tense (in agreement with the tense of the verb). The subject of a sentence and the object of an imperative verb are uninflected (as in the citation form)." Thus, a noun appears inflected in an accusative nonfuture form or in an accusative future form.*

(17)

uninflected	accusative nonfuture	accusative future	gloss
mela	*mela-n*	*mela-ṛ*	'sea'
parna	*parna-n*	*parna-ṛ*	'stone'
wanka	*wanka-n*	*wanka-ṛ*	'arm'

The above examples suggest assigning to the acc. nonfut. suffix the shape *-n* and to the acc. fut. suffix the shape *-ṛ*. The noun roots would be identical to their uninflected form.

The examples cited in (18) below involve morphophonemic alternation.

(18)

ŋuka	*ŋuku-n*	*ŋuku-ṛ*	'water'
kaṭa	*kaṭu-n*	*kaṭu-ṛ*	'child'
muṇa	*muṇu-n*	*muṇu-ṛ*	'elbow'
keṇṭe	*keṇṭi-n*	*keṇṭi-wuṛ*	'wife'
pape	*papi-n*	*papi-wuṛ*	'father's mother'
ŋiṇe	*ŋiṇi-n*	*ŋiṇi-wuṛ*	'skin'

Note that whereas *mela* 'sea' has the acc. nonfut. *mela-n*, *ŋuka* 'water' has the form *ŋuku-n*. If we were to analyze both of these roots as ending in /a/, there would be no general principles to predict that in the case of 'sea' this /a/ would remain constant, whereas in the case of the suffixed forms of 'water' it would change to /u/. If we adopt the inflected form of the root as the underlying structure, however, i.e., /mela/ versus /ŋuku/, then a rule that said that underlying /u/ is pronounced as /a/ in word-final position would predict that /ŋuku/, when uninflected, is pronounced as *ŋuka*. Such as analysis is supported on two grounds. First, there are no roots that end in /u/ both in the inflected and in the uninflected form: That is, there are no roots like *malu*, *malu-n*. The absence of such roots would be predicted by the rule changing /u/ to /a/ in final position. Second, if we analyse a root such as *pape*, *papi-n* as underlying /papi/, then its uninflected form could be accounted for by simply extending the rule that lowers /u/ to /a/, so that it also lowers /i/ to /e/.

(19) Lowering V ⟶ [-high]/___#

(We assume that subsidiary principles account for the fact that /u/ is lowered to an unrounded vowel.) (B) does not allow this analysis but instead requires that any variable phonetic property be represented in the UR as it appears in

* Lardil distinguishes four types of coronal consonants: laminal dental /th/, apico-alveolar /t/, laminal alveopalatal /tj/, and apical domal /ṭ/.

the unaffixed form of the morpheme. (B) thus chooses /ŋuka/ as the UR of 'water', merging it with /mela/. To account for the form *ŋuku-n* it would be necessary to posit a rule raising /a/ to /u/; nonphonetic information would be required in order to permit /ŋuka-n/ to undergo this raising, but not /mela-n/. Such an approach treats the absence of examples with invariant /u/, like the hypothetical *malu*, *malu-n*, as entirely fortuitous.

Consider next the following additional data.

(20)

thuŋal	*thuŋal-in*	*thuŋal-uṛ*	'tree'
kethar	*kethar-in*	*kethar-uṛ*	'river'
miyaṛ	*miyaṛ-in*	*miyaṛ-uṛ*	'spear'
ṭupalan	*ṭupalan-in*	*ṭupalan-kuṛ*	'road'
yaraman	*yaraman-in*	*yaraman-kuṛ*	'horse'

A few comments on the shape of the suffixes are required. The acc. nonfut. has the shape *-n* in (17) and (18), while it has the shape *-in* in (20). This difference is apparently a consequence of the fact that the roots in (17) and (18) are vowel-final, while in (20) there is no evidence of a vowel-final stem. If the underlying form of the suffix is /-in/, a rule deleting the initial vowel after a vowel-final stem could be formulated. Now consider the acc. fut., which has the shape *-ṛ* in (17) and in those words in (18) where the root ends in /u/. When the root ends in /i/, the acc. fut. is pronounced as *-wuṛ*. In (20) this suffix is pronounced as *-uṛ*, except after nasal-final roots, where it is realized as *-kuṛ*. If we take the UR of the suffix to be /-uṛ/, we can account for its allomorphy by inserting a *w* between root-final /i/ and this suffix, but dropping the suffix-initial /u/ after roots ending in other vowels: /papi-uṛ/⟶ *papi-wuṛ*, but /mela-uṛ/⟶ *mela-ṛ*. The examples in (20) require /k/ to be inserted between a nasal-final root and the suffix *-uṛ*. When the root ends in an oral consonant, the suffix reveals its underlying shape: /kethaṛ-uṛ/⟶ *kethaṛ-uṛ*.

The data in (21) present a new problem of analysis.

(21)

thuṛara	*thuṛaraŋ-in*	*thuṛaraŋ-kuṛ*	'shark'
peṛe	*peṛeŋ-in*	*peṛeŋ-kuṛ*	'vagina'
ŋalu	*ŋaluk-in*	*ŋaluk-uṛ*	'story'
kuṛka	*kuṛkaŋ-in*	*kuṛkaŋ-kuṛ*	'pandja'

The suffixal shapes in (21) are just what we would expect after consonant-final roots; see (20). Indeed, the roots display a consonant in the inflected forms. But the consonant that appears in the inflected forms is absent in the uninflected form. If we were to assume that the consonant in question is part of the root, thus accounting for the shapes of the following suffixes, it would be necessary to postulate a rule that deletes certain consonants in word-final position. This rule would have to convert /thuṛaraŋ/, /peṛeŋ/, /ŋaluk/, and /kuṛkaŋ/ to *thuṛara*, *peṛe*, *ŋalu*, and *kuṛka*. The rule could not be formulated so as to delete any word-final consonant, since /thuŋal/, /miyaṛ/, and /yaramin/ in (20) do not lose their consonants. Consideration of additional data reveals

that nonapical consonants delete finally, while apical consonants remain (for a systematic exception, see below). Thus, the data of (21) can be accounted for by a rule of the following form:

(22) Nonapical Deletion $\quad C \longrightarrow \emptyset / \_\_\_ \#$
[-apical]

While /ŋaluk-in/ will not be affected by any of the rules discussed, /ŋaluk/ will undergo nonapical deletion, yielding *ŋalu*. The fact that *ŋalu* ends in *u* confirms in part our analysis. Recall that there is motivation for a rule in Lardil that lowers /u/ to *a* in final position. If the root were in fact /ŋalu/, there would be no explanation for why lowering does not apply to this form. If /ŋaluk/ is the UR, however, the failure of lowering to apply can be attributed to the presence of the final /k/, which prevents lowering. That is, lowering is ordered to apply before nonapical deletion.

Our account of the data in (21) is based on positing the inflected form of the root as underlying. But if we were to accept (B), the uninflected form of the root would have to be selected as the underlying structure. This would require a rule to convert /ŋalu-in/ to *ŋaluk-in*, while converting /peṛe-in/ to *peṛeŋ-in* and at the same time permitting forms such as /mela-in/ to become *mela-n*. Nonphonetic information would thus be required to guarantee that /k/ is inserted in the case of /ŋalu-in/, but /ŋ/ in the case of /peṛe-in/. Nonphonetic information would also be needed to explain why /ŋalu/ and /peṛe/ undergo consonant insertion, while /mela/ does not.

(23) provides more relevant data.

(23)				
	yalul	*yalulu-n*	*yalulu-ṛ*	'flame'
	karikar	*karikari-n*	*karikari-wuṛ*	'butterfish'
	mayar	*mayara-n*	*mayara-ṛ*	'rainbow'
	kaŋkaṛ	*kaŋkaṛi-n*	*kaŋkaṛi-wuṛ*	'father's father'
	wiwal	*wiwala-n*	*wiwala-ṛ*	'bush mango'

The inflected forms of (23) have the shapes expected after vowel-final stems; see (17) and (18). A vowel precedes the suffix in each example: *yalulu-n*, *karikari-n*, and so on. But this vowel is not present in the uninflected form. If we consider this vowel to be part of the root, a rule is needed to convert /yalulu/, /karikari/ . . . to *yalul*, *karikar* . . . when these roots are uninflected. If we compare the examples where deletion of the vowel would occur—in (23)—with those where it would not—(17) and (18)—a crucial difference emerges: deletion occurs with roots that are trisyllabic or longer; it does not occur when the root is disyllabic. The following rule accounts for this difference.

(24) Apocope $\quad V \longrightarrow \emptyset / VC_1VC_1 \_\_\_ \#$

Note that *thuṛara* 'shark' in (21) does not become *thuṛar*. We have argued that this root is /thuṛaraŋ/, however; see *thuṛaraŋ-in*. The failure of apocope

to apply to *thuṛara* can be accounted for by simply ordering apocope before nonapical deletion. Thus, the presence of final /ŋ/ in the UR of *thuṛara* is responsible for the retention of the final *a* in this word. One final point can be made in favor of our analysis of (23): The UR of *karikar* is /karikari/, clearly a reduplicated word. The fact that it is reduplicated is obscured in the uninflected form but transparent in inflected forms.

Principle (B) requires a radically different approach to the data in (23). The URs would have to be /yalul/, /karikar/, and so on. Nonphonetic information would be required in order to specify that these roots are separated by a vowel from the following suffix, while the roots of (20) are not. Additional nonphonetic information would be needed to specify which vowel appears in the inflected forms.

Consider now the following examples, which are interesting for several reasons.

(25)				
	ṭipiṭi	*ṭipiṭipi-n*	*ṭipiṭipi-wuṛ*	'rock-cod'
	murkuni	*murkunima-n*	*murkunima-ṛ*	'nullah'
	puṭu	*puṭuka-n*	*puṭuka-ṛ*	'short'
	ŋawuŋa	*ŋawuŋawu-n*	*ŋawuŋawu-ṛ*	'termite'

In each of the examples the uninflected form is shorter by two segments than the corresponding inflected forms. The "added" syllables are *-pi*, *-ma*, *-ka*, *-wu* whose initial consonants are all nonapicals. This strongly suggests that the rule of nonapical deletion is operative here. Note furthermore that if the inflected form of the root is basic, the roots are all vowel-final and trisyllabic or longer. Thus, apocope could account for the absence of the vowel of the "added" syllables in question. All that would be required is that apocope be ordered to apply before nonapical deletion, an ordering that was suggested by *thuṛara*. The derivation of *murkuni* would be as follows.

(26)

/#murkunima#/	
———————	lowering
murkunim	apocope
murkuni	nonapical deletion

Note that lowering must be applied before nonapical deletion, otherwise /i/ would be lowered to /e/; apocope must be applied before nonapical deletion so that /murkunima/ can become /murkunim/ by the former rule and thus subject to the latter rule. Observe that *murkuni* does not undergo apocope, showing that apocope cannot reapply. The analysis of this data permits us to recognize *ṭipiṭi* and *ŋawuŋa* as reduplicated forms as well.

Once again (B) precludes this analysis, since it posits the shorter form appearing in the uninflected column as basic. Rules would be necessary to affix /pi/ to /ṭipiṭi/, /ma/ to /murkuni/, and so on. On phonological grounds

we could not predict which roots would take an additional syllable nor determine its vowel quality. Nonphonetic information would have to be specified in the UR to insure that the appropriate suffixes affix to the appropriate roots.

One additional rule of Lardil phonology needs to be mentioned. Examination of the language reveals no word-final consonant clusters.

(27) *kantukan* *kantukantu-n* *kantukantu-ṛ* 'red'

When we take an example like (27) into consideration, we find that once again the uninflected form is shorter by two segments than the inflected form. In this case the missing syllable is /tu/. Here we cannot invoke our nonapical deletion rule to account for the missing consonant, since /t/ is an apical. We could, however, appeal to a rule of cluster simplification.

(28) Cluster Simplification $C \longrightarrow \emptyset / C\_\_\#$

This rule must be assumed to apply after apocope:

(29) /#kantukantu#/

kantukant	apocope
kantukan	cluster simplification

More complicated cases arise as well.

(30)

muŋkumu	*muŋkumuŋku-n*	*muŋkumuŋku-ṛ*	'wooden ax'
tjumputju	*tjumputjumpu-n*	*tjumputjumpu-ṛ*	'dragonfly'

In (30) the uninflected form is three segments shorter than the inflected form. The "added" structure in these examples is /ŋku/ in 'wooden ax' and /mpu/ in 'dragonfly'. In both cases the first consonant of the added structure is a nonapical consonant. The absence of this consonant can be attributed to nonapical deletion, whereas the absence of the second consonant could be traced to the operation of cluster simplification. The absence of the vowel would of course be due to apocope. The derivation of *muŋkumu* is as follows.

(31) /#muŋkumuŋku#/

muŋkumuŋk	apocope
muŋkumuŋ	cluster simplification
muŋkumu	nonapical deletion

Once again (B) would require that /muŋkumu/ and /tjumputju/ be taken as the underlying representations for 'wooden ax' and 'dragonfly', respectively. Rules would then be required to expand the former to /muŋkumuŋku/ and the latter to /tjumputjumpu/ when the inflected root shapes are formed. There are no general principles that would determine that these roots add two consonants and a vowel in the formation of the inflected root shapes, whereas other roots do not: /mela/ 'sea' adds nothing; /miyaṛ/ 'spear' adds nothing; /nalu/ 'story' adds just /k/; /yalul/ 'flame' adds just /u/; /murkuni/ 'nullah' adds /ma/ (one consonant and a vowel). No general rules can be given to determine how many consonants to add and whether or not to add a vowel. Furthermore, the nature of the consonant or the vowel cannot be predicted. Thus, positing the uninflected allomorph as the underlying representation, as required by (B), means relinquishing the phonetic basis for the alternation between the uninflected and the inflected root forms, even though obvious phonetic contrasts exist when the inflected root forms are examined.

The evidence from Lardil suggests that (B) is untenable as an absolute constraint on URs. Nevertheless, there are cases in which the UR of a morpheme is identified with the form in isolation, even at the expense of rather severe descriptive complexity. For example, Hale (1971) contrasts certain data from Maori with the Lardil data discussed above. Proto-Polynesian underwent a sound change whereby the final consonant of a word was deleted, giving rise to alternations in Maori such as the following.

