Issues in the Phonology of Tiberian Hebrew

by

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ABSTRACT

This thesis studies some central problems in the phonological analysis of Tiberian Hebrew (TH). Chapter 2 contains a detailed account of the accentual system of the language and an analysis of those aspects of the segmental phonology which interact with the accentual system. The account is set within a framework, the principles of which are formalized and justified in Chapter 1. I argue that the assignment of stress involves rules of tree construction and the interpretation of these trees in a metrical grid by rule. The theory of stress assignment adopted allows for a greatly simplified account of TH stress in which there is only one set of stress trees instead of the three postulated in previous metrical accounts. It is suggested that there are two different binary alternations in the language - stress and reduction - which are not perfectly aligned. The rules of Vowel Reduction and Stress Assignment are both taken to involve the construction of metrical trees with each set of trees interpreted by a different rule. The stress trees are interpreted by rules of grid construction and the reduction trees are interpreted by a segmental rule which only indirectly affects the process of grid construction. The ultra-short vowels of the traditional literature are identified as those vowels with no grid representation. These vowels are ignored by the rhythmic rules of the language which are formulated as operations on the grid. I argue that a theory using only a metrical grid with no recourse to metrical trees has difficulty dealing with certain stress shift phenomena which are at the heart of the TH accentual system and are dealt with naturally in the framework adopted here.

Chapter 3 presents a solution to a classical problem in the morphological analysis of the TH verbal system. It is shown that although triconsonantal roots may be associated with one of three prosodic templates, at the deepest level of analysis there are only two such templates available to the morphology and that one of the templates is derived from another by rule. The solution makes crucial use of an autosegmental representation of morphemes and involves the postulation of two morphological strata in the TH lexicon.

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Chapter 1

Introduction

This thesis addresses some problems in the phonology of Tiberian Hebrew (TH) - the language of the Old Testament - in light of recent advances in phonological theory. Chapter 2 contains a detailed analysis of the accentual system of the language and an analysis of those aspects of the segmental phonology which interact with the accentual system. Chapter 3 offers a solution to a classical problem in the morphological analysis of the Hebrew verbal system. This study does **not** aspire to be an exhaustive account of the phonology and morphology of the language. Rather, its aim is to see how current theory can shed light on particular problems which have until now resisted satisfactory solution, on the one hand, and to see what the phonology of Tiberian Hebrew can tell us about issues in current theory which remain controversial, on the other. The phonology of Tiberian Hebrew is one of the best-studied linguistic systems, and the present study is heavily indebted to the penetrating insights of previous generative accounts of Hebrew - Prince (1975), McCarthy (1979) and

Dresher (1981a,b) - which in turn draw on a rich philological literature. I will not, in this study, engage in extensive morphological analysis, or motivate the underlying representations of the words analyzed, except where such motivation is crucial for the discussion at hand. The reader is referred in particular to Prince's study for detailed morphological analysis.

In this introductory chapter I will introduce the various principles of the subcomponents of phonology which are adopted in the thesis. Section 1 reviews at length the particular version of metrical theory on which the analysis of Chapter 2 crucially depends. Since there is much controversy in the current literature concerning the appropriate representation of stress and the formal apparatus for generating stress contours, I compare and contrast the theory adopted here with other metrical theories of stress and try to pinpoint exactly how the theories differ and the kinds of evidence which help choose between the theories. Section 2 introduces the theory of autosegmental phonological and morphological representation used throughout the thesis. Finally, Section 3 briefly introduces the principles of lexical phonology upon which the analysis in Chapter 3 is based.

1.1 Metrical Phonology

The basic insight of metrical theories of stress has been that the stress contours of languages are a reflection of a hierarchical structure imposed upon a stress domain, which expresses the *relative prominence* among the constituents. There is, however, much controversy concerning the appropriate mechanism for representing stress hierarchies and the kinds of rules needed for generating the hierarchical structure.

Early metrical theory (Liberman (1975), Liberman and Prince (1977)) employed three sets of rules for generating the stress contours of languages. First, the feature [+stress] was assigned by a context sensitive rewrite rule of the familiar kind to various syllables of a word. Then the relative prominence among the various syllables marked [+stress] was represented by a hierarchical tree structure produced by the second set of rules, whose primitive is the binary branching tree, with one node labeled S (strong) and the other W (weak). Finally, a third set of rules constructed a metrical grid which interpreted the abstract prominence relations of the tree structure and encoded the stress directly.

Later theory, (Selkirk (1980) and Hayes (1981)) dispenses entirely with the feature [stress]. In the newer theory, stress is the property of a syllable being the strong or sole member of a constituent called the _foot_. The first set of rules assigning the segmental feature [stress] is abandoned and stress is then generated by two sets of rules; the first set includes rules employing trees which mark off prosodic categories such as feet, and other rules which manipulate foot structure; the second set of rules interprets the abstract relations encoded in the tree in a metrical grid which represents the rhythmic beat of the language. Most of the research conducted in the metrical framework concentrated on the first set of rules, and very little, if any, attention was paid to the rules governing the construction of the grid or the nature of the grid representation.

Recently, Prince (1983) has argued that the set of rules erecting tree structure is superfluous and that the stress contours of languages can be generated directly with operations on the grid. Other phonologists (Hayes (1983), Halle and Vergnaud (forthcoming) argue for the employment of both grids and trees. In their theories the prominence relations between the syllables of an utterance are represented in the hierarchies of the metrical grid, but trees are still used to generate the basic pattern of stress in the grid.

In this section, I first outline the metrical theory I am adopting in this thesis. The theory employs both metrical trees and a metrical grid. What I try to show is that there is a natural division of labor between the two constructs, and that there is in fact need for both. The section includes an inventory of the types of rules available to the theory and the parameters associated with each rule. I then briefly compare it with earlier versions of metrical theory, such as the one developed in Hayes (1981) in which metrical trees played a much more prominent role than it does in the theo · advocated here. Finally, I compare the theory with the one outlined in Prince (1983) which dispenses entirely with trees, employing only a metrical grid.

1.1.1 The Present Theory

1.1.1.1 Feet and Tree Construction

I follow the practice of many metrical phonologists in assuming that generating the stress pattern of a language involves, first of all, parsing the stress domain into constituents. One of the most common stress patterns is that of binary alternation. For example, stress in Warao is described in Hayes (p.51) as falling on the penult and on alternating syllables preceding the penult, as in the words below.

(1)

yàpurùkitàneháse "verily to climb"

nàhoròahàkutái "the one who ate"

In the theory adopted here, assigning stress in Warao involves parsing the word into constituents, each containing two syllables, as in (2).

(2)

[[yapu][ruki][tane][hase]]

[[naho][roa]haku][tai]]

The left syllable in each constituent is marked for prominence. I will call each such syllable the **head** of the constituent, and assume that parsing the stress domain into constituents always involves singling out one of the syllables as the head.

As far as the appropriate notation for encoding the constituency, several alternatives present themselves. The first is the imposition of a bracketing on the string as in (2), with some additional convention for singling out the syllable which serves as the head. The information encoded in the bracketed string in (2) can equally well be expressed in a tree structure as in (3).

(3)

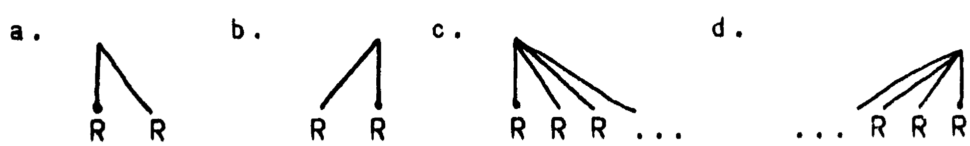
In (3) the head of each constituent is dominated by a vertical line, while the other syllables are dominated by diagonal lines.

I will adopt the tree notation of (3) for reasons which will become immediately clear. The word in (3) is represented as parsed into constituents each of which contains two syllables. In fact, not all aspects of the phonological string are relevant for the purposes of assigning stress. Perhaps the most pervasive generalization to emerge from the study of stress systems is that the nature of the onset is never relevant for the calculation of stress placement, and the rules of stress assignment should embody this generalization. Using tree notation, we can exclude certain elements of the phonological string from consideration, by defining the **terminal elements** (TE's) of the trees. So we may say that, universally, the TEs of stress trees may only be the rimes of syllables. Equivalently, we say that stress trees are **rooted** in rimes. So, stress in Warao is not really assigned to every other syllable, but rather every other rime.

I will call the constituents created by the stress trees **feet,** and rules for parsing the stress domain into feet with metrical tree rules of **tree construction** and **foot formation** interchangeably. The tree refers to the construct used to demarcate the domain of the foot and the foot refers to the constituent itself. To Hayes (1981) we owe the insight that trees come in two sizes: maximally binary and unbounded. We have just seen binary trees in the Warao example. The unbounded tree forms a constituent from the entire string in the stress domain, unless other complicating factors such as accent (see below (1.1.1.3)) arise. It is used to derive the stress pattern in languages in which stress is just plain final or initial. As with the binary trees, each unbounded tree has a head.

The head of any tree, binary or unbounded, must be a peripheral TE, either the leftmost or the rightmost.

(4)



In the diagram above, (a) represents a tree demarcating a binary foot, whose left member is marked as the head. I will call this a **left-headed bounded** tree. (b) represents the right-headed counterpart. (c) represents the tree demarcating an unbounded foot whose leftmost member is marked as the head. This is the **left-headed unbounded** tree. (d) is its right-headed counterpart. In this work, I will sometimes call the position of the head the **dominant** position of the tree and a non-head position a **recessive** one.

That maximally binary trees are the only bounded trees employed by the phonologies of natural languages is a very strong claim and by no means an obvious one, since it surely does not reflect a surface-true generalization. Languages such as English, with a basic alternating pattern of stress aboundd in unary and ternary feet. Hayes's important insight is that despite the surface deviations from strictly binary alternation, the rules employed for the initial calculation of stress assignment are best formulated in terms of binary or unbounded trees. In the course of this overview I will review the most common sources for deviations from smooth binary alternations in languages with a basically alternating pattern of stress.

When binary trees are constructed for the purposes of stress assignment, the **direction of iteration** must be specified in addition to the headedness of the trees. To see why this is so, consider a hypothetical language in which the stress pattern of words with an odd number of syllables is as in (5)a and that of words with an even number of syllables is as in (5)b.

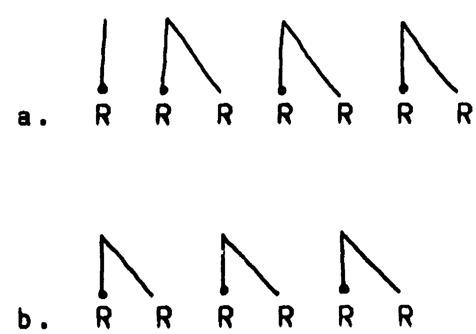
(5)

a. Ŕ Ŕ R Ŕ R Ŕ R
   1 2 3 4 5 6 7

b. Ŕ R Ŕ R Ŕ R
   1 2 3 4 5 6

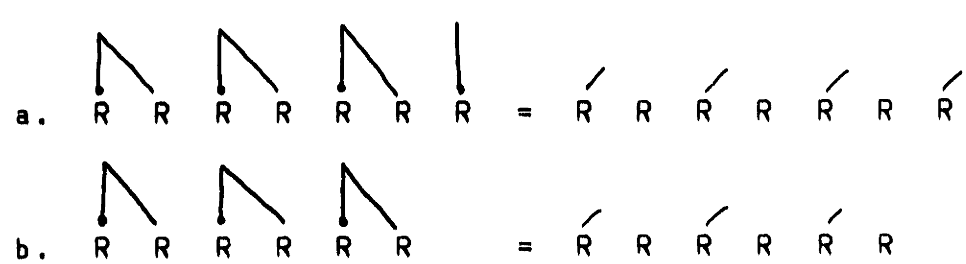
This pattern can be derived by constructing left-headed trees from right to left.

(6)



If the trees were constructed left to right , the following pattern would be derived.

(7)



These examples show an important property of tree construction: when a rule assigning binary trees encounters a domain with one syllable, it marks that syllable as the sole member of a unary foot. This is one of the most common sources for divergence from smooth binary alternation. Below I adopt a principle suggested in Halle and Vergnaud (forthcoming) that any tree construction rule must cover the entire domain to which it applies. In the case under consideration, each rime must be assigned to a foot. Since every foot must by definition have a head, the sole member of a foot is marked as the head of that foot.

The parameters of direction of iteration and headedness have been shown to be independent. Hayes (1981) gives examples of languages for each combination of direction of iteration and headedness. Maranunku is reported to be characterized by a system which constructs left-headed trees left to right, while Warao constructs left-headed trees right to left. The alternating stress pattern of Weri is derived by assigning right-headed trees from right to left , while that of Southern Paiute is derived by assigning right-headed trees from left to right (pp. 50-53).

Once the system allows for the specification of the terminal elements of the trees, we may expect the TEs of stress trees to vary from language to language. Indeed they do. Some languages take the subconstituents of the rime, the **moras** to be the TEs of stress trees. For example, the stress pattern of Southern Paiute is described in Hayes

(1981) as being calculated with the use of binary trees rooted in moras, since a sequence of two vowels, whether or not they are members of the same syllable, count as two terminal elements for the binary count. This is illustrated in the following examples:

(8)

mantcáAqàA	"to hold out one's hands"
maróOqwày'ɨqWᴍ	"I stretch it"

The stress pattern of Southern Paiute is generated with the use of right-headed feet constructed right to left, where the terminal nodes of the trees are the subconstsituents of the rimes. (The final mora is excluded from the domain of stress by means of the extrametricality diacritic (see below 1.1.1.4).)

Even more striking is the example of a language which employs two stress rules each based on a count of different terminal elements. Such a language is Auca, described by Pike (1964). According to Pike, Auca has two stress rules assigning alternating stress. The domain of the first is the stem, and it assigns alternating stress from left to right. The domain of the second rule is the string of suffixes, and it assigns alternating stress from right to left. Interestingly, the rule which operates in the stem treats a sequence of two vowels, whether or not they are identical, as two TEs for the stress trees, but the rule which operates in the domain of the suffixes, treats a sequence of two vowels as a single terminal element for the stress trees.