(32)

active	passive	gloss
hopu	*hopukia*	'catch'
aru	*arumia*	'follow'
mau	*mauria*	'carry'
awhi	*awhitia*	'embrace'

Instead of positing the allomorph in the affixed form as the underlying structure (and utilizing a rule to delete word-final consonants), present-day speakers of Maori regard the unaffixed (active) forms of the roots as underlying, requiring the division of the lexicon into a number of arbitrary lexical classes ("conjugations"): *hopu* belongs to a class that takes the *-kia* form of the passive suffix, *aru* belongs to a class that takes the *-mia* form, and so on. More than a dozen such lexical classes are required.

The evidence that Maori speakers have reinterpreted the data in (32) and assigned the consonant that appears in the passive forms to the passive suffix rather than to the verb root derives from various observations that *-tia* is developing into the REGULAR passive suffix (all other forms, such as *-kia*, *-mia*, *-ria*, etc., are regarded as irregular). The following observations support the conclusion that *-tia* is the regular passive suffix: (a) If a speaker forgets the correct passive form of a verb, he may use a form where *-tia* is added to the active verb form—and he is understood when he does this; (b) if a noun is used as a verb in spontaneous speech, this denominal verb will form its passive by adding *-tia*; (3) loan words add *-tia* in forming a passive, even if these loan words end in a consonant. (Additional arguments provided by Hale lead to the same conclusion.)

Although historically a root such as that in *awhi/awhitia* ended in a consonant, the evidence cited above suggests that speakers reanalyzed forms such as this and associated the consonant with the suffix. The result was that the passive suffix had multiple allomorphs. For some reason (as yet undetermined), the

-tia allomorph has developed into the regular form of the suffix. This analysis has resulted in numerous exceptional forms, falling into a dozen or so "conjugations."

The reanalysis of the data in (32) that appears to have taken place in Maori suggests that although (B) may not be an absolute condition on grammars, it may play a significant role nevertheless in a speaker's grammar-construction. That is, (B) may be a relative condition placed on URs—a condition that may be violated, but only if the analysis of the data demands a violation. The difficult problem of course is to discover the factors which determine whether (B) will or will not be violated.

The most frequently used form of a morpheme is generally the minimally affixed form (since lack of affixation often coincides with a more basic semantic concept). Our discussion of (B) showed, however, that such forms cannot be regarded as reliable reflections of underlying structure. There is another way though, in which frequency might play a role in deciding what underlying value should be assigned to an alternating phonetic feature. Consider (B′).

(B′) *The UR of a morpheme includes those variant and invariant phonetic properties that are idiosyncratic. But it may include only those variant properties that occur in the greatest number of "contexts".*

As formulated (B′) is imprecise. What is meant, for example, by "contexts"? This question might be answered in different ways, but for our present purposes we will simply assume that the number of contexts in which a morpheme can occur is a function of the number of different affixes that can precede or follow it (within the "word"—assuming that we are dealing with rules whose domain of application is the word itself). Consider, for example, the Russian data discussed earlier. The final consonant of the root 'bread' appears voiced in *xlebu* (dat. sg.) and *xleba* (nom. pl.), but voiceless in *xlep* (nom. sg.). The voiceless consonant occurs in just one context (when no suffix follows the noun root); the voiced consonant occurs in two contexts (when followed by the dat. sg. *-u* and by the nom. pl. *-a*). Since these examples are representative of the general situation (i.e., the voiced form of the root occurs throughout the noun declension excepting the case where no suffix follows the root), (B′) will correctly predict /xleb/ as the UR of 'bread'.

(B′) likewise leads to the most comprehensive analysis of the Lardil data. Consider the noun meaning 'nullah'. It has the shape *murkuni* when there is no suffix, but takes the shape *murkunima-* before the acc. nonfut. and acc. fut. suffixes. Since the syllable /ma/ occurs in the greater number of contexts, (B′) leads to the inclusion of these alternating sounds in the UR. This seems an accurate description of the Lardil data.

There are nevertheless many cases where the constraint on URs provided by (B′) is too strong. For example, in Russian the vowels *o* and *a* contrast phonetically only when accented. When unaccented, *o* and *a* merge into *a*. There are many nouns belonging to the so-called oxytone accentual class, in

which the stress falls on the first vowel of the suffix if there is one, but on the final vowel of the root when there is no suffix. For the entire masculine declension there are at most only two forms where the noun appears unaffixed and, hence, where a noun will be stressed on the root vowel. In all other forms the accent appears on the ending. In spite of this fact there are many examples in which the root vowel appearing under stress in the unaffixed form can be either *o* or *a*. For instance, the complete declension of *stol* 'table' and *vrak* 'enemy' is as follows.

(33)

	singular	plural	singular	plural
Nominative	*stól*	*stal-ý*	*vrák*	*vrag'-í*
Genitive	*stal-á*	*stal-óf*	*vrag-á*	*vrag-óf*
Dative	*stal-ú*	*stal-ám*	*vrag-ú*	*vrag-ám*
Accusative	*stól*	*stal-ý*	*vrag-á*	*vrag-óf*
Instrumental	*stal-óm*	*stal-ám'i*	*vrag-óm*	*vrag-ám'i*
Locative	*stal'-é*	*stal-áx*	*vrag'-é*	*vrag-áx*

Other examples include *vráč*, *vračá* 'physician'; *plášč*, *plaščá* 'cloak'; *etáš*, *etažá* 'story'; versus *kót*, *katá* 'tomcat'; *žívot*, *živatá* 'stomach'; *dvór*, *dvará* 'courtyard'. If (B′) were followed in the analysis of the data in (33), it would be necessary to posit an underlying /a/ for 'table' (since *a* occurs in more contexts than does *o*). We would also be obliged to posit underlying /a/ in 'enemy', since *a* appears in all contexts for this morpheme. Notice that once again we would be compelled to divide the lexicon into arbitrary classes in order to determine which underlying /a/'s appear as *o* when the stress falls on them, and which appear as *a*.

To cite one more example of this type, morphemes like /pek/ 'bake' and /žeg/ 'burn' in Serbo-Croatian exhibit the following patterns in the present tense.

(34)

1st singular	*peč-ē-m*	*žež-ē-m*
2nd	*peč-ē-š*	*žež-ē-š*
3rd	*peč-ē*	*žež-ē*
1st plural	*peč-ē-mo*	*žež-ē-mo*
2nd	*peč-ē-te*	*žež-ē-te*
3rd	*pek-ū*	*žeg-ū*

Here the *ē* is the thematic or stem vowel that is added to the root. It deletes by a general rule when the following person-number suffix begins with a vowel: *pek-ū* < /pek-ē-ū/, *žeg-ū* < /žeg-ē-ū/. (B′) requires us to set up the *peč-* and *žež-* alternants as underlying, since they occur most frequently. The associated rule in this analysis, however, which involves *č* and *ž* becoming *k* and *g* before *u*, is quite unnatural and furthermore would have to be limited to apply before just the /-u/ of the 3rd pl. morpheme, because *č* and *ž* freely occur before other *u* vowels in Serbo-Croatian. On the other hand, the analysis

setting up the velar stops *k* and *g* as basic involves a rule that is both phonetically natural and consistent with the general gap in Serbo-Croatian sound structure that velars do not normally appear before front vowels except in borrowed words. Finally, one needs a rule that changes velars to palatals before front vowels for many other alternations in the language. For instance, in the declension of certain nouns the vocative sg. ending is *-e*. Noun stems ending in *k* and *g* change to *č* and *ž* in the vocative: *junak*, *junač-e* 'youth'; *Bog*, *Bož-e* 'God'. (B′) requires the alternants /junak/ and /bog/ be selected as underlying forms, because they appear in the overwhelming majority of the remaining forms in the paradigms of these nouns. Thus, if we apply (B′) consistently, we find that alternations occurring in exactly the same phonetic context (palatals before *e*, velars elsewhere) must in some cases be analyzed with underlying palatals and in others with underlying velars, without any independent evidence for doing so.

It therefore appears that the surface alternant that best reveals the UR of a morpheme need not be the alternant that occurs in isolation—see the earlier discussion of (B)—nor the alternant that occurs in the most contexts—see the discussion of (B′). The next hypothetical condition on URs that we shall examine also belongs under the (B) heading in that it, too, tries to establish general criteria for identifying the underlying value for an alternating phonetic feature.

(B″) *The UR of a morpheme may include both variant and invariant phonetic properties. All of the variant properties selected to appear in the UR must occur in a single surface alternant of that morpheme, the basic alternant. The choice of the basic alternant is constrained by a principle of parallelism according to which the basic alternant for all morphemes of a given morphological class (noun, verb, particle, etc.) must occur in the same morphological context.*

This parallelism condition is weaker than (B) and (B′) in that it does not fix in advance the basic allomorph for all morphemes, but merely requires that if, for example, the basic allomorph for a particular noun root is identified as the nom. sg., then the allomorph appearing in the nom. sg. will be the basic alternant for all other nouns.

(B″) is consistent with the Lardil data discussed above. We saw that the morpheme /ŋuka/ ~ /ŋuku/ 'water' has an /a/ ~ /u/ alternation and that the alternant /ŋuku/ appearing in the inflected form offers the best underlying representation. (B″) requires that the allomorph appearing in the inflected form be chosen as basic for all noun stems in Lardil. It correctly forces us to set up the longer, nonreduced allomorph for a stem like 'nullah' /murkuni/ ~ /murkunima/, since it is the latter allomorph that appears in the inflected form.

(B″) is consequently weaker than either (B) or (B′) in that it does not predict in advance which morphological environment will yield the basic alternant of a morpheme. Nevertheless, (B″) is still an extremely strong constraint placed

on URs because it claims that the basic alternants of a given morphological class will appear in the same context. There is, however, evidence that (B″) is too strong.

Consider the following data from Pengo, some of which we looked at earlier.

(35)

2nd singular imperative	3rd singular masculine past	gloss
cupa	*cuptan*	'spit'
tu:ba	*tu:ptan*	'blow'
eca	*eccan*	'shoot'
uja	*uccan*	'suck'
ho:ka	*ho:ktan*	'wash clothes'
maga	*maktan*	'sleep'

The 2nd sg. imperative is formed by suffixing *-a* to the verb root; the past tense is formed by suffixing *-t-* to the verb root (*t* ⟶ *c* if preceded by *c* or *j*) and adding the subject marker (*-an* in the 3rd sg. masc.). The examples in (35) require positing the form of the verb root that appears in the imperative as basic; if the past-tense morpheme were basic instead, we could not account (phonologically) for the fact that /cup/ 'spit' retains a final /p/ in *cupa*, whereas /tu:p/ 'blow' converts final /p/ to /b/ in *tu:ba* (and so on for other examples). In other words, whereas obstruent-final roots may be either voiced or voiceless before the imperative suffix, they may only be voiceless before the past-tense marker *-t-*. It is possible to predict the past-tense form from the imperative form by means of a rule that devoices a voiced obstruent preceding a voiceless one, but not possible to predict the imperative form from the past by a phonologically conditioned rule. The imperative form thus represents the "position of maximal differentiation", while the past-tense represents a "neutralized position". The UR is the form that appears in the position of maximal differentiation, if there is to be a phonetic basis for a contrast such as *cuP-a* versus *tu:B-a*.

Having now constructed the argument where the imperative form of a verb root is posited as underlying, we now return to the parallelism constraint of (B″) that would require the imperative form to be basic for all verbs. With this in mind, let us examine the data in (36).

(36)

	2nd singular imperative	3rd singular masculine past	gloss
	aha	*astan*	'seize'
	gu:ha	*gu:stan*	'swallow'
	iha	*istan*	'strike'
cf.,	*tuza*	*tustan*	'wear'
	peza	*pestan*	'pick up'

There are no pairs such as **pesa/pestan* or **peha/pehtan*. In general [s] and [h] do not contrast in Pengo: [s] occurs word-finally and before voiceless consonants; [h] occurs prevocalically and before voiced consonants (though in some cases [h] will alternate optionally with [s] before voiced sonorant consonants). These examples indicate that not only are [s] and [h] in noncontrastive distribution, but that the same underlying sound unit may sometimes appear as [s] and at others as [h].

The parallelism requirement demands /ah/, /gu:h/, and /ih/ as the basic forms of 'seize', 'swallow', and 'strike'. Such URs would then require a rule like (37).

(37) $$h \longrightarrow s / \_\_\_ [-\text{voice}]$$

There are, however, considerations to suggest that /s/ rather than /h/ is the proper underlying representation, so that the URs for these morphemes would be /as/, /gu:s/, and /is/. In such an analysis the required rule would be as follows.

(38) $$s \longrightarrow h / \_\_\_ [+\text{voiced}]$$

Such URs would of course violate (B′), because the /s/ appears in the past-tense form and not in the imperative, whereas the URs of the roots in (35) appeared in the imperative and not the past-tense form.

A crucial argument for /s/ is provided by the following data.

(39)

Intransitive		Transitive		
2nd singular imperative	3rd singular masculine past	2nd singular imperative	3rd singular masculine past	gloss
laba	*laptan*	*lapa*	*laptan*	'fit into'
ruga	*ruktan*	*ruka*	*ruktan*	'hide'
maga	*maktan*	*maka*	*maktan*	'lie/lay down'
maza	*mastan*	*maha*	*mastan*	'turn'
vi:za	*vi:stan*	*vi:ha*	*vi:stan*	'finish'

In the first three of these forms the difference between the intransitive and transitive forms of the root is that the former ends in a voiced obstruent, the latter in the corresponding voiceless one. This pattern is extremely common in the language. At first glance 'turn' and 'finish' seem to violate this principle: We have *maza*, *maha* (not **masa*), and *vi:za*, *vi:ha* (not **vi:sa*). Instead of the expected /s/, we find /h/. To account for these forms it would seem that we need a second principle: Final /z/ in the intransitive form will be replaced by /h/ in the transitive form. But the additional statement is necessary only if /h/ is posited as basic from which the /s/ of *mastan*, for example, is derived. If /s/ is underlying and the imperative form of the root is derived from the past-tense form in these cases, the intransitive *maz-* and *vi:z-* will have the

expected *mas-* and *vi:s-* as their transitive variants; /mas/ and /vi:s/ will then be converted to *mah-* and *vi:h-* before a voiced sound.