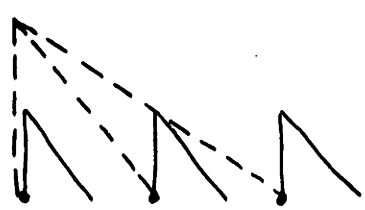
In Chapter 2, I argue that the calculation of stress placement in Tiberian Hebrew ignores certain phonologically identifiable rimes, and express this formally be excluding these rimes from the class of terminal elements of the stress trees.

The basic property of the binary foot is that each terminal element of the trees - each element relevant for the calculation of stress assignment - is marked in an alternating fashion as either a head or a non-head. The overriding constraint is that any element which is a non-head must be adjacent to a head. The converse - that each head must be adjacent to a non-head - does not hold. Languages which have been called **quantity-sensitive** typically display patterns of stress which are not strictly alternating due to the adjacency of heads. Below (1.1.1.3) I discuss how the theory adopted here handles the problem of quantity sensitive alternations.

1.1.1.2 Main Stress and the Word Tree

So far we have seen how the theory parses domains into feet for the purposes of stress assignment. In most languages with more than one stress per domain, one of the stresses is perceived as most prominent - the main stress. Just as the unbounded metrical tree can be used to gather all the rimes of a domain into a constituent and single one out for stress, so an unbounded tree - the word tree - can be used to gather the heads of the feet into a constituent and single out one of them for heightened stress. To do this, the word tree takes as its terminal elements only the heads of feet and marks one of them as the head of the word tree, as shown in (9). Notice that, in absence of accent, an unbounded tree can only single out a peripheral element - the leftmost or the rightmost. It is indeed a fact that it is usually the leftmost or the rightmost stress which is singled out as the main stress.

(9)



It is important to note that I do not take the feet and the word tree to form a nested constituent structure. The terminal elements of the tree are not feet - they are the heads of the feet. Just as the feet ignore parts of the segmental string - such as the elements in the onset - so the word tree ignores all rimes which are not marked as heads of feet.

YidinY (Dixon (1977)) and Tübatulabal (Voeglin

(1935)) are described as having alternating stress patterns in which all stresses are equally prominent. Presumably, these languages lack a word tree.

It has been suggested (e.g. Magnus (1983), Prince (1983) p.51) that the headedness of a word tree predicts the direction of the iteration of the bounded feet, so that a language with a right-headed word tree will assign its feet from right to left and a language with a left-headed word tree will assign its feet from left to right. Judging from the stress systems of languages with which we are familiar, this appears to be the most prevalent pattern. This could be made to fall out of the theory if it is assumed that main stress is always assigned non-iteratively, and that secondary stress always radiates out from the primary stress. However, this cannot be an absolute restriction since the generalization is counterexemplified by a number of languages. One such language is Piro whose stress sytem is described as follows (Halle and Clements (1983 p. 191)):

a. Primary stress falls on the penultimate syllable
b. Secondary stress falls on the initial syllable.
c. Tertiary stress falls on every other syllable following the initial syllable, except that the antepenult is always stressless.

Ignoring the distinction between secondary and tertiary stress, this system can be derived by constructing bounded left-headed feet from right to left, constructing a *right-headed* word tree, and including a rule which removes stress from a syllable immediately preceding the main stress. Other languages which display such a pattern are Cairene Arabic, and Seneca, where main stress falls on the final vowel marked for stress, but where the binary feet must be constructed from the beginning of the word.

Halle and Vergnaud in fact do not allow for the non-iterative formation of any feet. Trees must, in their system, cover the entire stress domain (disregarding the effects of extrametricality (see below)). In their system, the stress pattern of a language with alternating stress, for example, <u>must</u> be derived by forming bounded feet and singling out the head of one of these feet with a word tree. It cannot be derived by forming a non-iterative main stress foot, and then forming secondary stress feet iteratively in the domain not covered by the main stress foot. The stress systems of a number of well-studied languages, English and Tiberian Hebrew among them, have in the past been characterized by non-iterative main stress foot formation and iterative secondary stress foot formation filling out the domain not covered by the main stress foot. In the next subsection we will see that the rules for assigning main stress and secondary stress in English can be identified as one. The case of Tiberian Hebrew is a bit more complicated since it has been argued that a number of rules must be ordered crucially between main stress foot formation and secondary stress foot formation. I show, however, in my analysis of TH stress in Chapter 2, that it is in fact possible to construct all the bounded trees of Tiberian Hebrew at once; the rules of main stress and secondary stress foot formation are one, and the analysis is greatly simplified. It remains to be seen whether other languages which have been described with the non-iterative formation of bounded feet can be reanalyzed as well according to the restrictions set out in Halle and Vergnaud's system.

Just as each rule of tree construction must cover the entire domain, it must do so uniformly. Thus, when a rule constructs left-headed bounded trees, for example, the entire domain of the rule must be covered exclusively with left-headed bounded trees. The theory excludes the possibility of a domain covered partially with bounded trees and partially with unbounded trees or partially with left-headed trees and partially with right-headed trees.

1.1.1.3 Accent

So far we have seen one source for adjacent stresses in a language with a basically alternating pattern of stress. The situation arises under certain circumstances when a binary tree construction rule encounters a domain of a single syllable and makes that syllable the head of a unary foot. We now turn to another common source for adjacent stresses in languages with alternating stress - quantity sensitivity. It has long been noticed that syllable weight often plays a crucial role in stress systems. Languages which have a basic alternating pattern of stress are often sensitive to the prominence of heavy syllables so that all heavy syllables are marked for stress and in a sequence of light syllables every other one is. The most common light/heavy opposition is one which considers all syllables with branching rimes as heavy and all with non-branching rimes as light. The next most common pattern is that which considers syllables with long vowels heavy and those with short vowels - whether open or closed - to be light. The basic property of languages with quantity sansitive alternations is that certain rimes obligatorily serve as heads of feet. In earlier metrical theories the branchingness of heavy syllables was taken to be the primary property of these syllables and the process of foot construction was made sensitive to the branchingness of the terminal elements. (Cf. below 1.1.2.2.) It has become increasingly clear, however, that properties of branchingness play much less of a central role in metrical systems than was previously supposed. Halle and Vergnaud (forthcoming) show moreover, that even in languages with quantity sensitive alternations, the phonological properties of rimes are not always sufficient for determining stress contours. Heavy syllables in certain positions may pattern like light syllables, and conversely, certain light syllables may pattern as heavy. Halle and Vergnaud suggest that the process of tree construction is never sensitive directly to the internal geometry of rimes. Rather, an element which a language considers to be obligatorily a head is marked with an <u>accent</u> to which the process of tree construction is sensitive. An accented rime, regardless of its position, must be marked as the head of a foot. When it is entirely predictable from the phonological shape of the syllable that it must serve as the head of a foot, then the accent will be assigned to all such syllables by rule. In a language with what has been called a quantity sensitive pattern of alternation, the effect of accenting certain rimes is to interrupt the pattern of smooth alternation.

As an example, consider the stress pattern of Tubatulabal, which is described as follows: (Prince (1983 p. 63))

a. Final syllables are always stressed.
b. Long vowels are always stressed.
c. Certain morphemes contain inherent stress.
d. In a sequence of short vowels with no stresses derived from a - c, stress alternates right to left.

This pattern can be derived as follows :

a. Certain morphemes contain inherently accented syllables.
b. Accent syllables with long vowels.
c. Form right-headed feet right to left.

Example outputs (accented syllables are underlined):

(10)

wašaagahaja "it might flame up"

anaŋiinin+mut "he is crying (distr)"

witaŋahatal "the Tejon Indians"

In effect, introducing the accent eliminates quantity sensitivity as a parameter for tree construction. All tree construction rules are sensitive to accent, and languages just differ with respect to the extent to which they make use of accent. Although this greatly increases the use of diacritics such as accent, the result is also a simpler process of tree construction.

In the case of English, the use of accent allows the rule of primary stress assignment to be collapsed with the rule of secondary stress assignment. Hayes (1981) identifies two rules of foot formation for the generation of English word stress. The first, called the English Stress Rule (ESR), forms a left-headed quantity sensitive bounded foot at the right edge of a word (see below 1.1.1.4 for more extensive discussion). The second, the Strong Retraction Rule (SRR) fills the domain not covered by the ESR with left headed quantity insensitive bounded feet. With the use of the accent, the two rules can be collapsed into a single rule which forms bounded left-headed feet from right to left, with the quantity sensitivity of the final foot encoded in a series of accent rules which mark certain final and penultimate syllables as obligatory heads. Hayes in fact notes that the SRR always respects the structure erected by ESR. This follows without any stipulation if the two rules are really one. Furthermore, no phonological rule has been suggested to be ordered between the ESR and the SRR, lending further support to the idea that the rules are to be identified as one. I return to a discussion of this issue below.

Consider now the effect of introducing accent into a language employing unbounded trees. In the case of unbounded trees, no adjacency constraint is placed on the non-head so that only those elements which are taken to be obligatory heads are marked as such. When no such element is found in the stress domain, the peripheral element -initial if the tree is left-headed and final if the tree is right-headed - is made the head. A language which has unbounded feet and accent is Koya, whose stress pattern is reported in Hayes (1981 p.58):

> Primary stress falls on the initial syllable and secondary stress on closed syllables or syllables with a long vowel.

The Koya system, disregarding once again the distinction between primary and secondary stress, can be derived by accenting all branching rimes and then constructing unbounded left-headed trees rooted in rimes. Notice that in the case of unbounded feet the direction of iteration is unimportant.

1.1.1.4 Extrametricality

So far we have seen smooth binary alternation interrupted by the adjacency of heads of feet. Deviation from strict binary alternation also arises from feet which appear to be ternary. One common source for apparent ternary feet is **extrametricality.** I will illustrate the effects of extrametricality with examples drawn from English stress.

The pattern of stress for English words is basically an alternating one. The effects of cyclic assignment of stress (see below 1.1.1.7) often obscure the smooth alternation, but the basic pattern is most clearly visible in long underived words.

(11)

Àpalàchicóla   hàmamèlidánthemum   Tìcònderóga

From words like **Ticonderoga** which have two adjacent stresses word initially, we see that tree construction in English proceeds from right to left and forms left-headed feet.

When we look at a wider range of underived nouns, the generalization emerges that when the penult of a noun is light, main stress falls on the antepenult, and when it is heavy (is closed or contains a long vowel), it falls on the penult. This pattern holds regardless of the weight of the final syllable.

(12)

Amérіca	metrópolis	ársenal	lábyrinth
Arizóna	agénda	appéndix	elítist

If we simply formed left-headed bounded feet from right to left, the wrong stress pattern would result for the words in (12).

(13)

In fact cross-linguistically, it is very common for the patterns of stress at the edge of stress domains to deviate from the pattern found domain-internally. To account for a wide range of data which falls under the general rubric of stress-deviance at the periphery of stress domains, Hayes develops a theory of **extrametricality** from a notion introduced in Nanni (1977) and Liberman and Prince (1977). The extrametricality diacritic may be assigned to a constituent at the periphery of a stress domain to make that constituent invisible to the process of tree construction. In the case of English nouns, Hayes suggests a general rule of Noun Extrametricality, which makes the final rime of a noun extrametrical.

(14)

$$\text{Rime} \dashrightarrow [+ex]/\_\_\_\,]_N$$

In this work, I will indicate the extrametricality of a constituent by placing that constituent in parentheses. In the case of the nouns under consideration, the final rime, after being marked extrametrical, is outside the stress domain, so the feet will be constructed as in (15) and main stress will fall in these nouns on the antepenult.

(15)

Americ(a)   metropol(is)   arsen(al)

Despite the fact that the rule for foot formation will mark the initial syllable in **America** and **metrupolis** the head of a foot, these words surface without stress in the initial syllable, and thus contrast with words like **Ticonderoga** with adjacent stresses in the first two syllables. The initial stresses in **America** and **metropolis** are removed by a rule of Pre-stress De-stressing discussed in Hayes(p.71), which removes stress from a non-branching rime immediately preceding another stress. Stress is not removed from **Ticonderoga** because it has a long vowel, hence a branching rime, in its initial syllable. I will return to this de-stressing rule below. In the case of words like **agenda** and **elitist** the stress is penultimate due to the effects of a rule which accents heavy penults in nouns.

The combined effects of extrametricality and binary *tree* construction can derive antepenultimate stress, as in (13). It is extremely difficult for the present theory to derive pre-antepenultimate stress, with no other stresses between it and the edge of the stress domain.

1.1.1.5 Grid Construction

So far we have dealt with the rules for calculating stress placement. We have not, however, dealt with the actual representation of stress assumed to be employed by the phonology. Central to the analysis in Chapter 2 is the assumption that the stress trees are themselves inherently uninterpreted (this is in fact the assumption made originally in Liberman and Prince (1977)) and that they are interpreted by rule at a given point in the phonological derivation.

The construct used for interpreting the stress feet is the metrical grid. The grid can be seen as a representation of the rhythmic beat of the language encoding the heightened prominence of certain beats. Take, for example, the representation in (16).

(16)

```
         *
*        *
*   *    *
* * *  * * *
Apalachicola
```

The grid in (16) encodes the fact that the penultimate beat is the most prominent in the word and that the first is more prominent than the third. For each degree of prominence there is a row in the grid. English has been shown to distinguish between three degrees of stress, and so we postulate four rows. The first marks the basic beat of the syllable (even stressless syllables participate in the rhythmic pattern of the language) and three addtional rows - two for the two degrees of non-primary stress and one for word stress. The process of grid construction I will be assuming is as follows:

1. Mark an asterisk (create a grid position) for each stress-bearing unit.
2. Add an asterisk for the the head of every stress tree.