A second argument for underlying /s/ originates in another voicing alternation in Pengo. Vowel-final verb roots fall into two arbitrary classes: Class A devoices the initial underlying voiced obstruent of an immediately following suffix, while class B preserves the underlying voicing.

(40)

	I	II	III	IV	V	gloss
A	*ka:-*	*ka:-t-*	*ka:-pa-*	*ka:-ka-*	*ka:-hi-*	'watch'
	ḍo-	*ḍo-t-*	*ḍo-pa-*	*ḍo-ka-*	*ḍo-hi-*	'peck'
	ta-	*ta-t-*	*ta-pa-*	*ta-ka-*	*ta-hi-*	'bring'
B	*a:-*	*a:-d-*	*a:-ba-*	*a:-ga-*	*a:-zi-*	'be'
	ki-	*ki-d-*	*ki-ba-*	*ki-ga-*	*ki-zi-*	'do'
	va:-	*va:-d-*	*va:-ba-*	*va:-ga-*	*va:-zi-*	'come'

Column I gives the basic verb root; II, the verb stem used when the object, direct or indirect, is 1st or 2nd person; III, the intensive-frequentative verb stem; IV, the "motion" stem; V is a gerund. Note that in II we find *-t-* after the A roots but *-d-* after the B roots; in III, *-pa-* after A roots and *-ba-* after B roots; *-ka-* for A in IV but *-ga-* for B. In V, however, *-hi-* is the form that occurs following A roots, rather than the expected *-si-*, given that *-zi-* occurs after the B roots. This unexpected *-hi-* can be derived by the same principle that yields *-t-*, *-pa-*, and *-ka-*, *provided* we assume the *h* to be derived from underlying /s/. That is, /zi/ is converted to /si/ in roots of type A by the same principle that converts /ba/ to /pa/; /si/ is replaced by /hi/ via the general rule that changes /s/ to /h/ before a voiced sound. If the underlying form were /h/ and /s/ derived by rule from /h/, the appearance of *-hi-* in these examples would not follow from the general principles stated earlier.

If we are to account for the various voicing alternations and the $s \sim h$ alternation illustrated in (35), (36), (39), and (40) by general, motivated rules, then the UR of a verb root cannot be limited to a particular morphological category. The voicing alternations in (35) can be accounted for only if the imperative is posited as the UR of a given root, while the $s \sim h$ alternation is most appropriately described in terms of an underlying /s/, which appears in the past-tense form of the roots in (36).

The Russian data discussed earlier also provide a counterexample to (B′). Recall that the final-devoicing alternation (*trup*, *trup-u* versus *xlep*, *xleb-u*) requires that we take the allomorph appearing before various case suffixes as underlying, since the underlying voicing opposition is neutralized in word-final position. But nouns with oxytonic stress (*stól*, *stal-ú* versus *vráč*, *vrač-ú*) require that we posit as underlying the unaffixed nominative singular forms because only in this form of the paradigm does the stress fall on the root vowel, revealing the underlying /o/ versus /a/ contrast. In unstressed position underlying /o/ merges with underlying /a/ into phonetic *a*.

Thus, (B′) cannot be accepted as an adequate constraint on underlying representations because the phonologist must select the appropriate underlying form for each morpheme considered individually and not be tied to a particular context for all morphemes of a given class. This is true for a fairly obvious reason. The underlying representation of a morpheme will appear unaltered only in some environments. There is no reason to expect that there will be a single environment in which all morphemes of a given class will be unaffected by a given morphophonemic rule.

All of the principles under the heading (B) attempt to restrict the assignment of an underlying value for alternating phonetic features. They do this by claiming that certain surface alternants of a morpheme will be accurate indicators of what the UR of the morpheme is. A somewhat different approach to the problem of constraining URs is provided by the condition on grammars expressed as (C).

(C) *The UR of a morpheme includes those variant and invariant phonetic properties that are idiosyncratic. But all of the variant properties assigned to the UR must occur together in at least one phonetic manifestation of the morpheme. This manifestation can be referred to as the* ***basic alternant****.*

(C) leaves us greater freedom to select the appropriate UR for any morpheme than the various conditions under (B) allowed. In deciding which value to assign to the underlying structure of an alternating phonetic feature, we are not limited to any particular form or forms of the morpheme nor does a decision about the UR of one morpheme commit us to a decision about any other morpheme.

Nevertheless, (C) is a strong restriction on URs and seems to have been followed by a number of linguists in the past (see McCawley, 1967). (C) claims that if there are two or more alternating phonetic features, the choice of an underlying value for one of these features will restrict the choice of an underlying value for all the other alternating features, since there must be at least one PR that directly manifests ALL the underlying values of these alternating features.

What remain as counterexamples to the (B) conditions can be accounted for by (C). For example, for the Pengo data (C) allows the form of the verb root that appears in the past tense as underlying in *gu:h-a*, *gu:s-t-an*, while the imperative may be selected as the basic alternant in the case of *tu:b-a*, *tu:p-t-an*. Similarly, the basic alternant for *xlep*, *xleb-u* in the Russian example may be the one appearing before a case suffix, while for *stól*, *stal-ú* (C) permits the unaffixed allomorph to be identified as the basic alternant.

There are, nevertheless, severe problems with (C). For instance, it accounts for the Russian data presented in the preceding pages of this chapter by positing as underlying the suffixed allomorph for noun roots manifesting the voicing alternation, while positing the unsuffixed alternant for end stressed nouns that exhibit the neutralization of the /o/ versus /a/ contrast. But there is no reason

not to expect both of these alternations to occur in the same noun root. If they do, then (C) will not permit us to posit the *maximally general* UR—the UR that can be converted into the correct surface alternants by the rules of final devoicing and unstressed /o/ ⟶ *a*. Morphemes having these properties include *pirók*, *pirag-á* 'pie', and *sapók*, *sapag-á* 'boot'. In all forms of the paradigm except for the nom. and acc. sg., the accent is on the final syllable, inducing a change of the root vowel /o/ to *a*. But in the nom. and acc. sg., where the underlying /o/ shows up phonetically, the root is unsuffixed, so that the underlying /g/ is devoiced on the surface level. Thus, if we follow (C) in constructing the UR for 'boot', we must resort to arbitrary, nonphonetic information in order to describe its phonological behavior. On the other hand, if we do not require that all of the underlying values for alternating features appear in one basic alternant, we can assign this morpheme the UR /sapog/, and the correct phonetic alternants will be generated by the independently needed rules of final devoicing and unstressed /o/ neutralization.

Similarly, the Tonkawa data discussed earlier with respect to (A′) provide insuperable difficulties for (C) as well as for all of the (B) conditions. Recall that Tonkawa verb roots such as 'hoe', 'lick', and 'cut' were argued to have the URs /notoxo/, /netale/, and /picena/ respectively. Many similar verbs exist in the language. The vowels in these verbs all alternate with ∅. Furthermore, it is a fact that there are no surface realizations where ALL three vowels of one morpheme are pronounced. There is always at least one (and sometimes two) of the vowels subject to a deletion rule, regardless of the context. Consequently, to maintain that (C) is an appropriate condition on the grammar of Tonkawa would require URs to be set up for these verb roots where at least one of the vowels is omitted. But it will be totally arbitary which vowel is omitted, and in any case nonphonetic information will be required in order to insert the omitted vowel in the PRs where it occurs.

Finally, Yawelmani verbal roots with the phonetic alternants CV:CiC- and CVCC- could not be assigned the underlying representation CV:CC-, since distinctive length only appears when *i*, which we argued to be inserted and not part of the UR, is present. Condition (C) would require setting up one of the surface alternants as the UR, with the accompanying complications discussed earlier.

The preceding examples show that (C) is too restrictive a condition, since it bars a number of (internally) motivated analyses. How might (C) be modified so as to accommodate these examples, but at the same time impose significant restrictions on URs? (D) provides a possible approach to the problem.

(D) *The UR of a morpheme includes all those variant and invariant phonetic properties that are idiosyncratic. Given a morpheme with the underlying shape* $/P/_i, /P/_j, \ldots /P/_n$, *there must be a* $[P]_j$ (*where* $[P]_j$ *is one of the phonetic realizations of* $/P/_j$) *such that* $[P]_j$ *contains all of the feature specifications of* $/P/_j$.

(D) requires that all of the underlying specifications of variant features as well as of idiosyncratic invariant features for any segment must occur together in a single phonetic realization of that segment. This condition resembles (C) except that it is narrowed in scope, applying just to the relationship between underlying segments and their phonetic reflexes, as opposed to the relationship between the entire UR of a morpheme and its associated PRs. Hence, (D) is less restrictive than (C) in that it permits one segment in the UR to be revealed in one PR and another segment in some other PR. At the same time it imposes a relatively strong limitation on URs by requiring that each segment in an UR be more or less directly manifested on the surface.

Condition (D) permits the appropriate UR for 'boot' in Russian—namely, /sapog/. The segment /o/ appears in the phonetic form *sapók*, while the /g/ appears in the phonetic form *sapag-á*. Since (D) requires only that each underlying element surface directly in one phonetic alternant and not that all of the segments be manifested in the SAME phonetic alternant, /sapog/ is an acceptable UR as far as (D) is concerned. Similarly, (D) allows the UR /picena/ for 'cut' in Tonkawa, since each of the sounds in this UR appears in at least one of the surface forms of the morpheme (though there is no surface alternant where all the sounds are pronounced).

Although (D) permits appropriate descriptions of all the language data so far discussed in this chapter, it still seems too restrictive. If (D) were accepted as an absolute condition on grammars, what appear to be well-motivated analyses would be disallowed. One such example is developed in considerable detail below.

In Yawelmani, only three long vowels occur (in general) in surface structure, whereas five short vowels occur.

(41)

Yawelmani long vowels	e:	a:	o:		
Yawelmani short vowels	i	e	a	o	u

Of the five short vowels, only four are clearly underlying sounds; the vowel *e* is a surface variant of the long vowel *e:*, arising from the rule of vowel shortening discussed earlier—see. *me:k'-al* 'might swallow', but *mek'-hin*, 'swallows'. (See the following discussion for additional information regarding the vowel /e/.)

In many languages, long and short vowels occur 'paired'; that is, for any given short vowel there is a corresponding long vowel structurally parallel to it (though not necessarily of precisely the same quality). At first glance, Yawelmani appears to have an asymmetric vowel system, since the three surface long vowels *e:*, *a:*, and *o:* do not pair neatly with the four underlying short vowels. What we propose to do here is to present a substantial amount of evidence supporting the claim that the underlying long vowel system in Yawelmani is *i:*, *a:*, *o:*, and *u:*. We will argue that surface *e:* derives from underlying *i:*, while surface *o:* has its source in two different underlying segments, *o:* and *u:*. Postulating underlying *i:* and *u:* will be shown to violate (D),

since most morphemes containing an underlying *i:* or *u:* do not have surface realizations where these segments appear in an unaltered form. An underlying *i:* may appear on the surface as *e:*, *e*, *i*, *o:*, or *o* (as the consequence of various phonological and morphological rules of the language), but generally not as *i:*. An underlying *u:* may appear on the surface as *o:*, *o*, or *u*, but generally not as *u:*. Those morphemes where underlying *i:* and *u:* never appear as such violate (D).

Let us refer to the proposed analysis of Yawelmani that postulates underlying high long vowels as the "abstract" analysis. The first set of data supporting the abstract analysis involves the phenomenon of vowel harmony, which occurs extensively in Yawelmani. Examination of verb roots and suffixes containing underlying short vowels provides considerable evidence for a rule of vowel harmony of the following form.

(42) vowel harmony

$$\begin{bmatrix} V \\ \alpha\text{high} \end{bmatrix} \longrightarrow \begin{bmatrix} +\text{round} \\ +\text{back} \end{bmatrix} \Big/ \begin{bmatrix} V \\ +\text{round} \\ \alpha\text{high} \end{bmatrix} C_0 \_\_$$

Verbally stated, this rule claims that a vowel will become rounded and back if it is preceded by a rounded vowel of the same height within the word.

Alternations such as those listed below support this rule.

(43)

nonfuture	nonfuture passive	precative	dubitative	gloss
xat-hin	*xat-it*	*xat-xa*	*xat-al*	'eat'
xil-hin	*xil-it*	*xil-xa*	*xil-al*	'tangle'
bok'-hin	*bok'-it*	*bok'-xo*	*bok'-ol*	'find'
dub-hun	*dub-ut*	*dub-xa*	*dub-al*	'lead by hand'
max-hin	*max-it*	*max-xa*	*max-al*	'procure'
giy'-hin	*giy'-it*	*giy'-xa*	*giy'-al*	'touch'
k'o?-hin	*k'o?-it*	*k'o?-xo*	*k'o?-ol*	'throw'
hud-hun	*hud-ut*	*hud-xa*	*hud-al*	'recognize'

With one exception, there are no nonalternating suffixes in Yawelmani. Suffixes containing a high vowel, like *-hin*/*-hun*, have the unrounded variant following the vowels *i*, *a*, or *o*, whereas the rounded variant appears after *u*. Suffixes containing a nonhigh vowel, like *-xa*/*-xo*, exhibit the unrounded variant after *i*, *a*, or *u*, whereas the rounded variant appears after *o*. These facts can be accounted for nicely if we assume that the high vowel suffixes have an underlying *i* and the low vowel suffixes have a underlying *a*, and the rule of vowel harmony rounds a vowel that is preceded by a rounded vowel of the same height. Thus *i* will harmonize with a preceding *u* while *a* will harmonize with a preceding *o*. (It should be pointed out that *e(:)* and *o(:)* in Yawelmani are phonetically [ɛ(:)] and [ɔ(:)].)

Let us consider now verb roots containing long vowels in the underlying structures. These long vowels may, of course, appear shortened on the surface as a result of vowel shortening as discussed earlier.

(44)

nonfuture	nonfuture passive	precative	dubitative	gloss
ṣap-hin	*ṣa:p-it*	*ṣap-xa*	*ṣa:p-al*	'burn'
mek'-hin	*me:k'-it*	*mek'-xa*	*me:k'-al*	'swallow'
dos-hin	*do:s-it*	*dos-xo*	*do:s-ol*	'report'
c'om-hun	*c'o:m-ut*	*c'om-xa*	*c'o:m-al*	'destroy'

These examples obviously present obstacles to our rule of vowel harmony, as formulated earlier. In particular, the root *c'o:m-* 'destroy' reveals a discrepancy when it is compared with *do:s-* 'report'. Both of these roots contain the vowel *o:* on the surface level (which is shortened to *o* when a consonant cluster follows). Vowel harmony predicts that a suffix containing the vowel *i* will not change to *u* after a nonhigh rounded vowel, while a suffix containing *a* will change to *o*. Examination of the data reveals that *do:s-* behaves as expected: We find *do:s-it* and *do:s-ol*. *c'o:m-* poses a problem. Surprisingly, an *i* vowel after this root is changed to *u*, while an *a* vowel remains unaffected: *c'o:m-ut*, but *c'o:m-al*. *do:s-* and *c'o:m-* are not isolated examples.

(45)

wo:n-ol	'might hide'	*won-hin*	'hides'
sonl-ol	'might pack on back'	*so:nil-hin*	'packs on back'
hotn-ol	'might take the scent'	*ho:tin-hin*	'takes the scent'
versus			
ṣo:g-al	'might pull out a cork'	*ṣog-hun*	'pulls out a cork'
wo?y-al	'might fall asleep'	*wo:?uy-hun*	'falls asleep'
doll-al	'might climb'	*do:lul-hun*	'climbs'

(A number of these roots have the underlying structure CV:CC- and are subject to the rule of vowel epenthesis when followed by a consonant-initial suffix. The epenthetic *i* vowel undergoes vowel harmony, supporting the hypothesis that epenthesis must precede harmony.)

It is very simple to characterize the behavior of a root like *c'o:m-*; it behaves as though it contains a *high* rounded vowel and not a non-high rounded vowel. *do:s-*, on the other hand, behaves like a root containing a nonhigh rounded vowel. This difference in behavior can be readily accounted for if surface *o:* is derived from two different underlying vowels, *u:* and *o:*. For then one would posit the UR /c'u:m/ 'destroy' but /do:s/ 'report'. Given a UR like /c'u:m/, it would be necessary to include in the grammar a rule of vowel lowering that would have the effect of lowering *u:* to *o:*. Since *u:* does not generally occur in the language, the rule of vowel lowering would not have to be restricted contextually at all. All *u:* vowels would be lowered. (Actually, we will generalize vowel lowering so that it lowers *i:* to *e:* as well as *u:* to *o:*.)

The derivation of *c'om-hun* versus *c'om-xa* is given in (46).

(46)

/c'u:m-hin/	/c'u:m-xa/	
c'u:m-hun	inapplicable	vowel harmony
c'o:m-hun	*c'o:m-xa*	vowel lowering
c'om-hun	*c'om-xa*	vowel shortening

It is crucial that vowel harmony precede vowel lowering; if lowering were to apply first, incorrect derivations would result.

(47)

/c'u:m-hin/	/c'u:m-xa/	
c'o:m-hin	*c'o:m-xa*	vowel lowering
inapplicable	*c'o:m-xo*	vowel harmony
**c'om-hin*	**c'om-xo*	vowel shortening

It is also crucial that vowel lowering precede vowel shortening; otherwise the following incorrect derivations would result.

(48)

/c'u:m-hin/	/c'u:m-xa/	
c'u:m-hun	inapplicable	vowel harmony
**c'um-hun*	**c'um-xa*	vowel shortening
inapplicable	inapplicable	vowel lowering

Vowel lowering would not apply to an intermediate representation like /c'um-hun/ or /c'um-xa/ since only long high vowels lower, not short high vowels (cf., *hud-hun* 'recognizes', not **hod-hon*).

Vowel harmony, then, furnishes a certain amount of evidence for deriving some surface *o:* vowels from underlying *u:*. Other surface *o:* vowels are derived from underlying *o:*. Vowel harmony also provides evidence for deriving surface *e:* and its variant *e* from underlying *i:*. Consider, for instance, the behavior of the future suffix in the data below.

(49)

?ayy-en	'will pole a boat'	*c'o:m-on*	'will devour'
?edl-en	'will get hungry'	*t'uyt'uy-on*	'will shoot repeatedly'
bok'-en	'will find'	*wo?y-on*	'will fall asleep'

Notice that the future suffix, which always appears in word-final position, has two surface alternants: *-en* and *-on*. This variation would certainly appear to be the consequence of the vowel harmony rule. But given that *e* is a nonhigh vowel, one would expect it to appear rounded after nonhigh rounded vowels and remain unrounded after high rounded vowels. This is not what happens, however. *bok'-en* shows that the vowel of the future suffix fails to round after a nonhigh rounded vowel. *t'uyt'uy-on* indicates that this suffix does harmonize with a high rounded vowel. The *-on* variant also occurs in examples like *c'o:m-on* and *wo?y-on*; we have already seen that these roots have an underlying *u:* (/c'u:m/ and /wu:?y/).

While the future suffix appears to exhibit a strange pattern of behavior, a simple explanation is still possible—if we admit *i:* as an underlying vowel in Yawelmani. Recall that *e* is clearly derived from the vowel *e:* in most instances

via the rule of vowel shortening (which operates in the context

$$\_\_C \left\{ \begin{matrix} \# \\ C \end{matrix} \right\}).$$

If *e:* is derived from underlying *i:*, then the underlying representation of the future suffix will be /i:n/. Given this underlying form, the surface realizations of this morpheme will follow automatically from the rules already discussed.

(50)

/bok'-i:n/	/c'u:m-i:n/	
inapplicable	*c'u:m-u:n*	vowel harmony
bok'-e:n	*c'o:m-o:n*	vowel lowering
bok'-en	*c'o:m-on*	vowel shortening

The morphophonemic behavior of the future suffix can be accounted for by independently motivated rules only if *i:* is admitted as an underlying vowel in Yawelmani.

There are a few other morphemes whose vowel harmony pattern suggests that *e:* should be derived from an underlying high vowel. Compare *moyo ʔn-e:-* 'make tired' (cf., /mo:yn/ 'be tired') with *hubu ʔṣ-o:-* 'make choose' (cf., /hubṣ/ 'choose'). Causative verbs can be constructed in Yawelmani (in some, but not all, cases) by suffixing the vowel *-e:-* to the verb root. The root itself is modified in the process, but this modification is not relevant here. The crucial point is that the causative suffix *-e:-* is subject to vowel harmony. It does not, however, harmonize after a nonhigh rounded vowel (cf., *moyo'n-e:-*), rather it harmonizes after a high rounded vowel (cf., *hubu ʔṣ-o:-*). This behavior can be readily accounted for if the causative suffix has an underlying *i:* vowel, but not otherwise.

We have shown so far that the rule of vowel harmony can account for all the alternations between unrounded and rounded vowels, but only if surface *e:* (~*e*) is derived from *i:* and some surface *o:* (~*o*) vowels derive from *u:*. Let us turn now to additional data, unrelated to vowel harmony, that support our "abstract" analysis.

The structure of verb roots in Yawelmani is highly restricted. There are two basic types: monosyllabic and disyllabic roots. Monosyllabic roots have the structure CV(:)C(C). That is, they all begin with one and only one consonant, which is followed by a vowel that may be long or short, which in turn is followed by at least one and possibly two consonants. The disyllabic roots require closer scrutiny. Examples are given in (51).

(51)

dubitative	nonfuture	gloss
p'axa:t'-al	*p'axat'-hin*	'mourn'
hiwe:t-al	*hiwet-hin*	'walk'
ʔopo:t-ol	*ʔopot-hin*	'arise from bed'
ṣudo:k'-al	*ṣudok'-hun*	'remove'
pana-l	*pana:-hin*	'arrive'
ʔile-l	*ʔile:-hin*	'fan'
hoyo-l	*hoyo:-hin*	'name'
c'uyo-l	*c'uyo:-hun*	'urinate'

All of the above roots can be analyzed as having the basic structure CVCV:(C)-. The long vowel in these roots is shortened in the context

$$\_\_C \left\{ \begin{matrix} \# \\ C \end{matrix} \right\}$$

by vowel shortening. In the case of a root like /ʔopo:t/, this shortening occurs when a consonant-initial suffix is added. In the case of a root like /hoyo:/ this shortening occurs as a consequence of another rule that elides the initial vowel of the dubitative suffix *-al* when preceded by a vowel. When the suffixal vowel is deleted in /hoyo:-al/, the final vowel of the root precedes a word-final consonant and thus shortens.

An examination of all disyllabic verb roots demonstrates that only FOUR combinations of vowels occur in such roots: (a) *CaCa:*(C)-, (b) *CiCe:*(C)-, (c) *CoCo:*(C)-, and (d) *CuCo:*(C)-. Note that the (a) and (c) patterns can be characterized very simply: The first and the second vowels have the same quality, but the first is short while the second is long. The (b) and (d) patterns do not fit this description on the surface level, but if we adopt the abstract analysis then they too can be explained by the same generalization. If *e:* derives from underlying *i:*, then the (b) pattern is really *CiCi:*(C)- at the underlying level. The two vowels do have the same quality underlyingly. Similarly, if surface *o:* comes from either basic *o:* or basic *u:*, then the (d) pattern can be set up as *CuCu:*(C)- in its underlying structure. All disyllabic roots now have the structure CV_1CV_1:(C)- at the underlying level.

This analysis of disyllabic roots is supported by the observation that roots of type (c) and (d) exhibit quite different behavior with respect to vowel harmony. The final *o:* of *CoCo:*(C)- type roots behaves like nonhigh vowels, yielding forms such as *ʔopo:t-ol* and *ʔopot-hin*, whereas the final *o:* of *CuCo:*(C)- type roots behaves like a high vowel, yielding forms such as *ṣudo:k'-al* and *ṣudok'-hun*. If *CoCo:*(C)- type roots have this same shape in their underlying structure, it follows that they will induce following nonhigh vowels only to harmonize but not affect high vowels. On the other hand, if *CuCo:*(C)- type roots are derived from underlying representations of the form *CuCu:*(C)-, it follows that they will induce following high vowels to harmonize but not affect nonhigh vowels.

The evidence provided by disyllabic roots for the "abstract" analysis is actually more persuasive than one might think. We have indicated so far that there are just four types of disyllabic verb roots in the language, and that these four types can be subsumed under one generalization if the "abstract" analysis is accepted. Furthermore, the way in which the vowel of the suffix harmonizes with the vowel of the root supports the underlying structure proposed. We can reinforce these arguments further, however, because of the intricate nature of Yawelmani morphology. Although verb roots may either be of the shape CV(:)C(C)- or CV_1CV_1:(C)- in their underlying structure, there are a variety of suffixes in the language which require a preceding root to assume a particular shape. In particular, there are some suffixes that require that all verb roots

become disyllabic. The following chart illustrates the manner in which various verb roots are altered to a disyllabic pattern.

(52)

verb root	disyllabic stem shape	gloss
giy'-	*giy'e:-*	'touch'
hud-	*hudo:-*	'recognize'
bok'-	*bok'o:-*	'find'
xat-	*xata:-*	'eat'
ṭo:k'-	*ṭok'o:-*	'strike'
c'o:m-	*c'umo:-*	'destroy'
me:k'-	*mik'e:-*	'swallow'
ʔilk-	*ʔile:k-*	'sing'
luk'l-	*luk'o:l-*	'bury'
lown-	*lowo:n-*	'attend a feast'
do:ll-	*dulo:l-*	'climb'
mo:yn-	*moyo:n-*	'get tired'

For instance, the noun-forming suffix *-iwse:l-* requires that a preceding verb root be transformed into a disyllabic stem shape. The verb *luk'l-* 'bury' thus appears in the shape *luk'o:l-* in the noun stem *luk'o:l-uwso:l-* 'cemetery (literally, place for burying one another)'. The verb root *lown-* 'attend a feast' appears in the shape *lowo:n-* in the noun stem *lowo:n-iwse:l-* 'place where they attend one another's feast'. The noun-forming suffix *-hne:l-* also requires that a preceding verb root be transformed into a disyllabic stem shape. The verb root *c'o:m-* 'destroy' (which has already been shown to behave as though it contains a high rounded vowel) assumes the disyllabic stem shape *c'umo:-* in the noun stem *c'umo-hno:l-* 'place of x's being destroyed'. The verb root *ṭo:k'-* 'strike' (which triggers the kind of harmony that one would expect from a nonhigh rounded vowel) assumes the disyllabic stem shape *ṭok'o:-* in the noun stem *ṭok'o-hne:l-* 'place that was struck'. Note that in the preceding two examples, the initial consonant cluster of *-hne:l-* induces the shortening of the final vowel of the disyllabic stem.

Let us consider now the significance of the data just introduced. First of all, it can be readily observed that the disyllabic stems in (52) once again fall into the four patterns observed earlier. Secondly, there is a systematic correlation between the vowel of the underlying verb root and the disyllabic shape that this verb root assumes. For example, all verbs that have a short *i* vowel in their underlying representation (e.g., *giy'-* 'touch' and *ʔilk-* 'sing') assume the disyllabic pattern C*i*C*e:*(C)-. Similarly, all verbs that have a short *u* vowel in their underlying representation (e.g., *hud-* 'recognize' and *luk'l-* 'bury') assume the disyllabic pattern C*u*C*o:*(C)-. Furthermore, all verb roots that have a long *o:* vowel that behaves like a high vowel with respect to vowel harmony (e.g., *c'o:m-* 'destroy' and *do:ll-* 'climb') assume the disyllabic pattern C*u*C*o:*(C)- as well. In contrast, roots that have a short *o* vowel (e.g., *bok'-* 'find' and *lown-* 'attend a feast') or a long *o:* that behaves like a nonhigh vowel with respect to

vowel harmony (e.g., *ṭo:k'-* 'strike' and *mo:yn-* 'get tired') assume the disyllabic stem pattern C*o*C*o:*(C)-.