Halle and Vergnaud argue that universally there are only three lexical grid rows. Each row in their theory corresponds to a prosodic domain: the foot domain, the cola domain and the word domain. The grid then takes the following form:

(17)

```
-------------------------    Word Row
-------------------------    Cola Row
-------------------------    Foot Row
-------------------------    Basic Beat Row
-------------------------
```

A language then may utilize up to three sets of trees to determine the placement of grid marks, with each set of trees used to place marks in a particular row in the grid. English is assumed to employ only two sets of trees - one to mark off binary feet and the other to derive word stress. The derivation of **Arizona** is given below. (The final rime is extrametrical (see 1.1.1.4) and the penult is marked with an accent, as all heavy penults in nouns are):

(18)

Foot Construction

Word Tree Construction

```
      *
      *
*     *
*  *  *  *
Arizona
```

Grid Construction

Notice that the word tree marks the head of the penult for main stress, and hence a mark is entered into the word row of the grid over that syllable. A mark is then automatically entered in the row beneath in the same column. As mentioned, English employs only two sets of trees for determining stress placement. Other languages, for example Paasamaquoddy (Stowell (1979)), use trees to gather the heads of feet into higher binary constituents - cola - so that the heads of alternating feet are marked for a degree of prominence between that of word stress and tertiary stress.

1.1.1.6 Operations on the Grid

Processes such as stress retraction and deletion which have previously been assumed to be formulated as operations on trees (Kiparsky (1979) and Hayes (1981)) are argued by Prince (1983) and Halle and Vergnaud (forthcoming) to be most perspicuously formulated as operations on the grid. (For very extensive discussion of these issues see these works.) In Chapter 2, I argue that the Tiberian Hebrew Rhythm Rule cannot be formulated as an operation on tree structure but has a natural formulation as an operation on the grid. Here I will illustrate how these authors demonstrate that both the structural description and the structural change of rules such as stress retraction can easily be defined on the grid.

The structural description of a stress retraction rule is normally a situation of stress clash. Prince argues convincingly that the definition of a stress clash may be formulated over grid configurations. He defines a stress clash as a grid configuration in which a single row n in the grid contains two adjacent grid marks, where adjacency arises when there is no intervening grid mark on row n-1. Consider, for example, the representation of the phrase **achromatic lense** taken from Prince (1983):

(19)

```
            *
      *     *
*     *     *
*   * * *   *
achromatic lense
```

On the third grid row, there are two adjacent grid marks even though the syllables are not linearly adjacent, because there is no grid mark on the second grid row intervening between them. This example shows clearly how the grid can represent much of the hierarchical structure encoded in tree representation. In the case of a phrase like (19), the clash is resolved by stress retraction. The retraction cannot be formulated over a simple linear representation of the syllables, since the landing site for the retracted stress is defined over the hierarchical structure of the grid. In English, stress is always retracted to the nearest syllable bearing the highest degree of stress. In the case of (19), the stress is retracted to the first syllable of the phrase. The rule, Prince suggests, can be formulated as one which moves the grid mark from one column to another in the same row.

(20)

```
                 *
*  <--o          *
*     *          *
*   * * *        *
achromatic lense
```

1.1.1.7 De-stressing and Cyclic Application of Stress Rules

In the discussion of Extrametricality, we encountered the rule of Pre-stress De-stressing. Here I will show how this rule can be fed by the cyclic application of stress and can also give rise to apparent ternary feet.

One of the major results of the study of English stress in SPE was the demonstration that the stress of derived words in English is determined by the stress of the subconstituents. To see how this is so, consider the examples below. The antepenult of each word in the left column surfaces reduced, while the corresponding vowels in the words in the right column surface unreduced.

(21)

àdjectíval	òbjèctívity
còmpensátion	còndènsátion

Since in English only vowels bearing no stress may be reduced, the reduction contrast indicates that the non-reduced vowels bear some degree of stress. If the stress rule were not sensitive to the internal structure of the words in the right column, the wrong stress contour would be derived, as in (22). In the examples below, I omit the rules of accent assignment and tree construction.

(22)

```
       *                   *
       *                   *
 *     *            *      *
 *  *  *   *        *  *   * *  *
condensat(ion)      objectivit(y)
```

In order to derive the correct stress pattern, stress is first assigned to the inner constituents.

(23)

```
     *                 *
     *                 *
     *                 *
  *  *              *  *  *
[condense]         [objective]
```

On the outer cycle, the stress rules apply once more, constructing and interpreting left-headed bounded trees, and leaving in tact the stress assigned on the earlier cycle. A general convention (corresponding to the SPE stress subordination convention) ensures that the stress assigned on the last cycle receives main stress. The means for implementing this need not concern us here. The effect of the convention is to remove the word row grid mark from the inner constituent.

(24)

```
        *                  *
        *                  *
     *  *               *  *
  *  *  *  *         *  *  *  * *
[condensation]     [objectivity]
```

However, it is not always the case in derived words that the stress of an inner constituent is maintained. Consider, for example, the word **extraposition** derived from **extrapose.** If we assigned stress cyclically, then the following stress contour wouid be derived.

(25)

```
            *
            *
   *    *   *
   *  * *   *  *
[[extrapose]ition]
```

In fact, however, no stress surfaces on the antepenult. We have already seen that English has a rule which removes stress from a non-branching rime before another stress. This rule removed stress from the initial syllable in words such as **America** and **metropolis.** This rule of De-stressing will also remove stress assigned on one cycle if it ends up adjacent to a stress assigned on a subsequent cycle.

(26)

```
      *                   *
      *                   *
*     *         *     *   *
*   * *         *   * *   * *
extrapose      [extrapose[ition]]    --->

               *
               *
       *       *
       *   * * *  *
       extraposition
```

As a result, the first foot in **extraposition** is ternary. This De-stressing rule is easily formulated as one which removes a grid mark from a position immediately preceding another stress.

1.1.1.8 Partial Interpretation of Trees

The system I have been describing here makes use of two formal constructs: trees and grids. What I have tried to show in the preceding discussion is that there is a natural division of labor between the two; they are functionally distinct. The relations of stress prominence among syllables is directly represented in the hieracrchies of the grid. The trees are not used to express stress hierarchies but are used rather as abstract markers for dividing a domain into constituents and singling out one element per constituent to be affected by a phonological rule. Trees themselves are inherently uninterpreted, and must be interpreted by rule. The rule we have been considering here is that of grid construction.

If, as we have been assuming, the interpretation of stress trees in the grid is accomplished by rule, then we would expect there to be variation in the kinds of rules which interpret these trees. The rules governing the placement of tonal accent in Creek, as discussed in Haas (1977) provide a clear illustration of how this is so.

Accent in Creek is realized tonally, and in a large class of words, the placement of the tonal accent is predictable. In a string of syllables which contain no lexically supplied accent, the tonal accent will be associated with the last even-numbered syllable of the word. The placement of the accent is dependent on a binary count which of course, can be accomplished by means of bounded trees.

(27)

ifoci	"puppy"
amifoci	"my puppy"
imahicita	"one to look after for someone"
isimahicita	"one to sight at one" (Haas p.203)

The syllable to be associated with the tonal accent is determined with the use of right-headed bounded trees constructed left-to-right. Significantly, however, not all the trees are interpreted. Rather, a right-headed unbounded word tree is constructed over the heads of all the feet, and the tone is associated with the syllable which is the head of the word tree. The other feet remain uninterpreted.

(28)

The Creek example demonstrates first, that the metrical tree may be interpreted by means of a rule of tonal association rather than grid construction, and that the interpretation may not necessarily be full.

Although not all trees need to be interpreted, there are severe restrictions on partial interpretation. So, for example, one would not expect a language which constructed bounded trees but which interpreted only the fourth tree from the right. In the present theory, the only way to single out one of a series of feet is by means of the unbounded tree. The unbounded tree will only single out a domain-peripheral constituent, so that it may only single out the first or the last of the feet for interpretation, unless one of them is marked extrametrical.

We have seen that rules such as stress retraction and deletion, which were previously considered rules manipulating tree structure can best be formulated as operations on the grid. A question to ask at this point is whether any phonological rule other than that which interprets the tree structure makes reference to the tree structure. A priori we would expect there to be rules which are defined on tree structure, if such structure is given ontological status in the phonology. In Chapter 2, I suggest that the stress-sensitive rule in Tiberian Hebrew of Pretonic Lengthening is in fact triggered by the presence of the head of a word tree. I suggest, moreover, that the rule applies before the tree structure is given a grid interpretation.

I have claimed that metrical trees are interpreted by rule. Grid construction is one such rule but by no means the only one. Central to my analysis of the Tiberian Hebrew accentual system is the idea that there is a metrically defined rule of Vowel Reduction in that language, which operates independently of stress. I claim that the Vowel Reduction trees are interpreted not by a rule of grid construction but by a rule which affects the segmental features of a vowel in the recessive position of such a foot.

In general I propose that the metrical tree is the device made available to the phonology for the application of iterative rules and the expression of non-local phonological dependencies. It is a fact that rules of stress assignment are not the only ones which may operate in an iterative binary fashion. In Chapter 2 I show that the TH Vowel Reduction rule is another. There are languages in which rules of syllable quantity modification are sensitive to an odd-even count just as some stress rules are. In certain cases, these rules are demonstrably defined independently of stress. For example, Tübatulabal has both an alternating vowel lengthening rule and alternating stress rule. What is striking about the Tubatulabal case is that the stress rule applies from right to left, while the vowel lengthening rule applies left to right.

The claim made here is that the metrical tree is the device made available for the proper application of all these rules. What this means, of course is that a word may have a number of simultaneously represented tree structures associated with it. In some sense, we may think of the independent trees as represented on distinct tiers, analogous to the representation of different morphemes or different features on separate tiers (see section 3).

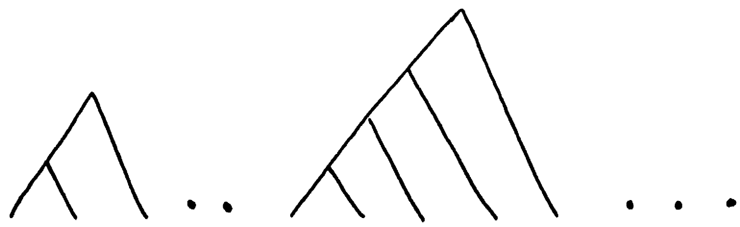
1.1.2 Previous Metrical Theories

The conception of tree structure just outlined differs markedly from that assumed in previous tree-based theories. Hayes's (1981) study represents an attempt at a careful formalization of a metrical theory of stress systematically applied to a wide range of languages. The theory Hayes develops is in many ways richer than the theory adopted here, in that the former makes use of constructs and operations not available to the latter. Moreover, that theory, unlike the one advocated here, has the entire utterance dominated by a hierarchical tree structure which represents the stress prominence relations. In this section, I review the essence of Hayes's theory and briefly show how much of the additional apparatus is not really needed. Many of the observations contained herein are due to Prince's (1983) insightful and incisive critique of tree-based metrical theory.

1.1.2.1 Binary Branching Trees

The primitive construct of Hayes's theory is the binary branching tree. We are familiar with the binary tree from looking at languages with a basically alternating pattern of stress. In earlier theory, the unbounded tree is derived from the binary tree by recursion on one of the branches; one branch of the binary tree is allowed itself to dominate a branching tree.

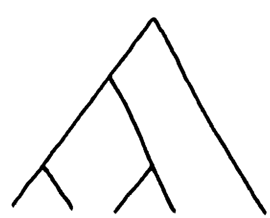
(29)



Corresponding to what we have called the headedness of a tree, the theory requires that the **dominance** of each binary branch be specified. In a **left-dominant** tree, the left node is dominant and the right node is recessive, while in a **right-dominant** tree the right node is dominant and the left node recessive. The overriding constraint on tree construction is that a recessive node may not dominate a branching structure. Since trees must be either left or right dominant, it follows then that they must also be uniformly left or right branching. The requirement of uniformity of dominance (= uniformity of branching) rules out a structure such as the one in (30).

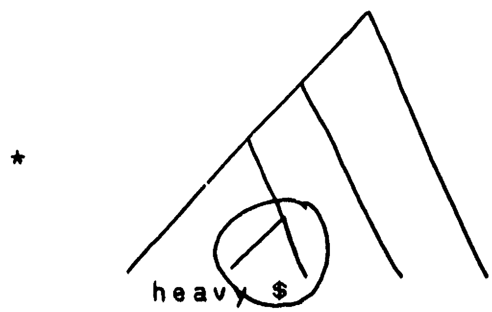
(30)

*



In the cases of languages with quantity sensitive patterns of stress, the branchingness of the rime is considered a special case of tree branching, on par with the branching external to the syllable. The effect of this is of course that heavy syllables in such languages must be in the dominant position of a binary tree. In the case of an unbounded tree, the heavy syllable is restricted to a peripheral position. Since a heavy syllable counts as a binary branch, placing a heavy syllable in a non-peripheral position would violate the uniformity of branching requirement.

(31)

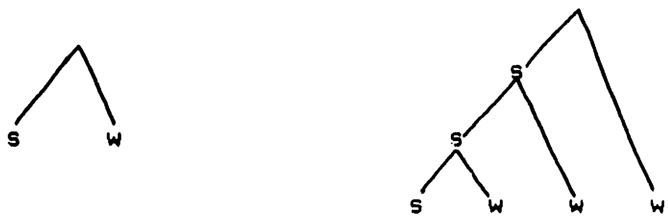


1.1.2.2 Labeling Conventions

In addition to the specification of the dominance of a tree, the theory employs **labeling** rules for trees. Each binary branch represents the relative prominence between the daughter constituents. For each binary branch one node is labeled **strong** and the other **weak.** The dominance of a set of trees determines how the trees are aligned with the string of syllables in the domain of the stress rule. The labeling encodes the prominence relations among the terminal elements of the trees.

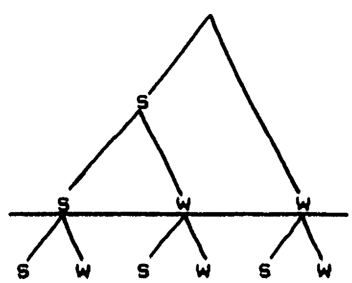
The unmarked rule for labeling trees is: label dominant nodes strong and recessive nodes weak. This yields the following labelings for a left dominant bounded tree and a left dominant unbounded tree:

(32)



As we have seen, not all heads of feet are always equally prominent, since one is often singled out for primary stress. In earlier metrical theory, feet are themselves gathered into a binary branching word tree, labeled with the same labeling conventions as the feet themselves.