Given the "abstract" analysis of Yawelmani proposed here the formation of the disyllabic stem in (52) from the underlying verb root is entirely straightforward. One simply takes the underlying vowel of the root and uses it in both vowel slots in the disyllabic formula CV_1CV_1:(C), maintaining at the same time the original consonantal structure. For example, the root *giy'-* will become *giy'i:-*, the root *hud-* will become *hudu:-*, and so on. The rule of vowel lowering will derive the correct surface form *diy'e:-* and *hudo:-*. Similarly, *luk'l-* will be altered to *luk'u:l-* whereas *lown-* will be altered to *lowo:n-*; vowel lowering will lower the *u:* of *luk'u:l-*, but only after vowel harmony operates. The derivation of *luk'o:l-uwso:l-* will thus be as follows.

(53) luk'l-iwsi:l-/

luk'u:l-iwsi:l-	morphological rule that produces the disyllabic stem
luk'u:l-uwsu:l-	vowel harmony
luk'o:l-uwso:l-	vowel lowering

It should be pointed out here that the fact that a root like *c'o:m-* 'destroy' adopts the disyllabic shape *c'umo:-* strongly confirms the proposal that this root has the UR /c'u:m/. For we now have two totally independent reasons for assuming this underlying representation: (1) the kind of vowel harmony that *c'o:m-* induces and (2) the disyllabic stem shape that it assumes.

The existence of suffixes that require that a preceding verb root adopt the pattern CVC(C)- provides yet more evidence for the "abstract" analysis of Yawelmani vowels. The following chart illustrates how various underlying verb roots are transformed so as to fit into the required stem shape.

(54)

verb root	CV̆C(C)- stem shape	gloss
me:k'-	*mik'*	'swallow'
do:s-	*dos-*	'report'
c'o:m-	*c'um-*	'destroy'
wa:xl-	*waxl-*	'weep'
ṣe:nṭ'-	*ṣinṭ'-*	'smell'
wo ʔy-	*wu ʔy-*	'fall asleep'
c'uyo:-	*c'uy-*	'urinate'
hoyo:-	*hoy-*	'name'
ʔile:-	*ʔil-*	'fan'

For example, the causative suffix *-a:la:-* requires that a preceding verb root adopt the CV̆C(C)- stem pattern. The root *me:k'-* 'swallow' assumes the shape *mik'-* in *mik'-a:la:-* 'make swallow'. The root *c'o:m-* 'destroy' (which would have an underlying *u:*, given the "abstract" analysis) assumes the shape *c'um-* in *c'um-a:la:-* 'make destroy', while the root *do:s-* 'report' (which would have an underlying *o:*) has the shape *dos-* in *dos-a:la:-* 'make report'. These examples

illustrate very clearly that when an underlying long vowel is shortened so as to conform to the CV̆C(C)- stem pattern, surface *e:* is shortened to *i* and surface *o:* is shortened to either *u* or *o*. There is, however, a definite pattern to the shortening of *o:*. Those surface *o:* vowels that act like high vowels with respect to vowel harmony shorten to *u*, while those surface *o:* vowels that behave like nonhigh vowels with respect to vowel harmony shorten to *o*. This pattern follows automatically from the "abstract" analysis, if it is the underlying (and not the surface) vowel that is shortened to form the CV̆C(C)- stem. Given URs like /mi:k'/, /c'u:m/, and /do:s/, the correct CV̆(C)- stems will result if we simply shorten the underlying long vowel of these roots.

If the "abstract" analysis of Yawelmani is accepted, the stem shapes that are required by various suffixes in the language can all be seen to involve a crucial shortening or lengthening of the underlying root vowel. (In some instances other changes are involved as well—vowel replacements, consonantal increments, etc.) Limitations of space require that we forego further illustration of this general point. It should be noted, however, that all of the stem forms not discussed here agree perfectly with the "abstract" analysis.

We mentioned earlier than the long vowels *i:* and *u:* do not generally occur in Yawelmani phonetic representations. One exception to this statement results from a contraction of *iw* to *i:* and of *uw* to *u:* in certain instances of these sequences (but not all). These surface *i:* and *u:* vowels are not subject to the proposed rule of vowel lowering. We could account for this fact by ordering vowel lowering *before* the contraction rule that produces *i:* from *iw* and *u:* from *uw*. There is, however, a second exception to the statement that *i:* and *u:* do not occur phonetically. Consider the following data.

(55)

verb root	causative stem	gloss
di?ṣ-	*di?i:s-e:-*	'make, repair'
?ugn-	*?ugu:n-o:-*	'drink'
be:wn-	*biwi:n-e:-*	'sew'
mo:yn-	*moyo:n-e:-*	'get tired'
p'axa:t'-	*p'axa:t'-e:-*	'mourn'

The causative stem illustrated in (55) occurs only with verb roots that possess three consonants in their underlying representation. In these cases, a short vowel appears between the first two consonants and a long vowel of the same quality appears between the second and third. The long *i:* in a form like *di?i:s-e:-* and the long *u:* in a form like *?ugu:n-o:-* do not undergo vowel lowering. Whereas long high vowels in other stem formations are subject to vowel lowering, the causative stem as exemplified must somehow avoid this rule.

Because of the existence of causative stems like *di?i:s-e:-* and *?ugu:n-o:-*, it cannot be said that the "abstract" analysis of Yawelmani involves postulating vowels that never occur in the language. Long, high vowels do occur. Nevertheless, the "abstract" analysis violates (D). An underlying form such as /c'u:m/ has various surface realizations: *c'o:m-*, *c'om-*, *c'um-*, *c'umo:-*, etc. All of the phonetic features of the underlying *u:* (namely, [+syll, +high, +long, +round]) are manifested in the various surface forms of this morpheme. But it is not the case that all of the features of *u:* are found together in a single surface reflex of this underlying segment. *u:* never occurs as a surface realization of the underlying *u:*.

Consequently, if the "abstract" analysis of Yawelmani is an appropriate one (and on the basis of internal evidence it seems to be), then (D) must be rejected, since it would disallow this analysis of Yawelmani vowels. Yawelmani is somewhat unique in terms of the AMOUNT of evidence that can be marshalled in favor of an abstract analysis that violates (D). There are, however, other cases where there is a certain amount of evidence in favor of analyses that violate this condition.

In the main dialect of Pengo examined in Burrow (1970) all obstruents occur in voiced/voiceless pairs: *b/p*, *d/t*, *z/s*, *ḍ/ṭ*, *j/c*, *g/k*. We will refer to this as dialect A. There are certain other dialects of Pengo that substitute *j* for the *z* of dialect A. Thus these dialects (call them the B dialects) lack a voiced *z* phonetically, although they retain the voiceless *s*. As will be seen below, there is evidence that B dialects have undergone a sound change whereby *z* has been replaced by *j*. The principal phonological consequence of the *z* > *j* change on the internal structure of the B dialects is that there are two morphophonemically distinct surface *j* sounds.

The discussion of Pengo earlier in this chapter noted that the language contains a rule of voicing assimilation. For example, the root *uj-*, 'suck', has the past tense stem *uc-c-* in both the A and B dialects as a consequence of this voicing assimilation process. In dialect A there is another root *noz-*, 'wash', which has the past stem *nos-t-*; in dialect B this root is *noj-*, but it also has the past stem *nos-t-*. Thus, some roots in dialect B ending in *j* devoice to *c* while others devoice to *s*. The roots that devoice to *s* are precisely the ones that are pronounced as *z* in dialect A.

Given the distinct morphophonemic behavior of the *j* of *uj-* and that of *noj-* in B dialects, we must incorporate sufficient apparatus to account for the difference between *uc-c* (clearly from *uj-t-*) and *nos-t-* (from ?) into the grammar of Pengo. We might of course mark *noj-* as distinct in that it undergoes a special *c* ⟶ *s* rule: thus, *noj-t-* would first become *noc-t-* by voice assimilation, then *nos-t-* by the special rule. Alternatively, specially marked *j*'s could be shifted to *s* directly before voiceless consonants. But in either analysis this additional rule would be limited to specially marked forms, since the *j* of *uj-* must not become *s* in the past stem.

There is an obvious alternative solution to the problem of the morphophonemic behavior of *noj-:* One could assign to it, and other roots like it, the underlying structure /noz/. All that would then be required is to posit a rule

$z \longrightarrow j$, applied after voice assimilation. We would then obtain derivations like the following.

(56)

/noz-a/	/uj-a/	/noz-t-/	/uj-t-/	
——	——	*nos-t-*	*uc-t-*	voice assimilation
noj-a	——	——	——	z ⟶ j
——	——	——	*uc-c-*	other

This analysis posits an underlying element /z/ that does not actually appear phonetically as *z*: its underlying voicing is apparent in the *noj-* alternant, its underlying continuant character in the alternant *nos-*. But there is no alternant in the B dialects where it appears phonetically both voiced and a continuant. Notice that this analysis also provides the B dialects with a symmetrical underlying system where each obstruent appears both voiced and voiceless. The imbalance in the system—the lack of a *z* phonetically—is treated simply as a phonetic gap not a phonological one.

Additional morphophonemic evidence in favor of the proposed analysis is that Pengo verb roots fall into two classes, A and B. A verbs induce a devoicing of an immediately following voiced consonant, while B verbs do not. Vowel-final roots may belong to either type. In A dialects, the gerund suffix is *-zi* for B verbs, but *-hi* < *-si* (as above) for A verbs, yielding, *a:zi* (root *a:-* 'be'), *o:-zi* (root *o:-* 'take away'), *va:-zi* (root *va:-* 'come'), but *ka:-hi* (root *ka:-* 'watch'), *ḍo-hi* (root *ḍo-* 'pick'), *ro-hi* (root *ro-* 'jump'). In B dialects, however, *-zi* has been replaced by *-ji*. If *-ji* were the underlying gerund suffix in these dialects, it would have to be converted to *-si* (>*-hi*); our independently motivated rule however, simply devoices a voiced obstruent after a type A verb. Thus, **-ci* would be the expected form of the gerund suffix after A verbs. If we posit *-zi* as the underlying form—in B as well as in A dialects—then the general devoicing of consonants after A roots will yield the correct *-si* (ultimately *-hi*). The rule $z \longrightarrow j$ will apply after this devoicing rule. The required derivations are as follows.

(57)

/a:-zi/(B root)	/ka:-zi/(A root)	
——	*ka:-si*	devoicing
a:-ji	——	z ⟶ j
——	*ka:-hi*	s ⟶ h

Another case where an analysis that violates (D) appears to be internally motivated is provided by Huamelultec Chontal, a Hokan language (Waterhouse, 1949). In this language 3rd sg. verbal forms have no overt affix marking person and number. However, stems that ordinarily begin with an alveolar consonant assume a special shape in the 3rd sg. form that begins with the corresponding alveopalatal consonant. Stems that do not have an initial alveolar have the same form in the 3rd sg. as in other verbal forms. Some examples of the alternation are as follows.

(58)

ceepa ya?	'I went'	*čeepa*	'he went'
simpa ya?	'I saw'	*šimpa*	'he saw'
ɬo?pa ya?	'I moved it'	*ɬʸo?pa*	'he moved it'
tepa ya?	'I bit it'	*tʸepa*	'he bit it'
n'apa ya?	'I bought it'	*ñ'apa*	'he bought it'
napa ya?	'I hit'	*ñapa*	'he hit'
loopa ya?	'I played'	*lʸoopa*	'he played'

These alternations can be readily accounted for by a rule that converts a stem-initial alveolar to the corresponding alveopalatal when the verb is in the 3rd sing. It is of some interest that there is a rule in Huamelultec Chontal that effects a parallel change of alveolars to alveopalatals after a high vowel or *y*. However, to our knowledge there is no independent evidence in this dialect that would warrant positing a 3rd sg. prefix containing a high vowel or *y*, which could serve to condition the observed changes. Consequently, we will assume that a morphologically conditioned rule is adequate to account for the appearance of the alveopalatal consonant in 3rd sg. forms.

Waterhouse (1949) notes an additional complication with respect to 3rd sg. verbal forms that has direct relevance to (D). Although the affricate *c* and the continuant *s* are contrastive in the speech of older speakers of the language (cf., *acala?* 'egg white' and *asalá?* 'wings'), younger speakers are gradually losing this contrast, replacing *c* by *s*. The degree to which *c* had merged with *s* at the time of Waterhouse's description varied from speaker to speaker. For some the merger was complete—*s* always occurred instead of the *c* of the older speakers. For others the merger was partial, but with *s* most likely to replace *c* in frequently used words. Despite this variation speakers consistently employed *č* in the 3rd sg. forms of verbs with initial *c* (in the speech of older people) and *š* in the 3rd sg. forms of verbs with initial *s* (in the speech of both older and younger speakers. Morphophonemically, then, the *s* of younger speakers, derived from an earlier form *c*, behaves differently from the *s* that derives from an earlier *s*. For younger speakers who have completely replaced *c* by *s* we find the following pattern of alternation of stem-initial alveolars.

(59)

other persons	3rd singular
t	tʸ
n	ñ
l	lʸ
ɬ	ɬʸ
s	č
s	š

One explanation would assume that even younger speakers who never pronounce *c* (always merging it with *s*) nevertheless maintain a *c*/*s* contrast in underlying representations; the rule that palatalizes stem-initial alveolars in 3rd sg. forms operates in terms of this underlying contrast, not in terms of

surface pronunciation. This underlying *c* would palatalize as *č*, whereas underlying *s* would palatalize as *š*. A rule would then be required that shifts *c* to *s* unconditionally (but in dialects where the merger is not complete, this rule would perhaps have to be viewed as lexically determined—only certain words would undergo it).

While this analysis is not, to our knowledge, motivated by any facts of the language other than those observed above, it does not appear unreasonable, given that speakers who merge *c* and *s* are exposed to speakers who maintain the contrast. As long as there are speakers who preserve this postulated underlying contrast as a phonetic contrast, the analysis does not seem particularly abstract. It does, however, violate (D), since underlying /c/ is (in at least some cases) realized as /s/ or as /č/, but never as /c/. The underlying features of /c/—an alveolar affricate—never occur together: The alveolar place of articulation is realized in the *s* phonetic variant, the affricate manner of articulation in the *č* phonetic variant.