(33)



If in most cases each dominant node is labeled strong and each recessive node is labeled weak, why employ labeling rules at all? In Hayes's theory labeling rules are employed for two reasons. The first is that under certain conditions trees may be **relabeled** to express a shift in the prominence relations of the terminal elements of a tree.

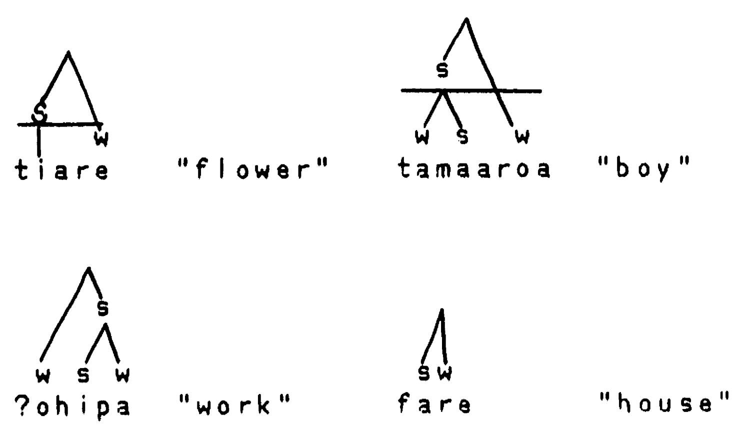
The second is that there are assumed to be languages which employ labeling rules different from the common one which labels dominant nodes strong. The second most common labeling rule is taken by Hayes to be : label dominant nodes strong iff they branch. One language which is purported to have such a labeling rule is Tahitian (Hayes p. 114). The stress pattern of Tahitian is described as follows:

a. Stress the left most long vowel or diphthong
b. In a word with no long vowel or diphthong, stress the penult.

If rimes with long vowels or diphthongs are the only rimes considered branching, then the stress pattern can be derived as follows:

a. At the left edge of the word, form a right dominant unbounded foot.
b. Label dominant nodes strong iff they branch.
c. Form a left dominant word tree.

(34)

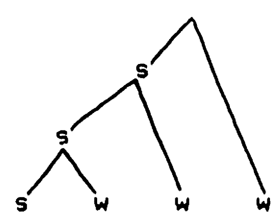


The tree construction procedure for the final two examples yields a single foot encompassing the entire word. Since only in the case of words lacking long vowels the last dominant node does not branch, only in these cases is the most embedded binary branch labeled [sw].

The theory supported here dispenses with labeling, making do with the concept of **headedness**. Moreover, while the present theory employs both bounded and unbounded trees, the unbounded trees are "flat," not derived from stacking up binary trees.

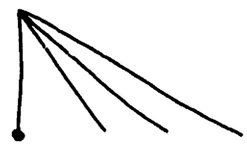
Is anything crucial lost by dispensing with structures such as the one in (35), and the labeling rules?

(35)



In (35), the labeling tells us that the first terminal element is more prominent than the second, and the second more prominent than the third, etc. Significantly, however, Liberman and Prince (1977) note that all speakers perceive in a stress pattern represented by a structure like (35), is that the leftmost element is more prominent than the rest. This is precisely what is encoded in (36) and no more.

(36)



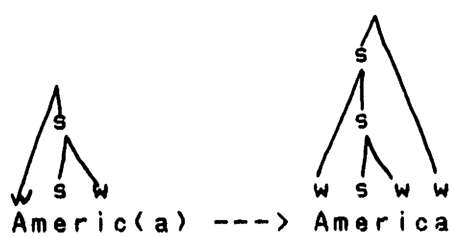
Furthermore, it appears that the information conveyed by the depth of embedding in a structure like (29) plays no role in any phonological rules in Hayes's system.

What about labeling rules? We have already seen that the cases of stress shift formerly handled by relabeling rules are naturally formulated as operations on the grid. When a tree is labeled in such a way that dominant nodes are strong, then labeling is redundant, since all the information is encoded in the dominance of the tree. What remains then to be accounted for are the labeling rules which depart from dominant=strong. We have seen that the most common one is dominant=strong iff it branches, which was used by Hayes to generate the Tahitian stress pattern. Notice, however, that the stress pattern of Tahitian may be derived by constructing a right dominant unbounded tree and marking the last rime extrametrical. This then removes one of the major motivations for retaining labeling feet in addition to establishing their headedness.

1.1.2.3 Stray Syllable Adjunction

Another kind of rule which is employed in Hayes's theory but is absent in the theory adopted here is Stray Syllable Adjunction. In Hayes's theory, the prominence relations of the syllables are read directly off of the metrical tree. For this reason, all the syllables of an utterance must be assigned a place in the overall hierarchical tree structure. Constituents which are precluded from the process of foot formation because of extrametricality are, at some point in the derivation, then *stray adjoined* to existing tree structure as weak sisters.

(37)



The same is taken to be true for syllables introduced by rules of epenthesis after foot formation, and syllables which are de-footed by de-stressing rules.

Under the approach adopted here, where prominence relations are read off the grid, operations like stray adjunction are unnecessary. What stray adjunction says, basically, is that syllables which have been excluded from foot formation remain unstressed. This information is contained in the grid representation of **America**, in which the last syllable has no foot level grid mark.

(38)

```
   *
   *
   *
*  *  *  *
America
```

In certain cases Hayes relies on SSA to derive a branching foot which plays a crucial role in a particular stress system. Stray Syllable Adjunction plays such a role in Hayes's analysis of Tiberian Hebrew. In Chapter 2 I show that there is a much more natural way to deal with the Tiberian data without resorting to a rule of SSA.

1.1.2.4 Foot Preservation

Kiparsky (1982) and Hayes (1981) discuss the conditions under which the metrical structure constructed by one rule may override that constructed by another. For example, Hayes observes that the SRR (see 1.1.1.3) always respects the domain covered by the ESR on the same cycle. As we noted above, this is precisely what we would expect if both rules were one. Hayes observes, however, that the SRR may override structure created on a previous cycle. For example, the derivational history of **parental** in Hayes's analysis is:

(39)

s w
[par(ent)] ESR, SSA

s w
[parent(al)] ESR, SSA, De-stressing

It is significant, however, that in case after case of metrical structure overriding previously existing metrical structure, a syllable originally marked weak is marked strong by the later rule. In no case do we find a later rule marking weak a syllable originally labeled strong. This however is precisely the effect which is captured if we assume that the **grid structure** is preserved from cycle to cycle. On each new cycle, trees may be used to calculate the placement of stress in the domain to which no grid marks have yet been assigned.

In Chapter 2, I review previous metrical accounts of Tiberian Hebrew phonology which employ the whole range of descriptive apparatus not available to the theory advocated here. I show that, not only is there an analysis available which does not make use of the additional apparatus, but in fact the analysis presented in the more restrictive framework is superior to the earlier analyses.

1.1.3 A Grid Only Theory

Much of the insight on which the critisim of earlier metrical theory in the previous section is based, derives from Prince (1983). In a radical departure from the accepted view of metrical structure, Prince advocates a theory of stress in which the stress contours of a language are derived by direct operations on the grid, with no intermediate step of constructing trees and designating certain elements as heads. He argues that all the well attested patterns of stress can be generated by two basic operations on the grid. The first, the End Rule, strengthens, or marks for prominence, an element at the periphery (beginning, end) of a domain. The second is a process called Perfect Grid (PG) which fills a domain with an alternating pattern of stress.

In Chapter 2, an attempt is made at providing a grid-only analysis of the Tiberian Hebrew stress system. The attempt founders on certain phenomena which are at the heart of the TH stress system. While I have no doubt that with sufficient ingenuity it is possible to devise a grid-only analysis which will handle all the data, the point made in that chapter is that a theory making limited use of trees in addition to the grid provides a maximally simple and natural account. In this section I review the essentials of Prince's theory and then go on to compare it with the theory advocated here.

Prince recognizes three separate sources for stress. The first, the End Rule, marks a domain-peripheral constituent with stress. The second, Perfect Grid, imposes maximal rhythmic organization on a string in such a way that stress alternates binarily and there are no stress clashes. The avoidance of stress clash is seen as the principle governing the construction and organization of the grid. The third source for stress comes from what has been called the quantity sensitivity of a language. Recall that in some languages, certain syllables, often identifiable phonologically, always receive some degree of stress regardless of their position in an utterance. Prince takes this stress to be an inherent one, with which the heavy syllables of a quantity sensitive language are endowed underlyingly. Alternatively, this may be due to a rule which simply stresses all syllables of a certain type.

We can illustrate how the system works by first generating the stress pattern of Maranunku in which primary stress falls on the initial syllable and secondary stress on every other syllable thereafter.

(40)

```
     *  *  * *
a.  yangarmata        "the Pleiades"

     *     *
     *  *  * *
    yangarmata        Perfect Grid

     *
     *     *
     *  *  * *
    yangarmata        End Rule


     * * * * *  *
b.  welepenemanta     "a kind of duck"

     *   *   *
     * * * * *  *
    welepenemanta     Perfect Grid

     *
     *   *   *
     * * * * *  *
    welepenemanta     End Rule
```

Notice that Perfect Grid derives the effects of interpreting binary trees without the use of binary trees. Corresponding to the parameters of headedness, Perfect Grid must be specified for whether it initiates its sweep with the peak (stress) or the trough (absence of stress). In the case of Maranunku, PG is specified as Peak First, and its direction of iteration is left to right. This corresponds directly to specifying that the feet constructed are left-headed and assigned left to right. It should be easy to verify that PG trough first iterating left to right has the effect of constructing right-headed bounded feet left to right. In the Maranunku case, the End Rule is specified to single out the first stress. This corresponds to the unbounded tree which singles out the head of the first foot in a word. Just as a word tree may be either left-headed or right-headed, so the End Rule may be specified for strengthening the initial or the final stress.

As mentioned, the quantity sensitivity of a language can be captured in the grid-only theory either by endowing heavy syllables with inherent stress, or else by including a rule which simply stresses heavy syllables. To illustrate how the system handles a language with a binary quantity sensitive alternation, I derive the stress of some words in Tubatulabal, which were cited above.

(41)

```
       * *  * * *
  a.  wašaagahaja          "it might flame up"

         *
       * *  * * *
      wašaagahaja          quantity-sensitivity

         *  *   *
       * *  * * *
      wašaagahaja          PG,R-->L, Peak First
```

```
       *  *  *    *  *  *
b.   anaŋiininɨmut            "he is crying"

           *
       *  *  *    *  *  *
     anaŋiininɨmut            quantity sensitivity

       *     *    *     *
       *  *  *    *  *  *
     anaŋiininɨmut            PG,R-->L, Peak First
```

Notice that the combination of quantity sensitivity and perfect grid yield stress clashes in Tubatulabal. Although the guiding principle of the Perfect Grid is Clash Avoidance, Prince allows for the setting of a parameter, Forward Clash Override (FCO), which allows PG to register a stress immediately before, but not immediately after, a previously existing stress. Tubatulabal then chooses the option of Forward Clash Override.

We saw above that in the tree theory, the terminal elements of the trees may vary from language to language. Varying the TEs changes the units counted for the calculation of stress placement. The grid-only theory can also vary the units counted for stress placement. Recall that in Southern Paiute, the terminal elements of the trees are taken to be the moras, since stress is assigned to alternating moras. In a grid-only theory, the lowest grid row for words in a language such as Southern Paiute would contain a mark (position) for each mora. The stress pattern of Southern Paiute can be generated as follows:

(42)

```
     *  *
 *   ** * *
mantcaAqa(A)        PG, trough first, L-->R

   *   *
 * **  *  *   *
maroOqway'ɨqW(A)        "   "
```

We have just seen that the tree-grid theory advocated here, and the grid-only theory espoused by Prince (1983) are designed to handle the same range of phenomena. The unbounded tree which singles out domain-peripheral elements accomplishes the same task as Prince's End Rule. The binary trees used to derive an alternating pattern of stress covers the same range of data as PG. The identical set of options - direction of iteration and initiation with "peak" or "trough" - is available to both theories. Each theory has a means to derive the effects of quantity-sensitivity; the tree-grid theory by means of an accent and the grid-only theory by directly assigning stress to syllables a language considers heavy. Furthermore, we have seen that just as the tree theory can vary the terminal elements of the tree so that the calculation for stress placement may be based on rime count, mora count, or a count of a subset of rimes, the grid-only theory has a means to vary the counting units as well.

What then is the distinction between the two theories? Given that the theory supported here posits two formal constructs - metrical trees and a metrical grid - where the grid-only theory posits only one - the metrical grid - it is incumbent upon me to justify the use of trees, since, without such justification, considerations of parsimony favor the grid-only theory.

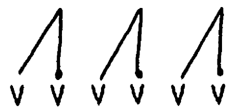
There are, I think, a number of reasons for maintaining metrical trees and the rules for constructing them. I mentioned above rules of stress assignment are not the only ones which may operate in an alternating iterative fashion. Although Prince is not explicit on this point, he seems to imply that all binary alternations are stress-dependent, and that segments and constituents which undergo phonological processes based on a binary count can alway be identified by means of their place in the grid. This, I would claim, is not the case.

In Chapter 2 I show that Tiberian Hebrew has two binary alternations - stress and vowel reduction. What is interesting about these two alternations is that they are not perfectly aligned. The stress rule may mark a vowel the strong member (head) of a stress constituent (foot), while the vowel reduction rule may mark the same vowel as the weak member of a reduction foot. In my analysis, two set of trees - stress trees and reduction trees - are simultaneously rooted in rimes and constructed independently. Each set of trees is interpreted by the appropriate rule - stress assignment and vowel reduction - and the correct surface forms are derived from the interaction between the two rules. I show in Section 4 of that chapter that a grid-only theory has difficulty handling the Hebrew data, because it has no way to indicate that a single vowel is in the "peak" position of one alternation and the "trough" position of another.

Another important difference between the two theories is that the tree theory imposes a constituent structure upon the stress domain, whereas the grid-only theory does not. Although it is not easy to find arguments for constituency, there is nonetheless evidence supporting the existence of stress constituents. The constituency implied by the tree theory is manifest in two ways.