This particular example of a possible counterexample to (D) is probably more typical than, say, the Yawelmani example. The evidence in favor of the postulation of /c/ in those dialects where *c* does not occur phonetically is provided essentially by a single phenomenon—the fact that some surface *s* sounds palatalize as *č* rather than *š*. This evidence seems sufficient, given that there are speakers who do pronounce *c*'s in the relevant forms. But it would seem that eventually there could be a situation where all speakers merge *c* with *s*, while preserving a contrast between *č* and *š* in the 3rd sg. forms. In this situation the evidence for the abstract *c*/*s* contrast would be limited to just one phenomenon. Is that a sufficient basis for positing an underlying contrast? This is, of course, the crucial problem that arises if it is accepted that the extent to which underlying forms may depart from surface forms is not regulated by a restriction like (D). How much evidence is necessary to warrant a representation that deviates significantly from surface forms? In supporting abstract representations we have discussed examples where the internal evidence was fairly extensive; the Huamelultec Chontal example, however, is more typical.

If we abandon (D) as unduly restrictive, in its precluding internally well-motivated analyses, we might attempt to restrict URs by another constraint.

(E) *The UR of a morpheme includes all those variant and invariant phonetic properties that are idiosyncratic. Furthermore, given a morpheme with the UR* $/P/_i, /P/_j, \ldots /P/_n$, *for all* $/P/_j$, *it must be the case that each feature value of* $/P/_j$ *occurs in a* $[P]_j$ (*though not all of the feature values are required to occur together in the same* $[P]_j$).

(E) simply requires that each underlying feature specification of a segment occur in at least one of the corresponding phonetic reflexes of that segment.

(E) is a sufficiently weak condition on underlying representations to permit internally well-motivated descriptions of a number of counterexamples to (D).

For example, a Yawelmani UR /c'u:m/ with the surface allomorphs *c'o:m-* and *c'um-* (among others) would be permitted, since the underlying sound /u:/—a long high rounded vowel—manifests all of its underlying feature values on the surface. The values [+long, +round, +syllabic] are all manifested in the *c'o:m-* alternant, while the [+high] value is realized in the *c'um-* alternant.

(E) would also permit the analysis of Pengo that posits /noz/, with surface variants *noj-* and *nos-*. The underlying /z/ is a voiced continuant; the underlying voicing is manifested in the *noj-* alternant, the underlying continuancy is manifested in the *nos-* alternant. Similarly, (E) would allow a Huamelultec Chontal UR like /ceepa/, with surface allomorphs *seepa* and *čeepa*. A voiceless alveolar affricate, /c/ manifests its alveolar place of articulation in the *seepa* alternant and its affricate character in the *čeepa* alternant.

Nevertheless, (E) is still not weak enough to account for all the analyses that can be strongly motivated on internal grounds. It was noted above that (E) permits UR like /c'u:m/ for the surface forms *c'umo:-* and *c'um-* in Yawelmani. But (E) does not allow every aspect of the abstract analysis of Yawelmani sketched in this chapter. Recall that it was suggested that the future morpheme, which has the PRs *-en* and *-on*, should be represented as /-i:n/. Such a representation would violate (E), however, since the underlying long high vowel would never be realized phonetically as either high or as long. This suffix is always a terminal suffix. Thus, if it has the underlying shape /i:n/, it will always be subject to the rule that shortens a long vowel before a consonant at the end of a word. The vowel of this suffix is never realized as high in any surface alternant, since there are no morphological processes that would affect it in such a way as to permit the underlying height of the vowel to be manifested.

Perhaps it will be useful here to review the internal evidence that supports a representation such as /i:n/. First of all, the vowel *e* is generally unambiguously derived from a long vowel in Yawelmani by means of the general vowel-shortening process; in most cases a surface *e* alternates with a surface *e:*. Consequently, *e* is not an underlying sound in the Yawelmani system, but rather a variant of /e:/, which itself is derived from /i:/ according to our interpretation presented earlier. Thus, if the vowel of *-en*/*-on* is NOT represented as an underlying long vowel, then a phonemic *e* will have to be postulated for this one morpheme, which would always occur in the environment ___C#, one of the contexts in which a vowel is shortened.

Another argument is that the suffix *-en* does not behave as though it possesses a nonhigh vowel. Its behavior is systematically different from a suffix like *-al*. Whereas *-al* rounds to *-ol* after a rounded nonhigh vowel, *-en* remains unchanged in that environment. Furthermore, whereas *-al* does not change after a high rounded vowel, *-en* changes to *-on* in that environment. These facts will follow automatically if *-en* derives from /-i:n/. The latter UR has a high vowel, which will predictably round after a high rounded vowel, but not after a nonhigh rounded vowel. Thus, if the behavior of the future suffix is to be accounted

for by independently motivated rules of the grammar, it is necessary to assume an UR /-i:n/, in direct violation of (E).

Another particularly convincing example violating (E) is provided by Efik (Welmers, 1968 and Cook, 1969). Consider the following forms.

(60)

sió	'take out'	*dùòp*	'ten'
tiɛ̃	'sit'	*kìèt*	'one'
bíà	'yam'	*níɔ́ŋ*	'become tall'
kùì	'shut out, screen'		

The problem that concerns us here is the analysis of the [i] and [u] vowels that occur prevocalically in the above examples. These vowels are very similar to the [i] and [u] vowels cited below, though somewhat shorter.

(61)

díp	'hide (trans.)'	*dúk*	'enter, use (vehicle)'
bìt	'be damp'	*búp*	'ask'
étigi	'okra'	*ótu*	'group'
dù	'be (location)'		

Prevocalic [i] and [u] cited in (60) are distinctly vocalic in nature, in contrast to the following prevocalic [y] and [w] consonants.

(62)

yàk	'let, permit'	*wàgá*	'get torn'
yìp	'steal'	*wèt*	'mark, write'
yóm	'look for, want'	*wùt*	'show'

The question that arises is whether prevocalic [i] and [u] are to be treated as vowels in their underlying representation, or are they better treated as the corresponding consonants /y/ and /w/. Depending upon how this question is answered, the examples in (60) will have the syllable structure

$$C\left\{\begin{matrix}y\\w\end{matrix}\right\}V(C)$$

or

$$C\left\{\begin{matrix}i\\u\end{matrix}\right\}V(C).$$

In either case a unique syllable structure results, since otherwise there are neither syllable-initial consonant clusters nor vowel sequences. Thus, either analysis of prevocalic [i] and [u] necessitates positing a unique underlying syllable structure, so the proper analysis of these elements cannot be decided on the basis of general considerations of permissible syllable structures. We must bring other considerations to bear on the matter.

Tonal phenomena provide some evidence suggesting that prevocalic [i] and [u] should be treated as underlying consonants. In Efik syllables that unambiguously contain a single vowel show the following tonal shapes: V́, V̀, V, V̂, V̌—high tone, low tone, mid tone, falling tone, or rising tone.

(63)

high:	*fík*	'press down',	*dé*	'sleep'
low:	*kèm*	'be equal to',	*kɔ̀ŋ*	'become high'
mid:	*káma*	'hold',	*éto*	'tree, wood'
falling:	*à-ŋâ*	'cat',	*í-kɔ̂*	'language, word'
rising:	*bě*	'go past',	*kă*	'go'

If prevocalic [i] and [u] were underlying vowels, one might expect to find the resulting two-vowel sequence to contain any sequence of the tones mentioned above. That is, one might expect [i] and [u] to have one of the five tonal shapes cited above and the following vowel to have another. But in fact the surface vowel sequences *i*V and *u*V reveal precisely the same tonal shapes that are permitted on a syllable containing a single vowel. Thus, we find only *i*V́ (equivalent to V́), *i*V̀ (equivalent to V̀), *i*V (equivalent to V), *i*V̂ (equivalent to V̂), and *i*V̌ (equivalent to V̌). Examples of all types are cited in (60).

The vowel sequences *i*V and *u*V thus have the same tonal possiblities as single vowels but these do not correspond to the range of possibilities exhibited by sequences where two vowels are involved, as in (64).

(64)

à-ŋâ	'cat'	(there is no corresponding *i*V̂)
éto	'tree, wood'	(there is no corresponding *i*V)
èka	'mother'	(there is no corresponding *i*V)

Thus, there is evidence that as far as their tonal properties are concerned, *i*V and *u*V are analogous to *V* rather than to *V . . . V*.

Negative verb forms provide more evidence that prevocalic [i] and [u] should be treated as underlying /y/ and /w/. Note the following examples, where the *ŋ-* is the 1st sg. subject pronoun prefix, *-k*V- is a past tense marker, and *-g*V is the negative morpheme.

(65)

ńŋ-ke-dí-ge mí	'I didn't come here'
ńŋ-ka-ă-ga dó	'I didn't go there'
ńŋ-ke-sé-ge fí	'I didn't look at you'
ńŋ-ko-dù-go dó	'I wasn't there'
ńŋ-kɔ-bɔ́-gɔ́ òkúk	'I didn't receive money'
ńŋ-ka-tá-ga unàm	'I didn't eat meat'
ńŋ-ka-díá-ga ùdíá	'I didn't eat (food)'

The past-tense marker shows the following regular alternation and consequently supports analyzing prevocalic [i] and [u] as underlying consonants rather than vowels.

(66)

-ke-	if following vowel is *i* or *e*
-ko-	if following vowel is *u*
-kɔ-	if following vowel is *ɔ*
-ka-	if following vowel is *a*

But notice that a root like *-díá-* takes the *-ka-* form of the past, which indicates

that phonetic [i] does not behave as a vowel with respect to this rule. But if we posit /dyá/ in the underlying structure, the principles in (66) will correctly predict the *-ka-* form of the past-tense marker.

A comparison of the data in (65) with that in (67) provides another argument.

(67)

ŋ̀-ke-ỹéne-ke ȍkúk	'I didn't have any money'
ŋ̀-ke-kémé-ke ńdinam útom ɛ̂mì	'I wasn't able to do this work'
ɛ̀ỹé í-kpɔ̀ri-ké ísɔŋ káŋa	'he hasn't swept the floor yet'

In (67) there are bisyllabic stems (*-ỹéne*, *-kémé*, *-kpɔ̀ri*). The negative marker has the shape *-k*V (the quality of the vowel being determined by the same principle as that in the past tense morpheme) in these forms, whereas after monosyllabic stems, as in (65), it has the shape *-g*V. The root *-díá* in (65) behaves like a monosyllabic stem rather than like a bisyllabic stem.

Thus, there are at least three different aspects of Efik phonological structure that independently support the position that prevocalic [i] and [u] arise from underlying /y/ and /w/. Such an analysis implies the UR /dyá/ for the morpheme 'eat', where the second segment is specified [-vocalic]. However, this /y/ is always realized phonetically as [+vocalic], in direct violation of condition (E).

Another counterexample to (E) is found in Turkish (Lees, 1961). Turkish has an underlying voicing opposition for stops:

(68)

/p/	*para*	'money'	/b/	*boru*	'pipe'
/t/	*tat*	'taste'	/d/	*dip*	'bottom'
/č/	*čilek*	'strawberry'	/ǰ/	*ǰezir*	'root'
/k/	*kuš*	'bird'	/g/	*göz*	'eye'

As the following examples show, this opposition is neutralized in preconsonantal and final positions.

(69)

absolute	plural	objective	gloss
ip	*ip-ler*	*ip-i*	'rope'
dip	*dip-ler*	*dib-i*	'bottom'
at	*at-lar*	*at-ı*	'horse'
at	*at-lar*	*ad-ı*	'name'
sač	*sač-lar*	*sač-ı*	'hair'
ač	*ač-lar*	*aǰ-ı*	'tree'
kök	*kök-ler*	*kök-ü*	'root'
ek	*ek-ler*	*ek-i*	'joint'
gök	*gök-ler*	*gö-ü*	'heaven'
čilek	*čilek-ler*	*čile-i.*	'strawberry'

The last four items are the ones of interest to us here. The roots for 'root' and 'joint' are clearly /kök/ and /ek/. But for 'heaven' and 'strawberry' we need to posit a root-final consonant that will appear phonetically as [k] in preconsonantal and final positions, but as ϕ before a vowel-initial suffix. This consonant

cannot be /k/, if we are to distinguish the morphophonemic behavior of 'heaven' and 'strawberry' from that of 'root' and 'joint'. Examination of Turkish phonetics reveals that *g* does not occur intervocalically, despite the fact that in initial position it freely contrasts with /k/, as we have seen. This clearly suggests that we posit /g/ as the final consonant in 'heaven' and 'strawberry'; in this manner not only may these words be distinguished from 'root' and 'joint', but the absence of *g* intervocalically represents an imbalance on the phonetic level rather than one on the underlying level. That is, in UR /g/ has the same distribution as each of the other stops.

Thus, the internal evidence from Turkish suggests that the URs for 'heaven' and 'strawberry' are /gög/ and /čileg/ and that there is a rule deleting *g* in intervocalic position. However, this analysis violates (E) because the underlying [+voice] feature characterizing the final segments of /gög/ and /čileg/, and thereby distinguishing them from /kök/ and /ek/, never appears in any phonetic realization of the /g/. This segment appears as [k], and hence [-voice], before a consonant and in final position, and as ϕ before a vowel.*

In order to weaken (E) to the point where analyses such as those sketched above are permitted, it is necessary to move in the direction of only requiring that some of the underlying features of any given segment be manifested phonetically. In the Turkish URs /gög/ and /čileg/ all of the features of the final segments are realized phonetically except for that of [+voice]. Similarly, in the Efik example all of the features of the underlying /y/ in /dyá/ are realized phonetically except for that of [-vocalic]. In the case of the UR /-i:n/ in Yawelmani, however, the distinctive features for /i:/ are [+high, -round, +long], and of these, only the [-round] specification is realized phonetically. Of course, certain nondistinctive properties of /i:/, such as [-back], are also realized phonetically. But the point is that in this case not even a majority of the distinctive features of the underlying segment are directly attested in phonetic representations. It would seem, then, that there is no basis for determining how many of the underlying features of a segment must be directly attested in phonetic representation. Let us therefore propose (F) as a condition imposed on the relationship between an underlying structure and its phonetic manifestations.