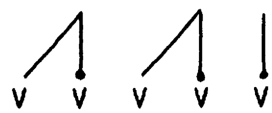
Recall that I have been assuming that a rule which constructs trees over a domain must do so exhaustively - the entire domain must be included in the tree structure. This means that every element in the domain is included in some constituent demarcated by a tree. Consider for example a language which assigns stress to even-numbered vowels counting from the left edge of the word. In the tree theory, this pattern can be derived by forming bounded right-headed feet from left to right as in (43).

(43)



Consider now what happens when the rule is applied to a word with an odd number of syllables.

(44)



The first four syllables are gathered into two binary feet. What about the last syllable? It must be assigned to a foot, since the tree construction rules must apply to the entire domain. It cannot be included in the foot to its left, since each foot can be maximally binary. It must then constitute a foot of its own. By definition, each foot has a head, and so the syllable will be marked as the head of the unary foot. All other things being equal, that syllable should be assigned a foot row grid mark when the trees are interpreted through grid construction.

On the other hand, if Perfect Grid were applied to the same string, there would be no reason to expect stress to surface on the final syllable. To derive the pattern of stress described above, Perfect Grid would operate right to left, trough first. After the fourth syllable is assigned to a peak, the fifth syllable should be aligned with a trough and should surface without stress. The stress system of English itself bears out the predictions made by the tree theory. Recall that the stress system of English may be generated with the use of bounded left-headed trees constructed from right to left. Final rimes in nouns are marked extrametrical, and heavy penults are accented. A grid only theory would characterize the same system with the use of extrametricality, inherent stress on heavy penults and Perfect Grid, trough first, iterating from right to left. Consider now how the stress pattern of a word such as **Ticonderoga** would be generated exclusively with grid operations.

(45)

```
        *
 * *  * *
Ticonderog(a)    Lexical representation

   *    *
 * *  * *
Ticonderog(a)    PG, trough first, R-->L
```

After PG registers its first "peak" on the second syllable of the word, there is no reason for it to register another grid mark on the first syllable.

This situation is not always found in languages with the rules which would produce such a stress configuration, since there are languages with absolute restrictions against adjacent stresses. However, such a patttern of stress distribution is well-enough attested to suggest that it supports the claims made by the tree theory.

The final piece of evidence for constituency comes from stress shift following deletion of the head of a stress constituent. There is evidence that tree structure is preserved even following the deletion of an element serving as the head of a tree. Given that a foot is a constituent with a head, if the tree structure representing the foot persists after deletion of the head of the foot the head status is then transferred to another element in the foot, and the element to which the head status is transferred is determined by the properties of the foot. If the foot is left-headed, the surviving left-most syllable will become the head of the foot. If the foot is right-headed the status of head will be conferred to the surviving right-most syllable. Halle and Vergnaud (forthcoming) bring evidence from Sanskrit and Russian to illustrate this phenomenon. They show that in Sanskrit a rule which desyllabifies an accented vowel results in stress surfacing on the vowel to the right of the accented vowel, while in Russian deletion of an accented vowel results in stress surfacing on the vowel to the left of the accented vowel. This leads them to postulate a left-headed foot structure for Sanskrit and a right-headed foot structure for Russian.

A particularly striking example of stress shift as a result of deletion of a vowel in the head postion of a foot comes from the Bani Hassan Bedouin dialect of Arabic described in Kenstowicz (1983). Kenstowicz shows that the stress pattern of Bani Hassan can be derived from marking final syllables extrametrical and interpreting bounded left-headed trees constructed left to right.

(46)

banat(u) ---> bánatu

šaafat(u) ---> šaáfatu

baarakatn(aa) ---> baàrakátnaa

baarakat(u) ---> baàrakátu

Main stress may be derived from interpreting a right-headed bounded foot. Kenstowicz also motivates a rule which deletes a short vowel in an open syllable under certain conditions.

(47)

sáḥab

sḥábuu

sḥábat

The example in (48) shows that when this rule deletes a vowel which is marked as the head of a secondary stress foot, secondary stress surfaces on the vowel which was originally marked as the non-head of the secondary stress foot.

(48)

saḥabatu ---> sḥabatu

sàḥabátu ---> sḥàbátu

This example is compelling for a number of reasons. First, the left-headedness of the secondary foot is independently motivated for the stress pattern of the language. Second, it is not primary stress, but secondary stress which "shifts" as a result of deletion. Therefore, the retention of stress cannot be attributed to some requirement that words of major lexical categories must bear stress. Finally, the stress "shift" gives rise to a stress clash. As mentioned, the leading principle governing PG is Clash Avoidance. Clash may arise when PG is parameterized for Foward Clash Override (FCO). Forward CLash Override is relevant when Perfect Grid registers a stress adjacent to a previously assigned stress, as in the case of Tubatulabal. In the Bani Hassan case, the stress clash is not the type handled by FCO, suggesting that it is a result of foot structure preservation after deletion of a foot head.

In Chapter 2, I suggest that a similar kind of stress shift is operative in TH as well. I show that a theory employing metrical trees in the manner described in this section deals with the stress shift facts without any rules and quite straighforwardly. This grid-only theory, on the other hand, has great difficulty dealing with the same range of facts.

1.2 Lexical Phonology

The theory of Lexical Phonology has emerged from the research of various authors, including Pesetsky (1979), Kiparsky (1982) Mohanan (1982), Pulleyblank (1983) and Halle and Mohanan (1983). Central to the theory of lexical phonology is a view, which departs from that of SPE, of the interaction between phonology and morpholgy.

Although SPE predates explicit theories on the structure and internal workings of the morphological component of grammar, the implicit assumption in that work is that all morphological concatenation and syntactic arrangement of words takes place prior to the operation of phonological rules. After morphological concatenation, lexical insertion into syntactic phrase markers and the application of certain readjustment rules, the rules of phonology were thought to apply to representations which were viewed as linear sequences of matrices punctuated by boundary markers.

Since SPE, much research has been done on the structure of the lexicon and the nature of morphological rules. An important result which emerges from this work is that there is an interdependency between the rules of phonology and morphology which a system such as the one presupposed in SPE cannot naturally account for. On the one hand, phonological rules are known to be sensitive to morphological information such as the internal constituency of a word. On the other hand, certain morphological processes are known to be sensitive to the derived phonological properties of the words to which they apply.

I will first illustrate how phonological rules may be dependent on morphological information. It has long been known that the affixes of English can be divided into two classes - the Class I and Class II affixes of Siegel (1974). These affixes can be distinguished in two ways. First, certain phonological rules are known to operate across the boundary of one class but not across the boundary of the other. For example, Nasal Assimilation is triggered by affixation of the the prefix in-.

(49)

illegal (*inlegal)   irresponsible (*inresponsible)

In contrast, it is not triggered by the affixation of the the prefix non-.

(50)

nonlegal (*nollegal)   nonresponsible (*norresponsible)

Corresponding to the phonological difference betwen the two prefixes is the morphological fact that, although words with both prefixes are not often spontaneously produced, in- can occur inside of non- but not vice versa.

(51)

non-illegal *inonlegal

A similar dependency of the phonological rules on morphological information can be illustrated with suffixes in English as well.

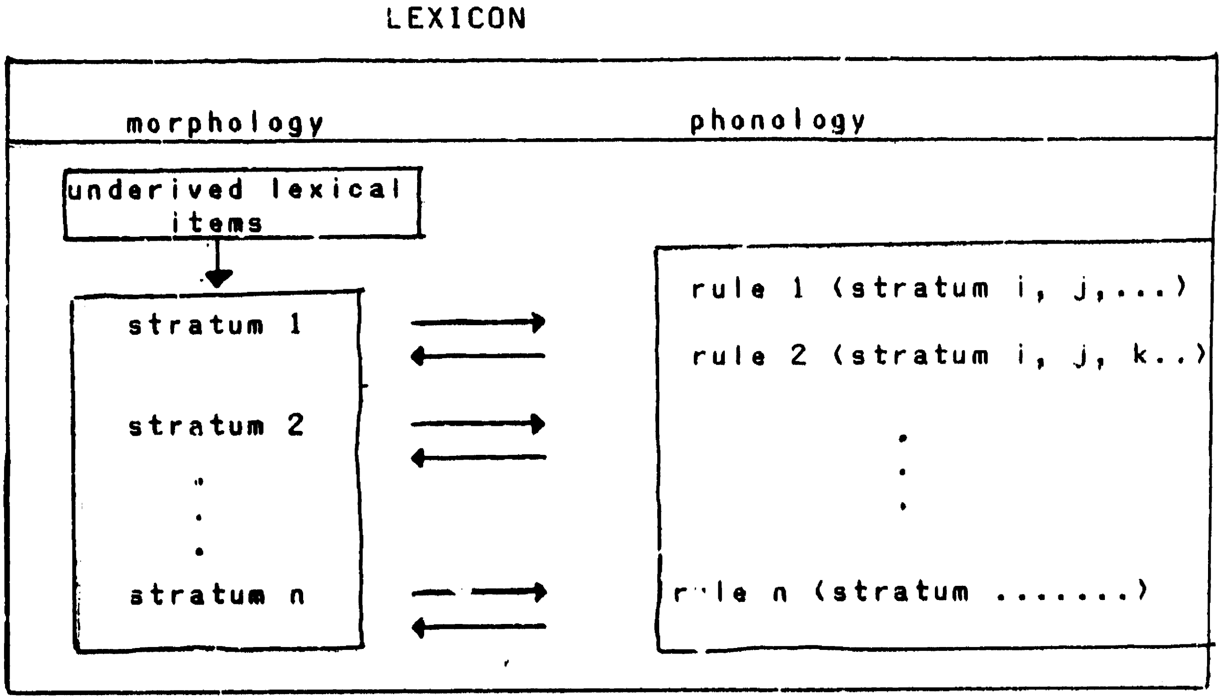
That morphological processes may by dependent on phonological properties can be seen from the restriction placed on the affixation of the deverbal nominalizer -al. It has been shown by Ross (1972) that -al will attach to verbs with final, but not prefinal, stress.

(52)

arrival refusal *exital *promissal

The theory of lexical phonology accounts for this range of data by attributing a particular organization to the lexicon from which the interdependency follows naturally. The theory assumes tnat morphological processes are organized into a series of ordered blocks, or strata, in the lexicon. Each morphological process is assigned to one stratum. The phonological rules as well are specified for the strata at which they apply. It is assumed that the output of of each morphologicasl stratum is a well-formed word, which is the input to the phonological rules assigned to that stratum.

(53)



The number of lexical strata in English is a matter of controversy (see, for discussion, Kiparsky (1982) and Halle and Mohanan (1983)). To account for the English data mention above, we need only distinguish between two lexical strata. Let us assume that the prefixation of non- occurs at stratum 2, while that of in- occurs at stratum 1. The rule of Nasal Assimilation operates at stratum 1 but not at stratum 2, accounting for the fact that the rule applies across the boundary of a stratum 1 affix but not a stratum 2 affix. More importantly, however, the idea that morphological processes apply in ordered sets of blocks, with rules of phonology ordered between the blocks, accounts quite naturally for the fact class I affixes are always found inside Class II affixes and for the fact that the affixation of Class II affixes may be sensitive to phonological features of words with Class I affixes but not vice versa. In Chapter 2, I suggest that Tiberian Hebrew, too has two morphological strata, and that at least two rules - Vowel Reduction and Vowel Deletion - apply at both lexical strata.

Although the phonological rules operating at stratum _n_ may be sensitive to the morphological constituency derived at that particular stratum, it has been observed that it may never be sensitive to the morphological constituency derived at stratum _n_-1. To account for, this various versions of a **Bracket Erasure Convention** have been assumed, the main gist of which is that as a lexical item exits a given stratum, its internal bracketing is erased, so that its internal constituency is no longer available for the phonological and morphological processes of the following stratum.

Contrasting with the rules which apply in the lexicon - the lexical rules - is the set of rules which apply after words emerge from the lexicon and are inserted into syntactic phrase markers. These are the post-lexical phonological rules. Some earlier studies assumed that the set of lexical and the set of post-lexical rules are disjoint, but recent studies have come to conclude that a rule may apply both lexically, in a number of continuous strata, and post-lexically. In Chapter 3, I will suggest that at least two rules of Tiberian Hebrew apply both lexically and post-lexically. When the manner of application differs lexically and post-lexically, the differences are attributed to general principles governing the application of lexical and post-lexical rules. I will not discuss these issues further here, but refer the interested reader to the discussions in Mohanan (1982), Harris (1983), Kiparsky (1982, 1983), Pulleyblank (1982) and Halle and Mohanan (1983). It should be clear, however, that given the Bracket Erasure Convention, no information concerning the internal constituency of a lexical item may be available for post-lexical rules.

1.3 Autosegmental Phonology and Morphology

The theory of Lexical Phonology of which I have just given a brief sketch, presents a new perspective of the interaction between the phonological and morphological components of grammar. The theory of autosegmental phonology, on the other hand, is concerned with the nature of the phonological representation itself.

In SPE, the phonological representation was conceived of as a linear sequence of segments punctuated by boundary symbols. We have just seen that the use of boundary symbols has been made obsolete with the theory of lexical domains. But it has also been shown that the SPE view of the structure of the segments themselves is inadequate. It has long been recognized that segments are not atomic units, but can be decomposed into sets of features corresponding to such properties as manner of articulation. These features, which are the primitives of the phonological string, are, in the SPE theory, arranged in linear sequences of discrete matrices into which the phonological string is exhausitively parsed.

Autosegmental phonology challenges the idea of the "integrity of the segment," suggesting that the phonological representation consists of several parallel sequences of entities which operate independently of each other. Each sequence is called an autosegmental tier, and contains entities corresponding to a particular feature or set of features.

The major impetus for the devlopment of the autosegmental phonological representations came from the analysis of tone languages. The autosegmental representation of tone postulates a tonal tier which is independent of the segmental tier. The tonal tier consists of a sequence of tones, called a tonal melody, each tone being a phonological entity in its own right, and not a mere diacritic associated with a segment. The segments of the language are specified for whether or not they are tone-bearing, i.e. whether or not they may be associated with a tone. The alignment of the tones with tone-bearing units is accomplished by rules of association or linking. Following Clements and Ford (1979), tones are represented as T and the tone-bearing units as t .