(F) *Given a morpheme with the UR* $/P/_i\ /P/_j \cdots /P/_n$, *for all* $/P/_j$, *at least one of the features of* $/P/_j$ *must appear in a corresponding* $[P]_j$ *of at least one PR of that morpheme.*

* It turns out that this example from Turkish is not nearly as convincing as our discussion in the text indicates, since the overwhelming majority of velar stops that delete occur in polysyllabic roots, while the majority of nondeleting ones occur in monosyllabic roots. It is thus possible to posit an underlying /k/ for both types of root and formulate a rule deleting intervocalic /k/ when it is the final sound of a polysyllabic root. Zimmer (1975) mentions some external evidence from experiments with nonsense words that supports the contention that the k/∅ alternation is determined by the number of syllables in a root instead of the hypothetical contrast between /k/ and /g/.

This condition permits any underlying element provided at least one of the distinctive features of that element is present in a surface form of the morpheme. It is an exceedingly weak constraint, violated only when the phonetic representation of a segment shares no features with its underlying representation. This might occur in two ways: Either all of the underlying feature values of a segment would have to change their values (an unlikely situation), or the underlying segment would have to never appear in phonetic representations at all. This latter situation—which represents an obviously extreme form of abstractness—is the one we shall focus on, since analyses hypothesizing such a state of affairs have in fact been presented for a variety of languages, both from generative and nongenerative points of view. We must restrict ourselves to a selected number of cases where evidence in favor of analyses violating (F) can be adduced.

One analysis that violates (F) is the analysis of English that derives all occurrences of phonetic [ŋ] from underlying /ng/ sequences. This account of the velar nasal is motivated by the following considerations. For one thing, [ŋ] has a more restricted distribution than *m* or *n*, since it nevers occurs word-initially (*map*, *nap*, but not **ŋap*) nor internal to a morpheme before a vowel (*smear*, *sneer*, but not **sŋeer*). A restricted distribution often indicates that a sound is derived rather than underlying (since the restricted distribution would follow automatically from the fact that the rule in question operates only in certain contexts). Second, the sequences [nk] and [ng] do not occur in English phonetic structure. On the other hand, [ŋk] and [ŋg] do occur (*link*, *plank*, *finger*, *anger*). These data can be accounted for by postulating a rule that /n/ assimilates to the point of articulation of a following velar. Such a rule could, of course, be regarded as just one aspect of a more general nasal assimilation process. Third, although [ŋ] occurs in final position, *[ŋg] does not (we have *sing* [sĩŋ], but not *[sĩŋg]). This distributional fact enables us to derive [ŋ] by a rule that deletes *g* in the environment ŋ____#. This rule must be applied after the nasal assimilation rule that converts /n/ to [ŋ] when a velar follows. *g* deletes not just in absolute word-final position, but also before certain suffixes as well—e.g., the *-er* agentive suffix (*singer*), the verbal suffixes *-ing* (*singing*) and *-ed* (*hanged*). Finally, we observe that there are some examples of alternation that support a rule deleting *g* word-finally after [ŋ]. For instance, *long* ends in a velar nasal, but in *longer*, the comparative form of the adjective, a *g* is pronounced after the velar nasal. This alternation requires a rule of *g* deletion, since there would be no way to insert the *g* by a general rule (for example, *thin* does not acquire a *g* in *thinner*).

Deriving the [ŋ] of *long* from an underlying /ng/ sequence does not violate condition (F) since the underlying /g/ is actually pronounced in one of the surface alternants of this morpheme. But deriving the [ŋ] of *sing* from /ng/ does violate (F), since the underlying /g/ is never pronounced in any form of the morpheme—it is always realized as ∅, although it does effect the change of a preceding underlying /n/ to [ŋ].

In addition to the internal evidence found in English, which supports deriving [ŋ] from underlying /ng/, there is some external evidence cited in Fromkin (1975). She notes the occurrence of slips of the tongue of the following sort: [swĩn] *and* [sweyg] for the intended *swing and sway* (phonetically, [swĩŋ] and [swey]). This slip of the tongue provides evidence for an underlying /g/ in *swing*, even though the /g/ is not pronounced. This underlying /g/ in *swing* seems to have been transposed to the end of the following word, *sway*, preventing the assimilation of the underlying nasal. The result is that the underlying /n/ shows up phonetically. Another slip of the tongue supporting an underlying /g/ is [sprɪg] *time for* [hĩntlər] instead of the intended *Springtime for Hitler*. This example seems to involve the transfer of the underlying /n/ of *Springtime* to *Hitler*. In transferring the /n/ to the later word, the underlying /g/ is left behind, resulting in [sprɪg].

Marshallese provides another example that violates condition F (Bender 1968, 1969, 1970). According to Bender's analysis this language has a linear vowel system composed of the following four phonemic members: *i*, *&*, *e*, and *a*. Each of these vowels is subject to rounding, fronting, and backing, depending upon the consonants adjacent to it, so that in reality the phonetic inventory of vowels in Marshallese is much larger than the phonemic inventory (see Bender, 1968, for details). In what follows we will ignore phonetic adjustments of the vowels and retain the phonemic representation.

Bender argues that the higher mid-vowel *&* is not contrastive in Marshallese, but instead is a predictable variant of either *i* or *e*. Before exploring the details, we must discuss a pervasive rule of Marshallese phonology—apocope. Examination of the following data reveals a rule deleting the final vowel of a word.

(70)

Noun	his Noun	my Noun	gloss
naj	*naji-n*	*naji-h*	'child'
giy	*giyi-n*	*giyi-h*	'tooth'
qen	*qena-n*	*qena-h*	'catch'
jem	*jema-n*	*jema-h*	'father'
kilep	*kilepa-n*	*kilepa-h*	'bigness'
jeneq	*jeneqa-n*	*jeneqa-h*	'footprint'

We may now turn to the data of interest here, the limited distribution of the vowel *&*. This vowel is essentially limited in occurrence to the following types of roots.

(71)

Noun	his Noun	my Noun	gloss
w&b	*wibe-n*	*wib&-h*	'chest'
p&t	*pite-n*	*pit&-h*	'pillow'
k&l	*kile-n*	*kil&-h*	'technique'
w&n	*weni-n*	*weni-h*	'turtle'
b&g	*begi-n*	*begi-h*	'night'

For the moment let us ignore the third column. As far as the first two columns are concerned, these alternations may be accounted for in one of two ways. First, *i* will change to *&* when it is followed by an *e* that will eventually delete, and *e* will change to *&* when it is followed by an *i* that will delete. Another possible treatment is to metathesize the word-final vowel into the preceding syllable instead of simply deleting it. The resultant *ie* and *ei* sequences may then be converted into *&* directly. Fortunately, for our purposes it does not matter which of these two treatments is adopted. In either case underlying /#wibe#/ and /#weni#/ will be converted into phonetic *w&b* and *w&n*. The important point is that the vowel *&* is derivable in all cases from a combination of *i* and *e*.

In the third column stems such as *weni-* 'turtle' and *begi-* 'night' exhibit an unmodified stem-final vowel before the 1st-person possessive morpheme: *weni-h*, *begi-h*. On the other hand, stems such as *wibe-* 'chest' and *pite-* 'pillow' deflect their final vowel to *&* in the 1st person possessive: *wib&-h*, *pit&-h*. If we are to give a maximally general account of the distribution of the *&* vowel (to account for it with the rules already at our disposal), we must assign the underlying representation /-hi/ to the 1st person singular possessive morpheme. The /i/ is of course needed to deflect the preceding /e/ to *&*. It has no effect on any other preceding vowel and is deleted by the general rule of apocope.

In the data at our disposal the 1st person possessive morpheme always appears at the end of a word. As such, its vowel never shows up phonetically. However, because of the particular nature of the vowel alternations in the language, we are able to see its effects quite clearly. The proposed analysis of Marshallese violates (F), since it postulates an underlying sound for the 1st person possessive morpheme that is never pronounced in any of the morpheme's overt forms. The available internal evidence, however, supports that analysis.

Lithuanian (Kenstowicz, 1972a) provides another example along the same lines. Before discussing the relevant points, however, we must dispense with several preliminaries. To begin with, the language has the following phonetic vowel inventory.

(72)

long	short
i: u:	i u
e: o:	
ɛ: a:	ɛ a

The long open vowels ɛ: and *a*: are predictable variants of the corresponding short vowels, appearing in accented nonfinal syllables. Alternations like the following demonstrate this point. (In the following citations the acute accent marks the accented syllable; the tone of the syllable is not indicated, as this is not relevant to our discussion.)

(73)

nominative singular	instrumental singular	locative singular	gloss
kɛ́:las	*kɛlú*	*kɛlɛ́*	'road'
mɛ́:tas	*mɛtú*	*mɛtɛ́*	'time'
lá:pas	*lapú*	*lapɛ́*	'leaf'
rá:tas	*ratú*	*ratɛ́*	'wheel'

We account for these alternations by the following rule of secondary lengthening.

(74)
$$\begin{matrix}\acute{V}\\ [+\text{low}]\end{matrix} \longrightarrow [+\text{long}]/\_\_C_0V$$

Removing ɛ: and *a*: from the underlying vowel system leaves a rather asymmetrical vowel inventory: each of the two high vowels occurs in a long-short contrast, but for the nonhigh vowels, *e*: is paired with ɛ and *o*: is paired with *a*. Given the tendency for balanced underlying vowel systems, we might expect there to be internal evidence in Lithuanian that would reduce these two pairs to a simple long-short opposition, the differences in vowel quality being predictable by rule. The following data are suggestive.

(75)

present		past				
1st singular	3rd singular	1st singular	3rd singular	gloss		
minú	*mína*	*mi:naú*	*mí:ne:*	'trample'	cf., *miná*	'mob'
girú	*gíra*	*gi:raú*	*gí:re:*	'praise'		
tupú	*túpa*	*tu:paú*	*tú:pe:*	'perch'	*tupiklá*	'perch'
dumú	*dúma*	*du:maú*	*dú:me:*	'blow'	*dúmple:s*	'bellows'
drɛbú	*drɛ́:ba*	*dre:baú*	*dré:be:*	'splash'		
gɛrú	*gɛ́:ra*	*ge:raú*	*gé:re:*	'drink'		
lɛmú	*lɛ́:ma*	*le:maú*	*lé:me:*	'doom'	*lɛ́:manas*	'critical'
vagú	*vá:ga*	*vo:gaú*	*vó:ge:*	'steal'	*vagis*	'thief'
karú	*ká:ra*	*ko:raú*	*kó:re:*	'hang'	*karó:lai*	'necklace'

The derived nominals suggest that the underlying root vocalism is exhibited in the present tense and that the past-tense vocalism is derived. Comparing the present and past-tense roots, it will be observed that not only is the vowel of the latter a lengthened variant of the former, but when the underlying root vowel is open ɛ or *a*, the derived long vowel of the past appears as *e:* and *o:*, respectively. This is actually a general trait of Lithuanian. There are several other morphological rules that lengthen vowels. Wherever they apply to ɛ and *a*, the mid-vowels *e:* and *o:* result. This suggests that we abstract the raising of open long vowels from each of these rules and formulate it as a separate process. The rule of raising states this in approximate terms.

(76) raising [ɛ:, a:] → [e:, o:]

This rule permits us to derive all occurrences of *e:* and *o:*, which in turn permits us to postulate a completely symmetrical underlying vowel system for the language.

(77)

short	long
i u	*i: u:*
ɛ a	*ɛ: a:*

Phonetic *e:*'s and *o:*'s arise from long open *ɛ:* and *a:* by vowel raising, while phonetic *ɛ:* and *a:* arise from *ɛ* and *a* by secondary lengthening, which is ordered after raising.

The secondary-lengthening rule is not the only source of long open vowels in Lithuanian. There is another rule that deletes a dental nasal before a continuant consonant, compensatorily lengthening the preceding vowel. This rule must be ordered after raising because lengthened open vowels resulting from the loss of a nasal do not become mid-vowels. We may illustrate the operation of this rule by showing the range of allomorphs for the prefix *san-*.

(78)

sámbu:ris	'assembly'	*bú:ris*	'crowd'
sándo:ra	'covenant'	*dó:ra*	'virtue'
sántaka	'confluence'	*tɛké:ti*	'to flow'
sáŋkaba	'coupling'	*ká:be:*	'hook'
sá:vo:ka	'idea'	*vó:kti*	'to understand'
sá:skambis	'harmony'	*skambé:ti*	'to ring (bell)'
sá:šlavo:s	'sweepings'	*šlá:ve:*	'he swept'
sá:žine:	'conscience'	*žinó:ti*	'to know'

We may express the nasal-loss rule informally as follows:

(79) V*n* continuant ⟶ V: continuant

Turning to the relevance of these data to the validity of condition (F), note that a crucial feature of the analysis we have presented is that all occurrences of long open vowels in phonetic representation are the result of either nasal loss or secondary lengthening. An underlying long open vowel will never be realized on the surface level because raising will convert it to a mid-vowel. As such, our analysis seems to run into difficulties when confronted with forms like the following:

(80)

nominative singular	genitive plural	gloss
á:žualas	*a:žualú:*	'oak'
kɛ́:sas	*kɛ:sú:*	'moss-grown hillock'
žá:šis	*ža:šú:*	'goose'

If these roots are assigned URs with short open vowels, we can account for the long root vowels in the nom. sg. forms by secondary lengthening. But this account fails to explain why the root vowels are long in the gen. pl., where the accent is not on the root. On the other hand, if the roots are assigned underlying long open vowels, raising will convert them into phonetic mid-vowels. There is, however, another source for long open vowels—nasal loss. If these roots are assigned the URs /anžual-/, /kɛns-/, and /žanš-/, their superficially anomalous behavior can be explained. This analysis is supported by the existence of two additional "gaps": first, there are no *n* plus *continuant* clusters within a morpheme in phonetic representations; second, all unaccented *a:* and *ɛ:* vowels are followed by a continuant. These gaps are natural consequences of the analysis just proposed. Note, however, that a UR like /žanš/ violates (F). The *n* never appears phonetically in any allomorph; it is always deleted because of the following *š*.