(54)

$$\begin{array}{cccc} T & T & T & T \\ | & | & | & | \\ t & t & t & t \end{array}$$

The following conventions accomplish the linking between unassociated tones and tone-bearing units (from Pulleyblank (1983):

(55)

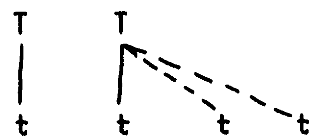
Associate tones with tone-bearing segments

a. left to right

b. in a one to one-relation

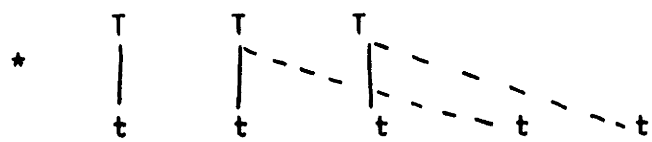
For extensive discussion of the nature of the association conventions see Pulleyblank (1983)). After these links are set up by convention, further rules may effect other associations. For example, if after the initial association is accomplished, there remain segments unassociated with a tone, a rule of <u>spreading</u> may result in a many to one association between tone and segment.

(56)



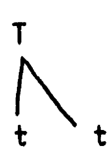
The linking of tones to segments is constrained by a universal well-formedness condition that association lines may not cross.

(57)

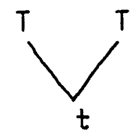


The most important consequences of this mode of representation are the following:

- The number of entities on one tier need not correspond to the number of entities on another tier, and the association of tones to segments may be one to many or many to one. A single tone may be linked to more than one segment:



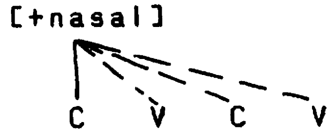
and more than one tone may be linked to a single segme



- Phonological rules may affect an entity on one tier without affecting the entity with which it is associated on another tier. So, a rule may, for example, delete a tone, but not the segment with which it is associated, or delete a segment but not its associated tone.

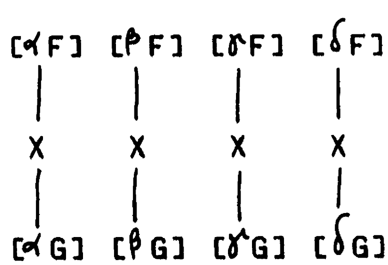
The extension of the autosegmental apparatus to non-tonal phenomena was quick to come. It was suggested that not only prosodic features such as tone, but segmental features such as nasality may be represented on distinct autosegmental features as well. For example, processes of harmony such as nasalization can be naturally described as an autosegmental process of spreading, if it assumed that the the feature [nasal] is represented on a sepearate autosegmental tier. Just as the tone-bearing units must be specified for the association of tonal autosegments, so for each autosegment, such as [+nasal], the autosegment bearing units (or p-bearing units) must be specified, since languages differ, for example, in the set of segments which may be specified [+nasal]. Processes such as nasal harmony then provide examples of one to many mappings between a nonprosodic feature and segments.

(58)



A given phonological representation may contain a number of autosegmentalized features, with each such feature behaving independently from the rest. I assume, that there is one basic tier, composed of featureless time slots and called the skeletal tier or the skeleton, to which the features on all the various tiers associate. Each entity on every tier must associate directly to a slot in the skeleton. The properties of a particular segment corresponding to a single slot in the skeleton are determined by the sum of the features associated witn that slot.

(59)



Since we distinguish now between the features of the segments and the slots to which they are associated, I will refer to a sequence of feature matrices as a phonemic melody and to a single matrix as a melody unit.

The original motivation for the separation of the phonemic melody from the skeleton was morphological, not phonological. McCarthy (1979) showed that the theory of autosegmental representations provides a solution to the problem of dealing with non-concatenative systems of morphology such as those of the Semitic languages and lends important insights into their internal workings. The system McCarthy studied most closely is that of the Classical Arabic verbal system. Since then, the autosegmental theory of morphology has been applied to a wide range of phenomema and to other language families beyond Semitic. (See, for example, Marantz (1982), Yip (1982), Levin (1983) Archangeli (1983) and McCarthy (1983).) Here I do not give an extensive review of all the aspects of the theory of autosegmental morphology but introduce those aspects which are relevant for the discussion throughout the dissertation.

Every word of a major lexical category in Semitic languages such as Classical Arabic and Tiberian Hebrew is a based on an abstract (most often tri-) consonantal root. Each such consonant is called a radical. Morphological derivation consists of the arrangement of the radicals in various patterns and the intercalation of different vowel sequences. For example, šabar is the third person singular perfective form of the verb "to break" in TH. The abstract root which may be extracted is ŠBR. Different words may be derived from the same root by intercalating a different sequence of vowels or varying the arrangement of the radicals. So, for example, šibber is the intensive form of the same word, and šubbar is the passive of the intensive. This "root and pattern" process is the strategy used for stem derivation. The languages also make use of affixational morphological processes.

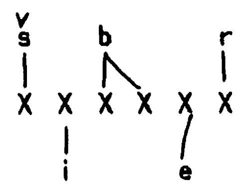
The autosegmental analysis of such a morphological system takes the abstract root to be represented as sequence of consonantal feature matrices unassociated with skeletal slots. The process of morphological derivation consists of pairing the consonantal root with a particular skeleton, or skeletal template, and a sequence of vowels. The templates represent the canonical shapes which the morphemes of the language may take. The vowels, consonants and skeletal slots are each represented on distinct autosegmental tiers. The association of phonemic melodies with slots in the template is constrained by the same well-formedness condition governing the association of tonal autosegments - association lines may not cross. The representation of šabar would be as in (60). <1>

(60)

```
š   b   r      (consonantal melody tier)
|   |   |
X X X X X      (skeletal tier)
  |   |
  a   a        (vocalic melody tier)
```

New words may be derived from the same root by varying the skeleton and the vocalic melody. So to derive the related word "he broke (intensive)," a different skeleton and vocalic melody are supplied.

(61)



Notice that in (61), there is one more skeletal slot than there is in (60). A general principle of TH morphology ensures that when a triconsonantal root is associated with a template with four consonantal slots, the medial radical geminates, i.e. it associates with two adjacent skeletal slots.

The independence of the three tiers represented in (61) is supported by the fact that all three may vary independently. The verbal sytem of Tiberian Hebrew consists of seven major derivational classes, or binyaniim (sg. binyan), each associated with a particular skeletal template and vocalic melody. Some of the classes are also associated with with prefixal material. The examples in (62) illustrate the three stem template shapes made available for verbal derivation with triconsonantal roots in Hebrew.

(62)

```
š   b   r
|   |   |
X X X X X
  |   |
  a   a

š   b     r
|   |\    |
X X X X X X
  |     |
  i     e

l     š b   r
|     | |   |
X X + X X X X
  |       |
  i       o
```

In Chapter 3 I argue extensively that there are really only two skeletal templates and that the one in (c) is derived from the one in (a) by rule.

That the consonants and the vowels must be represented on distinct autosegmental tiers may be seen from the strategies the language employs when the number of consonantal slots <2> exceeds the number of consonantal radicals. Although the majority of roots in the language are triconsonantal, there exists a large class of bi-consonantal roots. The bi-consonantal roots may be associated with special bi-consonantal templates, but may also associate with tri-consonantal templates. So, for example, the root SB ("to turn"), may appear in the following forms:

(63)

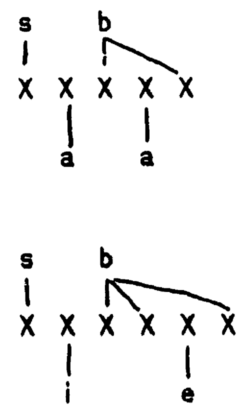
a. saab

b. sabab

c. sibbeb

(b) results from the association of the root with the triconsonantal template of (60) and (c) from the association of the same root with the template of (61).

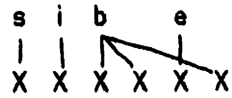
(64)



In (64) we see that the last consonantal melody unit spreads in the manner of tonal autosegments to fill the skeletal template. If the vowels and the consonants were not represented on distinct tiers, the spreading would lead to the crossing of association lines.

(65)

*



Spreading is not the only strategy for filling out a template. In some cases the consonantal melody of a bi-consonantal root will reduplicate to fill out a quadri-consonantal template, as in (66).

(66)

```
q   l q   l
|   | |   |
X X X X X X
  |     |
  i     e
```

As is the case with tonal autosegments, a rule may affect any unit of the phonemic melody without affecting the slot in the skeleton to which it is associated. I illustrate this with a brief account of compensatory lengthening in TH.

Geminate consonants arise from a variety of sources in TH. Here I will illustrate one such source. In TH there is a regular process which fully assimilates the nasal [n] to an immediately following consonant. This process is responsible for:

(67)

yi+npol ---> yippol "he will fall"

min#bayit ---> mibbayit "from house"

The process may be formulated autosegmentally as the deletion of the [n] melody unit and subsequent spread of the adjacent consonantal melody unit to fill the vacated skeletal slot.

(68)

```
y   n p   l         y     p   l
|   | |   |         :   ,'|   |
X X X X X X  --->   X X X X X X
  |     |             |     |
  i     o             i     o
```

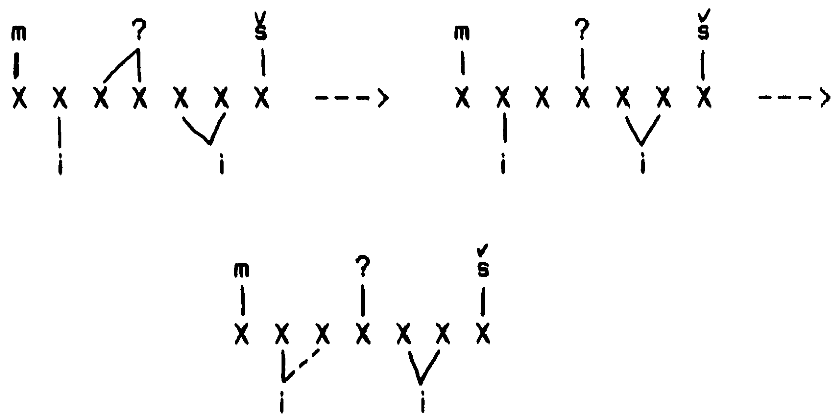
When one of the laryngeal or pharyngeal glides is adjacent to a nasal, the process of assimilation is followed by the degemination of the glide. The degemination itself is followed by a compensatory lengthening of the preceding vowel. (Lengthening of the high vowel is accompanied by a lowering to the mid-range by a regular process)

(69)

min#?iiš	"from a man"
mi??iiš	Nasal Assimilation
mee?iiš	Degemination and Lengthening

If we view the process of degemination as the dissociation of the glide from the left skeletal slot leaving the slot in tact, then the compensatory lengthening is seen a spreading process which fills an empty skeletal slot.

(70)



From these processes we see that a rule may delete the features of a segment, leaving in tact the corresponding skeletal slot. In Chapter 2, I suggest that the TH rule of Vowel Reduction is best formulated as one which removes the features of certain vowels, without affecting their associated skeletal slots.

Footnotes

1. The representation here of the vocalic melody of the simple active is different from the one which appears in McCarthy (1979) for the corresponding Classical Arabic forms which is a single /a/ multiply attached. Careful examination of the verbal paradigm of Tiberian Hebrew reveals that, although the identity of the second stem vowel varies with binyan, tense and aspect, the first stem vowel, when it surfaces, is /a/ for all verbs in the active voice and /u/ for all forms in the passive voice. The only exceptions to this are the past forms of the perfect in pi9el (as in šibber below), but the /i/ there is the result of a lexical rule which raises /a/ to /i/ in closed initial syllables. I thus take the second stem vowel in each form to be <u>the</u> stem vowel, which varies with binyan, tense and aspect, and the first stem vowel to be filled by the vowel which represents the voice of the form. In the case of šabar, the first /a/ is the active molody, and the second /a/ is the stem vowel for the simple perfect.

2. In representing the binyan templates with preassociated vocalic melodies, I sidestep an important issue concerning the representation of the binyan templates. I speak here of consonantal slots as those free slots after the association of the vowels. But given an unassociated template, how do the vowels "know" where to associate? In a language such as English, there is no reason to postulate the existence of morphemes with no associated skeleton and the association may be viwed as given in the lexicon or derived by a simple process of one:one linking. But in Semitic, the templates exist independently in the lexicon to represent the canonical shapes of the stems, and the roots themselves are morphemes with no associated skeleton. Originally, (McCarthy (1979)), the slots in the skeleton were conceived of as specified for syllabicity, with [+syllabic] slots represented as C and [-syllabic] slots represented as V. Consonantal melodies associated with C slots and vocalic melodies with V slots. This model has been criticized by a number of researchers, e.g. Levin (1983) and Lowenstamm and Kaye (1983). Some phonologists, e.g. Lowenstamm and Kaye (1983) and Clements and Keyser (1983) suggest that the slots of the skeleton are the terminal elements of syllable structure. I reject this view for two reasons. First, this implies that every template is a well-formed sequence of syllables. This is demonstrably not the case, as the discussion of the segholate nouns in Chapters 2 and 3 show, where the shape of a large class of nouns in TH is determined by a template which gives rise to an unsyllabifiable sequence. Second, full syllabification in underlying representation would involve a tremendous amount of redundant information in the underlying representation, while I take lexical representaiton to contain that which is not predictable by rule. Finally, various studies, most prominently Steriade (1982), have shown

that syllabification is accomplished by rule and that these rules in fact must sometimes be ordered among the rules of the phonology. I follow here a suggestion of Levin (1983) to represent the templates of TH as X slots with minimal pre-associated syllable structure. Thus, the slots to which the vowel initially associate, are represented as dominated by pre-associated rimes. The template of śabar is thus taken to be

```
  R   R
  |   |
X X X X X
```

in underlying representation.