So far, in the examples of "ghost" segments from English, Marshallese, and Lithuanian it has been possible to pinpoint the exact phonetic nature of the abstract segment. There are, however, cases where this appears impossible. A particularly clear example is provided by "*h* aspiré" words in French (Schane, 1972). Final consonants in French are deleted in phrase-final position as well as word-internally in preconsonantal position. If the following word begins with a vowel, the final consonant of the preceding word is normally pronounced, a process called *liaison* in traditional terminology. Thus, we have *les garçons* [legarsõ], but *les amis* [lezami]. There is however a group of words that induces the deletion of a preceding consonant despite the fact that they always begin with a vowel phonetically.

(81)

les héros	[leero]	'hero'
les haches	[leaš]	'ax'
les haricots	[leariko]	'bean'
les hibous	[leibu]	'owl'

Although one might simply mark these morphemes in the lexicon as conditioning consonant truncation exceptionally, other relevant facts cast some doubt upon the validity of such an approach. For instance, words beginning with a vowel normally induce the deletion of the final vowel of a preceding word: *le garçon*, but *l'ami*, where the /ə/ of the article has been deleted. Morphemes that exceptionally induce the truncation of a preceding consonant (the *h* aspiré words) consistently fail to trigger the deletion of a preceding vowel despite the fact that they always begin with a vowel.

(82)

le héros	[ləero]	*le haricot*	[ləariko]
la hache	[laaš]	*le hibou*	[ləibu]

Merely marking these morphemes as triggering consonant truncation exceptionally fails to explain why they also automatically fail to induce vowel deletion. On the other hand, if we say that these morphemes begin with an

underlying consonant, and if this consonant is deleted after all relevant rules have applied, then both exceptional properties of these morphemes can be linked with one another. In fact all phonological rules of French that are sensitive to vowel- versus consonant-initial words consistently treat the *h* aspiré words as if they began with a consonant. To cite just one more example, prenominal adjectives ending in a nasal consonant normally delete the nasal if the following word begins with a consonant, but retain the nasal if the following word is vowel-initial (with no nasalization of the preceding vowel; see Dell, 1973): *bon vélo* [bɔ̃velo] 'good bicycle' versus *bon ami* [bɔnami] 'good friend'. The *h* aspiré words behave like consonant initial words: *bon heros* [bɔ̃ero].

In order to account for the consistent behavior of the *h* aspiré words, it would appear that they must be entered into the lexicon with an initial consonant that is deleted after all relevant rules have applied. The problem is, which consonant? Historically, these words derive by and large from Germanic borrowings with an initial *h*. However, except for a few eastern dialects and stage pronunciations, *h* has been deleted everywhere in French. Although one could identify the ghost segment as /h/, it appears that there is no real motivation for doing so. A glottal stop, which also does not occur in French, would suffice. In fact any otherwise nonoccurring consonant could be selected. In view of these facts Schane (1972) has suggested that the underlying consonant merely be represented as [+consonantal] without any further specification, a kind of *archisegment*.

Selkirk and Vergnaud (1973) have called attention to some additional facts that call the whole question of the abstract consonant into question. Specifically, they point out that most morphological derivatives of *h* aspiré words behave as if they began with a vowel. Thus, while we have *les héros* [leero], we also have *l'héroïne*, not **la héroïne*. A phonological analysis would require a very peculiar rule deleting the abstract consonant when a derivational suffix is added. On the other hand, if the *h* aspiré words are treated as being exceptional in some way, their behavior in derivative formations can be seen as a manifestation of the tendency to regularize morphologically derived forms. (For example, *sit* in English has the marked past-tense from *sat*, while the past tense of *babysit* can be heard as either *babysat* or *babysitted*, the latter form exhibiting the regular past-tense suffix). This would appear to argue for treating the *h* aspiré words like *héros* as exceptional in some way. But even if we mark such forms as exceptions (via some lexical marking system), this still fails to explain the systematicity of their behavior.

The *h* aspiré words in French thus represent what is perhaps a more typical case of a possible violation of (F) than do our earlier examples. First of all, the evidence does not lead to any NECESSARY "ghost" segment. That is, there exists more than one hypothetical underlying sound that could produce the correct surface results, and there exists no evidence warranting the choice of one over the others. Second, not all of the implications of the ghost segment

are borne out. Consequently, postulating a consonant at the beginning of *héros* implies that this consonant will also appear in forms derived via suffixation from *héros*. But since this implication does not hold in French, there is some doubt cast on the proposed ghost segment.

In this chapter we have examined a series of possible conditions imposed on the abstractness of underlying representations—that is, on the extent to which the UR of a morpheme may differ from its associated set of phonetic realizations. We have seen that the weakest possible condition—namely, (F)—cannot be maintained if certain internally supported analyses are to be accepted. The failure to find any absolute condition determining the relationship between an UR and its PRs leaves open the possibility of describing any case of contrasting patterns of morphophonemic behavior in terms of an underlying phonological contrast. Perhaps it will be useful to consider in detail one example where postulating an underlying phonological contrast does not appear to us to provide the best description of the observed contrasts in morphophonemic behavior. (See Chapter Two for many other examples.)

Menomini, an Algonquian language, provides some interesting material in this respect. The sound *n* in Menomini displays two different patterns of behavior. One *n* alternates with *s* before nonlow front vowels and *y*, while the other *n* does not. (It should be noted here that *t* is converted to *č* in this same environment in Menomini.)

(83)	*en-ōhnɛ-t*	'if he walks hither'	*es-yā-t*	'if he goes hither'
	w-ēn-owawan	'their hands'	*w-ēs* < /w-en-e/	'his head'
	ōn-an	'canoes'	*ōs* < /on-e/	'canoe'
(84)	*o-tān-an*	'his daughter'	*o-tān-ew*	'he has a daughter'
	aʔsɛnyāk	'stones'	*kōn-ēwew*	'it is snowing'
	kōn	'snow'	*kūnyak*	'lumps of snow'

Thus, in the phonological description of Menomini there must be some difference in the URs of the morphemes in (83) and (84) in order to be consistent with the fact that the *n*'s in the former set palatalize to *s* while those of the latter do not. In Bloomfield (1939) these morphemes are differentiated by representing the *n*'s of (83) as /n/ in their underlying structure, and those of (84) with the capital letter morphophoneme /N/. The palatalization rule is then defined to operate on /n/ and ordered after it is a rule that converts the nonpalatalizing /N/s to *n*.

Unlike Bloomfield and many structuralists, generative phonologists have assumed that segments in the UR are to be represented in the same fashion as in the PR: that is, as matrixes of distinctive features that indicate whether or not a given segment possesses a particular phonetic property. Consequently, generative phonologists can differentiate the two different *n*'s in Menomini in only two ways: They may be assigned different underlying feature matrixes (distinguished by an underlying phonetic contrast that is later neutralized in

all positions), or the morphemes of the language can be subcategorized by an arbitrary nonphonetic lexical classification on the basis of whether or not they undergo the palatalization rule. (In effect, the latter option involves marking in the lexicon all the morphemes containing /N/s in Bloomfield's analysis as exceptions to the palatalization rule.)

Now unlike our earlier discussion of counterexamples to (A)–(F), the first option is not nearly as attractive for these Menomini examples, because an underlying phonetic contrast cannot be substantiated. The only difference between the two *n*'s is that some undergo the rule of palatalization while others do not. In all other respects the two *n*'s behave exactly the same. Thus, if we were to try to differentiate them in terms of an underlying phonetic contrast, the choice of which phonetic differentiation to make would be totally arbitrary. This situation can be profitably compared with the one in Yawelmani, where surface *o:* shows two different patterns of behavior. One behaves like a low vowel with respect to vowel harmony and the other like a high vowel. We suggested that the proper way to differentiate the phonological behavior of the two different kinds of *o:*'s was in terms of an underlying contrast that never appeared directly on the phonetic surface: The first type was posited as /o:/, the second as /u:/. This underlying contrast was supported by several other criteria besides vowel harmony, all of which allowed us to pinpoint exactly in phonetic terms the underlying difference between the two kinds of *o:*'s. In the Menomini case, however, there are no synchronic facts that permit such a phonetic differentiation of the two kinds of *n*'s. The only relevant synchronic facts are that some *n*'s palatalize to *s* and some do not.

In spite of the difficulty in positing an underlying phonetic differentiation in cases like this, early generative phonology was so biased in favor of proposing phonological explanations for contrasting morphophonemic behaviors (rather than treating them as the result of nonphonetic factors, such as grammatical conditioning or lexical subclassification) that we find such analyses proposed even in the most implausible circumstances. This was especially true when the historical antecedents of the language were known. Thus, in his doctoral dissertation on Menomini, Bever (1967) differentiated the two *n*'s by deriving the palatalizing one from /θ/ and the nonpalatalizing one from /n/. In Bever's analysis the palatalization rule is defined as transforming /t/ and /θ/ to *č* and *s*, respectively, before /y/, /i/, and /e/. Subsequently, another rule changes all remaining /θ/s to *n*. To some extent this analysis recapitulates the historical development, since many of the palatalizing /n/s come from Proto-Algonquian **θ*, while the nonpalatalizing /n/s come from **n*. Aside from this fact, which is irrelevant in a synchronic description, Bever tries to motivate the selection of /θ/ on grounds of simplicity. To differentiate the two /n/s one needs to set up a consonant that otherwise does not occur in Menomini. This consonant must appear as *s* in the palatalizing environments and as *n* elsewhere. The choice of the underlying segment can be restricted to some extent by attempting to formulate rules that will effect these changes to *n* and *s* as simply as possible.

θ differs from *s* just by the feature of stridency (and the rule of palatalization renders a consonant [+strident]; see the change of *t* to *č*). *θ* differs from *n* by the feature of nasality. If /θ/ is selected as the underlying segment, the rules required in the analysis will be rather simple, involving minimal feature changes.

The latter argument is extremely weak because it is based on an inadequate conception of the role of simplicity in phonology. In addition, it fails to eliminate one of the two liquids, which do not occur in Menomini either, as candidates for the UR of the palatalizing *n*'s. There are, besides, other pertinent facts that render this analysis not only implausible but actually incorrect. They have to do with the fact that the merger of PA **θ* to *n* was not direct, but went through an intermediate stage of **l*. In an important study Piggott (1971) has shown that in PA **t* alternated with *č* and **θ* with *s* before front nonlow vowels and glides. In most of the Algonquian languages **θ* became *l*, merging with PA **l*. At this stage there were some *l*'s (derived from **θ*) that alternated with *s*; other *l*'s (derived from **l*) did not. Now, if we were to follow the logic of Bever's analysis for this stage of the language, the alternating *l*'s would be derived from /θ/ and the nonalternating ones from /l/, with a subsequent rule changing all /θ/s that did not palatalize to *l*. But this kind of analysis would be inconsistent with the fact that in all of the Central Algonquian languages the *l*∼*s* alternation was generalized to the *l*'s that derive from PA **l*. This is a totally unexpected change as far as a phonological analysis is concerned, but finds a ready interpretation according to a lexical analysis that differentiates the two kinds of *l*'s by means of an arbitrary lexical classification: the tendency for arbitrary nonphonetic properties to be lost in linguistic change. (Cf., the fact that many of the nouns and verbs that formed their plurals or past tense by umlaut or ablaut in earlier stages of English now take the regular *-(e)s* plural and weak past *-(e)d* endings.) At some time after the merger of **θ* with **l*, **l* merged with **n* to yield the present-day Menomini situation. We thus might expect in the future development of Menomini that either the *n*∼*s* alternation will be generalized to the *n*'s that derive from **n* or perhaps the alternation will be lost entirely from the language. In either case both of these changes would be comprehensible according to a lexical analysis of the *n*∼*s* alternation, but not according to a phonological one.

It is clear that phonological theory must impose some constraints on underlying representations so that unmotivated analyses like the one for Menomini can be excluded. The problem of abstractness thus remains one of the most important issues facing contemporary generative phonology.

In this chapter we have discussed a large number of possible conditions imposed on underlying representations and have presented (internally) well-motivated counterexamples to each one; as a result we must exclude the possibility of accepting any of these constraints as absolute conditions on underlying structures. However, the number of cases in which evidence is available to support an abstract phonological solution is small when compared to the number of cases in which such evidence is unavailable. In most cases

our only recourse will be to lexical analyses. This means that the weaker conditions we have discussed—especially (D), (E), and (F)—function as rules of thumb setting upper limits on the amount of abstractness in URs that most phonologists implicitly follow. These conditions are violated only infrequently, and then only when a fair amount of evidence is available to motivate a more abstract analysis. Furthermore, even when internal evidence is available, this still leaves unanswered the fundamental question of whether or not the native speaker actually constructs his internalized grammar along such abstract lines. At present there is little evidence one way or the other on this issue as well as on most other issues facing contemporary phonological theory. But this only reflects the speculative nature of the still-developing discipline of linguistics.

2

The Nonphonetic Basis of Phonology

1.0 THE SUBVERSION OF THE PHONETIC BASIS OF PHONOLOGICAL ALTERNATIONS

Phonological alternations generally have their ultimate source (historically speaking) in sounds being affected by the phonological context in which they occur. In other words, synchronic phonological alternations are largely the consequence of sound changes that have occurred in the history of the language, and these sound changes are generally phonologically conditioned, altering a given sound only in a specific environment. Furthermore, the sound changes in question are generally phonetically motivated; that is, not only does the change take place in a specific phonological context, but there is also a phonetic explanation for why the change in question occurs in the context that it does.

The sound changes that occurred historically, and the conditions under which they occurred, often become obscured through subsequent historical evolution. The phonetic basis of the original change may thus be lost, resulting in an alternation that from a synchronic point of view must be accounted for by a rule that lacks phonetic motivation. In some cases the alternation may continue to be conditioned by phonological factors alone (though not the same phonological factors as originally induced the alternation), while in other cases (partial) nonphonetic conditioning may arise. In this chapter we consider several different ways in which the original basis of an alternation may become altered in the course of language change.