Chapter 2

The Accentual Structure of Tiberian Hebrew

2.1 Preliminaries

The accentual system of Tiberian Hebrew has received a fair amount of attention within the framework of generative phonology, and of metrical theory in particular. Many of the phonological processes seem best accounted for with the mechanisms of metrical theory, yet the system has remained a challenge for each particular version of metrical theory developed. The source of the difficulty is twofold. First is the complexity of the system and the processes involved. Complicating the task is the fact that the system is known to us through an orthographic record with an elaborate set of diacritics, the interpretation of which is not always clear. The consonantal text of the Old Testament was annotated by a group of Jewish scholars called Massoretes in the city of Tiberias in the eighth century A.D. These scholars were a link in a long tradition of scholars whose task it was to preserve the proper pronunciation of the language of the Old Testament. The diacritics register such details as vocalism, gemination. spirantization and accent. The accentual diacritics, each of which has a musical value for public cantillation, mark the placement of main stress and also provide and exhaustive parsing of the verses.

2.1.1 Three degrees of length in vowels

One of the outstanding features of Tiberian Hebrew phonology is its distinction between long, short and ultra-short vowels. Besides the ultra-short reduced vowel /ə/, the non-high vowels /a/, /e/ and /o/ have ultra-short variants, called hateph vowels in the traditional literature, and written as /ă/,/ĕ/ and /ŏ/ in this work. Generative linguists, following Prince (1975) and McCarthy (1979), have restricted the inventory of Hebrew vowels segmentally to geminate (long) and non-geminate (short) vowels, and have considered ultra-shortness to be a prosodic feature of short vowels in certain syllables. Ultra-short vowels appear only in light syllables; a short vowel in a closed syllable is never marked by the orthography as ultra-short. But it is not the case that all vowels in light syllables surface ultra-short; the first vowel in each of the following words is in a light syllables but is not ultra-short.

(1)

a. nahărotáy "my rivers"

b. ?eḥáw "his brothers"

Nor can the ultra-shortness of a vowel be predicted by the surface alignment of light and heavy syllables, as the contrasts in (2) and (3) show.

(2)

a. na9amdaá "let us stand"

b. ?ăšabbér "I will break"

(3)

a. ?aḥáy "my brothers"

b. ?ăzáy "therefore"

Both words in (2) have a light syllable followed by two heavy syllables and yet the first vowel in (b) is ultra-short, while the first vowel in (a) is not. Likewise, both words in (3) have a light syllable followed by a heavy, and yet only the first vowel of (b) is marked for ultra-shortness.

All generative treatments have derived ultra-short vowels from a rule of Vowel Reduction (VR). Any adequate account must provide both for a way in which to determine which of the underlying vowels are to be marked for ultra-shortness and for a mode of representing the surface property of ultra-shortness. In this section, I will restrict attention to the question of identifying the vowels which surface ultra-short; much of the discussion in the coming sections will be devoted to the questions of the precise mechanism to be employed for identifying the vowels destined for ultra-shortness and the appropriate mode of representing this property.

The first thing to note with respect to the reduction process is that long vowels never reduce. Among the long vowels, grammarians have distinguished between those which are unalterably long and non-deletable, and those which alternate with short and ultra-short vowels. The contrast can be seen in (4a & b):

(4)

a.	9oolaám	"world"
	9oolaamiím	"worlds" (eternity)
b.	daabaár	"word"
	dəbaariím	"words"

The words 9oolaám and daabaár both have two long vowels. When these words are suffixed, the first vowel of 9oolaám remains unchanged, whereas the first vowel of daabaár reduces. In generative terms, we may say that the first vowel of 9oolaám is underlyingly long, and that of daabaár is underlyingly short and lengthened by rule. The lengthening which applies to the first vowel in the unsuffixed form of daabaár fails to apply when the form is suffixed, allowing the vowel to reduce. I discuss the rule responsible for the lengthening immediately below.

Long vowels are derived principally by two rules: the first is Pretonic Lengthening (PTL). Hebrew has a tendency to strengthen light syllables in pretonic position. Basically, /a/ and /e/ will usually lengthen in a light syllable before main stress, and /o/ will induce gemination of a following consonant in the same position.

(5)

a. 9oolamíim	--->	9oolaamíim	"eternity"
b. yišlaḥéka	--->	yišlaaḥéka	"he will send you m.s.
c. lebáb	--->	leebáb	"heart"
d. zaqeníim	--->	zaqeeníim	"elders"
e. kotónt	--->	kottónt	"shirt"
f. 9agolóot	--->	9ăgollóot	"round ones"

(Outputs are often intermediate representations)

Some scholars have questioned the authenticity of these strengthening processes, suggesting that they are either an artifact of the orthography or a reflection of overzealous carefullness in the pronunciation of words of a dead language. Cross-linguistically, short vowels preceding stress have a tendency to reduce, not lengthen. These interpretations of the orthography which consistently records these alternations in quantity are not very likely, since the rule involves quite a bit of lexical idiosyncracy, governed, for the most part, morphologically. /a/ and /e/ in pro-pretonic position occasionally lengthen, and in certain cases fail to lengthen altogether before stress. These exceptions, discussed fully in McCarthy (1981), will not concern us here. But this kind of morphologically governed exceptionality is hardly what one would expect if these syllables were artificially strengthened. Despite the widespread exceptionality, the effects of the processes are quite pervasive. Blake (1951), in his survey of pretonic vowels in TH, lists 20 morphological categories in which the processes apply. In the ensuing discussion, I will illustrate the process of pretonic strengthening with examples of lengthening and not gemination.<1> The vowel /a/ is the vowel which lengthens most consistently, and the examples I bring to illustrate PTL will usually show lenghtened /a/. The important point to bear in mind is that there are alternations between long and short vowels handled by PTL.

Now let us return to the pair of words in (4). Since both /a/s of the stem are reducible, we have identified them as both underlyingly short. The first /a/ lengthens in (a) as the result of PTL, which in turn protects the vowel from reduction. Hence, we establish an order

PTL

VR

The structural change of PTL is simple to formulate with the autosegemental notation introduced in Chapter 1.

(6)

```
                 [-rd]
                   |        /
ø ---> X/___       X        $
                   |
                   R
```

The conditioning environment is written provisionally as in (6) with $́ indicating a syllable with stress. Since an issue which concerns us in this study is the appropriate representation of stress, this rule is of interest as it is a segmental rule which makes reference to a following stressed syllable very early in the derivation. Given that we are studying two mechanisms for representing stress - trees and grids - I will explore later the differences between formulating the rule as sensitive to grid structure on the one hand and tree structure on the other.

The second rule responsible for the derivation of long vowels is Tonic Lengthening, which lengthens any vowel of a non-verb form under main stress. This rule is responsible for the lengthening of the second vowel in (4a) and for the alternations shown below.

(7)

a. gannáb ---> gannaáb "thief"

b. qédmaa ---> qéedmaa "eastward"

c. qaaṭón ---> qaaṭóon "small one"

2.1.2 Main Stress, Vowel Reduction and Their Interaction

So far, we have encountered two rules, PTL and TL, which are triggered by main stress. We now turn to the distribution of main stress itself. The alternations below illustrate the generalizations concerning the distribution of main stress in TH.

(8)

a. šalləḥéenii "you m.s. send me!"

b. šalləḥeém "you m.s. send them!"

c. kaatábtii "I wrote"

d. kətabtém "you m.p. wrote"

e. ?anáḥnuu "we"

f. ?attém "you m.p."

The generalization which emerges is that main stress falls on the final syllable if that syllable is closed and on the penult if the final syllable is open. Final stressed open syllables usually arise from processes of de-dipthongization. For example, the word śadé "field" is analyzed as having a "weak" third radical /y/, and is derived from śadáy by de-dipthongization.

There is a large class of penultimately stressed words with final closed syllables. This includes the very large class of nouns called segholates in traditional grammars, which have the surface shape CV́CVC. The analysis given for these nouns directly reflecs their history. They are taken to be of the underlying form CVCC. So, at the point in the derivation at which stress is assigned, these nouns have only one vowel to be marked for stress. Hebrew syllable structure allows for no tautosyllablic consonant clusters, and a late rule of epenthesis breaks up the final cluster. This is iluustrated below.

(9)

šorš	"root"
šórš	stress
šóreš	epenthesis

The same pattern is found when the feminine suffix is added to the present participial forms.

(10)

loomed	"he learns"
loomed + t	"she learns"
loomédt	stress
loomédet	epenthesis

Besides these systematic deviations, the generalization that stress is final if the ultima is closed and penultimate if the ultima is open, is fairly pervasive. The nature of the rule of main stress assignment (MS) will be addressed in the coming sections.

We are now in a position to determine which of the non-lengthened vowels are marked for ultra-shortness. The examples below illustrate the effects of reduction.

(11)

a. yalaadiim	--->	yəlaadiim	"children"
b. yaladeehem	--->	yalədeehem	"their m. children"
c. yiktobuu	--->	yiktəbuu	"they m. will write"
d. kotobeka	--->	kətobəka	"your m.s. writing"
e. kootebiim	--->	kootəbiim	"they are writing"

(The stem /e/ of the participial is a systematic excetion to PTL)

(11a, e and c) illustrate that the vowel of a light syllable immediately preceding a heavy syllable will reduce. (b) demonstrates that in a series of two such syllables, the one immediatey preceding the heavy syllable is affected. Finally, (d) shows that in a sequence of four light syllables every other one is affected.

In fact some of the outputs in (11) do not represent the surface phonological form. A reduced vowel which is preceded by an open syllable deletes, so that (b) and (d) have as their final outputs **yaldeehem** and **kətobkaa**. The vowels which delete form a subset of the vowels which reduce and so the task still remains to identify the vowels which reduce. I might point out that in the philological literature there has been much debate concerning whether or not a reduced vowel deletes following a CVV syllable, as in (e). See W. Chomsky (1972) for discussion. In section 3 I will show that there is in fact good evidence supporting the view that these vowels did indeed delete, resulting in CVVC superheavy syllables.

Prince identifies the rule of VR as one which operates in an alternating quantity sensitive fashion: all heavy vowels are immune from it and in a sequence of light syllables every other one is affected. He notes the similarity between the operation of the reduction rule and that of stress rules of a familiar sort which endow with a degree of stress every heavy syllable and every other syllable in a sequence of light ones.

The interaction between VR and MS is one of the most interesting aspects of TH phonology. Consider the words in (12).

(12)

a. kaatbúu "they wrote"

b. paatḥáa "she opened"

c. yiktəbúu "they will write"

d. dəbaarkáa "your word"

The words in (12) have final open syllables which, as mentioned, normally do not receive main stress. Further morphological analysis suggests that main stress is in fact initially assigned to the penultimate vowel in each word. (12a) is a 3p plural perfective form, and (b) a 3pf singular perfective form, both based on triconsonantal stems(/katab/ and /pataḥ/). We find that in analogous forms based on biconsonantal monosyllabic stems, stress indeed surfaces on the penult.

(13)

a. šáabuu "they returned"

b. qáamaa "she arose"

(12c) is the 3p plural imperfective form of /katab/. Analogous forms bases on biconsonantal stems also have penultimate stress.

(14)

a. yaaʕúubuu "they will return

b. yaaqúumuu "they will arise"

In the pausal form of (12c), the penult likewise surfaces stressed. "Pausal" refers to the shape a word assumes at a major intonational break. There are a number of differences between pausal and non-pausal forms of words, the most salient of which is that a variety of stress shifts which take place in the non-pausal forms are inhibited in the pausal forms.

(15)

dəbaarékaa

Further evidence in support of the original penultimate stress in the words of (12) comes from the non-final long /aa/s of (12a,b and d). The first vowel of the stems in kaatbúu and paaṭháa are underlyingly short, since they are reducible (as in kətabtém and pəṭaḥtém.) The second stem vowel in dəbaarkáa is likewise underlyingly short, since it too is reducible (as in dibreehém). The fact that these vowels surface long suggests that at some point in the derivation of each of these words, the vowel under consideration immediately precedes main stress and lengthens by PTL.

(16)

katabuu	"they wrote"
katábuu	MS
kaatabuu	PTL

If we reconstruct the examples in (12) as katábuu, patáḥaa, yiktóbuu and dabaréka, assigning each penultimate MS, what determines the ultimate surface form with the penult deleted? Prince suggests that it is the rule of VR which is responsible. It should be clear that if the rule operates quantity sensitively from right to left in each of the examples in (12) the penult will be affected. After being affected by Vowel Reduction, the penult in each form except (c) will delete by Vowel Deletion (VD), since they are all preceded by open syllables. Precisely what phonological change is wrought by Vowel Reduction, and how it effects the stress shift exhibited in the words in (12), is one of the main issues which will concern us in the analysis of TH. In the next section I briefly review previous metrical analyses of the phenomenon and point out some difficulties with them. In the following section I offer my own solution to the problem implemented in the framework supported in this thesis. It turns out to be remarkably similar to the solution proposed in Prince (1975).

A syllable with an onset containing one of the laryngeal or pahryngeal glides (?,ḥ,9 or h; henceforth, gutturals) will never have a schwa nucleus. Rather, any ultra-short vowel in such a syllable will have the quality of one of the non-high vowels of the language - /a/, /e/ or /o/. As mentioned, these are the hateph vowels of the traditional literature. In the examples below, the penult in each case is in a position to be affected by reduction (cf. (11)). In each case the vowel surfaces as an ultra-short /a/, and doesn't delete despite the fact that it is preceded by an open syllable.

(17)

a. tiš?aluu ---> tiš?ăluú "you p. will ask"

b. kooheniim ---> koohăniím "priests"

c. 9enaabiím ---> 9ănaabiím "grapes"

Prince takes this to be handled by a rule of Schwa-to-A, which he recognizes as a kind of assimilation rule in which the guttural shares its feature of lowness with the neighboring vowel.

2.1.3 Other Ultra-short Vowels

Hateph vowels also arise from a rule which Prince calls Hateph Formation and McCarthy calls Post Guttural Epenthesis. This is a lexically idiosyncratic rule which epenthesizes a short vowel after a guttural which closes a syllable.

(18)

a. ya9mód ---> ya9ămód "he will stand"

b. he9míid ---> he9ĕmíid "he stood s.o. up"

c. ho9mád ---> ho9ŏmád "he was stood up"

d. ca9cúu9 ---> ca9ăcúu9 "play thing"

As these examples show, the epenthetic vowel surfaces ultra-short and harmonized in quality to the vowel to is left.

So far we have seen ultra-short vowels arise from Vowel Reduction and Post Guttural Epenthesis. Ultra-short vowels in TH have been assumed to arise from one other source: Vowel Insertion. Hebrew syllable structure allows for no tautosyllabic consonant clusters. There are, however, words of the form CəCV(V)C, where the initial schwa doesn't alternate with any other vowel. These words have traditionally been analyzed as having an underlying consonant cluster which is broken up by a rule of Schwa Insertion.

(19)

a. gbuul ---> gəbuul "border"

b. cbii ---> cəbii "deer"

c. zman ---> zəman "time"

d. zbuul ---> zəbuul "abode"

As with other ultra-short vowels, when such an inserted vowel appears in a syllable with a guttural onset, it usually surfaces with an /a/ quality.

(20)

ḥmoór ---> ḥămoór "donkey"

The same rule of Vowel Insertion is taken to be triggered by the cliticization of the monoconsonantal proclitics b-, k-, l- and w-.

(21)

a. daabaár "word"

k#daabaár "as a word"

kədaabaár epenthesis

b. mélek "king"

l#mélek "to a king"

ləmélek epenthesis

Prince (1975) suggests that this epenthesis rule may be collapsed with the epenthesis rule operative in (9). I will consider this proposal in detail in Chapter 3.

In the next section I will review previous metrical accounts of TH. The discussion will focus on the questions of the appropriate representation of the ultra-short vowels, the rule which derives ultra-short vowels and the interaction between that rule and stress assignment. In the course of that review I will introduce further facts about the accentual system which are relevant for the analysis in Sections 3 and 5.

2.2 Previous Metrical Accounts

2.2.1 The Interaction between VR and MS

It was pointed out in the previous section that Prince noticed the similarity of VR's mode of application to that of familiar alternating stress rules. All metrical analyses have therefore taken the application of VR to involve the assignment of binary quantity sensitive right dominant feet from the right edge of the word. The analyses have been somewhat vague concerning whether any other phonological rule accompanies the assignment of these feet, but most have implied that phonologically the rule consists solely in the assignment of feet. McCarthy (1979, p. 57) writes: "...the rule of VR just assigns these binary tree structures from right to left... Conventionally, any vowel in the weak position is interpreted as reduced." These analyses then answer the questions concerning ultra-short vowels posited in the previous section as follows: underlying vowels are singled out for ultra-shortness by means of reduction feet; ultra-shortness is the property of a vowel being in the recessive position of a reduction foot.

Given the implicit assumption that the metrical trees of a word assigned by various rules form a nested constituent structure, the challenge has been taken to be that of finding the appropriate way to integrate the reduction feet into the overall metrical structure of a word. The analyses have tried to integrate these feet in such a way as to explain the stress shift facts described in the previous section.

2.2.1.1 McCarthy (1979) and Hayes (1981)

McCarthy (1979) and Hayes(1981) take the main stress foot to be a left-headed foot formed at the right edge of the word with the restriction that a closed syllable may not be in the recessive position of the foot. They each assume that with the formation of this foot, the entire string is gathered into a right-headed word tree.

(22)

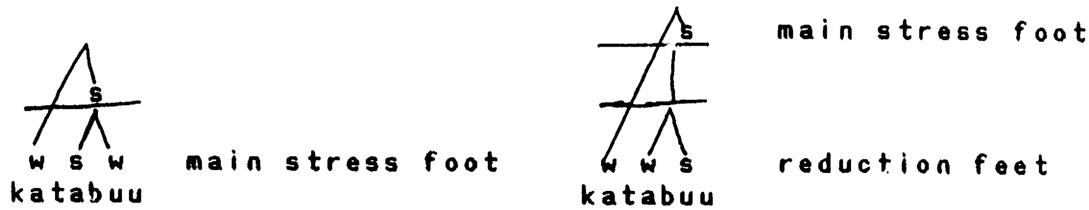
McCarthy (1981) takes main stress to be determined by an unbounded right-headed word tree, with final open syllables marked extrametrical, as in the diagram below:

(23)

I will not consider this proposal further for the following reason. It will be seen below that the placement of secondary stress depends on that of primary stress in TH, and that the secondary stress feet are bounded left-headed feet. This would suggest either that the main stress foot and the secondary stress feet are formed by the same rule, or that the main stress tree is constructed non-iteratively and the secondary stress feet fill the domain not covered by the main stress foot. In either case, the unbounded tree would be used to single out the head of one of these feet, but not to determine the placement of main stress.

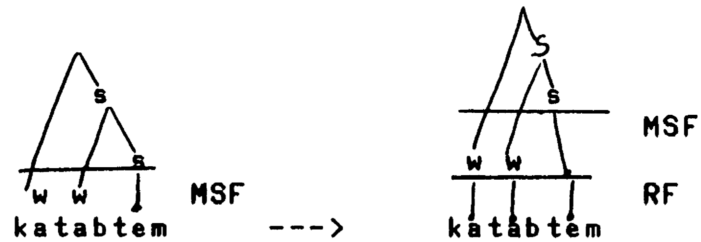
Although McCarthy is not explicit about it, Hayes interprets his (1979) analysis by assuming that the reduction feet are "tucked under" the main stress foot (MSF), forming a lower layer of metrical structure. The stress shift, which comes when the MSF marks a rime dominant and a reduction foot (RF) marks the same rime recessive, is supposed to follow from the formal apparatus. Hayes gives the following derivation.

(24)



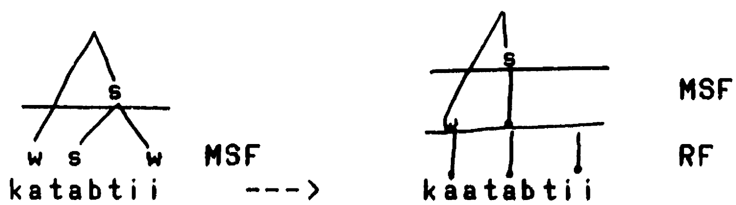
It is not quite clear what the exact interpretation of the derivation should be. As seen in Chapter 1, metrical theories generally define the terminal elements of each layer of metrical structure. Defining the terminal elements of a particular tree is equivalent to the specification, in earlier formulations, of the particular <u>projection</u> on which a metrical layer is constructed. In the case at hand, the derivation in (24) allows a single foot, the MSF, to have rimes as its terminal elements initially, and then have a reduction foot as its terminal element later in the derivation. Aside from the additional freedom that such an analysis allows, which to my knowledge is not needed elsewhere, it simply doesn't work in all cases. Notice that in (24), the MSF which initially dominates rimes, subsequently dominates the final reduction foot. The same would presumably be true for (25).

(25)



This is not, however, true for kaatábtii in which the MSF would have to be said to dominate the penultimate reduction foot.

(26)



Nor can we say that the final reduction foot in (26) is extrametrical. This would imply that whenever stress is penultimate, the MFS dominates the penultimate reduction foot. Then in a word such as šáabuu, in which the final syllable constitues a reduction foot, that foot would also be considered extrametrical. But then there would be no explanation for why the final syllable in katabuu, which is the same morpheme as the final syllable in šáabuu, is not marked as extrametrical. There is then a problem with formulating the exact relation between the main stress foot and the feet forming the new layer of metrical structure. If it must be specified when the MSF dominates the final reduction foot, and when the prefinal foot, the stress facts cannot be said to follow from anything.

2.2.1.2 Dresher (1982)

Dresher (1982) speaks of the final reduction foot "overrunning" the MSF and suggests a principle which defines the conditions under which one metrical foot may destroy the structure built by another. The principle he offers states that a metrical structure assignment rule may alter previously existing metrical structure if the rule is applying in a derived environment. He proposes that the rule which assigns the reduction feet can alter the structure erected by MS because PTL has applied between the two rules, creating a derived environment. As far as I can tell, this analysis is based on a mistaken notion of "derived environment." The following is one version of the definition of "derived environment" relevant for the proper application of cyclic rules (taken from Kiparsky (1982):

> A representation Φ is derived w.r.t. rule R in cycle j iff Φ meets the structural analysis of R by virtue of a combination of morphemes introduced in cycle j or the application of a phonological rule in j.

It should be clear that the string to which VR applies "overrunning" the MSF is not derived in any relevant sense according to the cited definition. PTL certainly has nothing to do with the creation of a derived environment.

The domain of VR in which it overruns the MSF is contained in the final two syllables in (27),

(27)

kat<u>abuu</u>

but the segment affected by PTL, the antepenultimate vowel, is not contained in the string. PTL in no way creates the environment for the application of VR. Nor is it the case that the application of VR is triggered by the affixation of new material after the application of MS.

Moreover, the Hebrew case is not at all analogous to other cases in which one metrical structure has been said to override a pre-existing one. As we saw in Chapter 1, all those cases involved marking for stress an element which on a previous cycle was dominated by the recessive node of a tree. In the Hebrew case, one metrical foot is said to mark as recessive a vowel which was originally marked for stress. In fact, I suggested in Chapter 1 that there probably is no such thing at all as one merical foot overriding another.

It appears, then, that no tree-based analysis has been set forth which satisfactorily explains the stress shift facts described in the previous section.

2.2.2 Secondary Stress

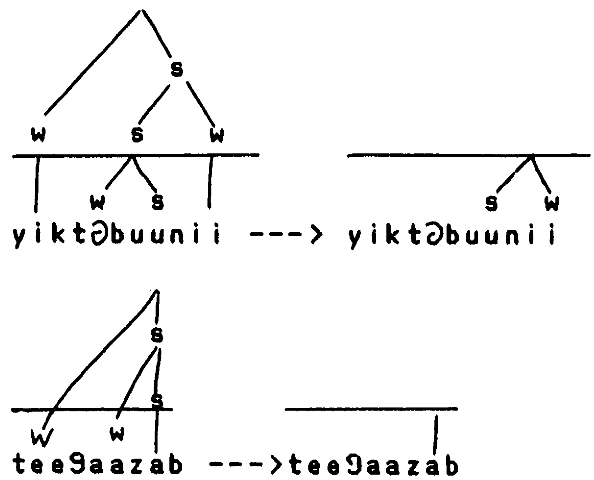
An account of the distribution of secondary stress was absent from the discussion in the previous section. The facts described hitherto are indisputable; they are unambiguously recorded in the Tiberian orthography. Syllables bearing main stress are marked with textual accent signs and ultra-short vowels are marked with an unambiguous diacritic. Secondary stress is generally taken to be marked with a diacritic called the méteg which is a vertical stroke placed beneath the stressed syllable. The difficulty in ascertaining the distribution of secondary stress stems first from the fact that the meteg is used for a variety of purposes, only one of which is to represent secondary stress. Second, there is quite a bit of variation among manuscripts concerning the distribution of meteg. Scribes over the generations have formulated elaborate systems of principles governing the distribution of the diacritic, and later grammarians developed extensive taxonomies of different kinds of meteg, according to the phonological environments in which they appear. It is not clear to what extent their systems correspond to the facts of the language as it was spoken or to what extent their taxonomies reflect the linguistically significant generalizations. What all this amounts to is the need for quite a bit of ingenuity to infer what the facts concerning secondary stress were. Any analysis proposed for secondary stress feet obviously presupposes a particular interpretation of the facts.

2.2.2.1 McCarthy and Hayes

McCarthy (1979), following one traditional interpretation, took secondary stress to fall on every CVV syllable which is separated by at least one syllable from a previously assigned stress, and on every CVVC syllable even when it is adjacent to another stress.

McCarthy and Hayes account for this distribution by forming unbounded left-headed feet with CVV syllables marked as heads to the left of the main stress foot. The first problem confronting this analysis is that of finding a place to put the secondary stress feet. Given the assumption that all feet form a nested constituent structure, the secondary stress feet have to be integrated into the metrical structure already built. As seen in 1.1, the analysis takes quite a bit of tree structure to be present before the assignment of secondary stress. On the assumption that secondary stress is assigned only to CVV and CVVC syllables, Hayes notes that the structure already built to the left of the main stress foot is not relevant for the placement of secondary stress, and proposes a rule of deforestation which removes all the irrelevant structure to the left of the main stress foot.

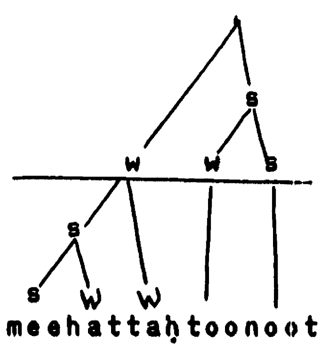
(28)



The secondary stress feet are then taken to be unbounded left headed feet with long-voweled syllables counting as heads. In the above examples, only tèe9aazáb has a syllable with a long vowel to the left of the main stress, and so a secondary stress foot is erected for tèe9aazáb but not for yiktəbúunii.

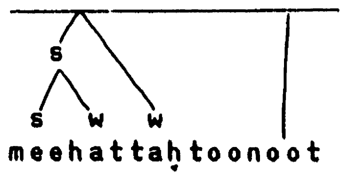
The analysis requires further modification to account for words like mèeḥattahtoonoót. Building the unbounded feet to the left of the main stress foot yields

(29)



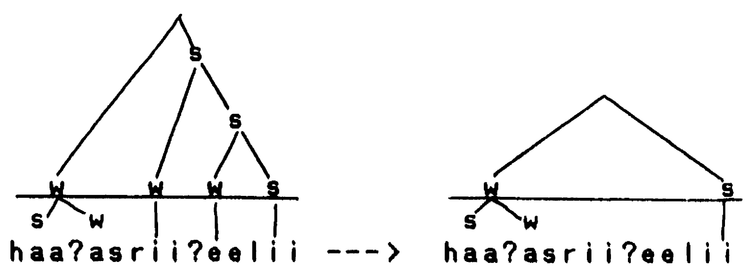
which would incorrectly place a secondary stress adjacent to the main stress. Hayes (1981) proposes a rule of de-stressing which removes a non-branching foot in a weak position of the word tree.

(30)



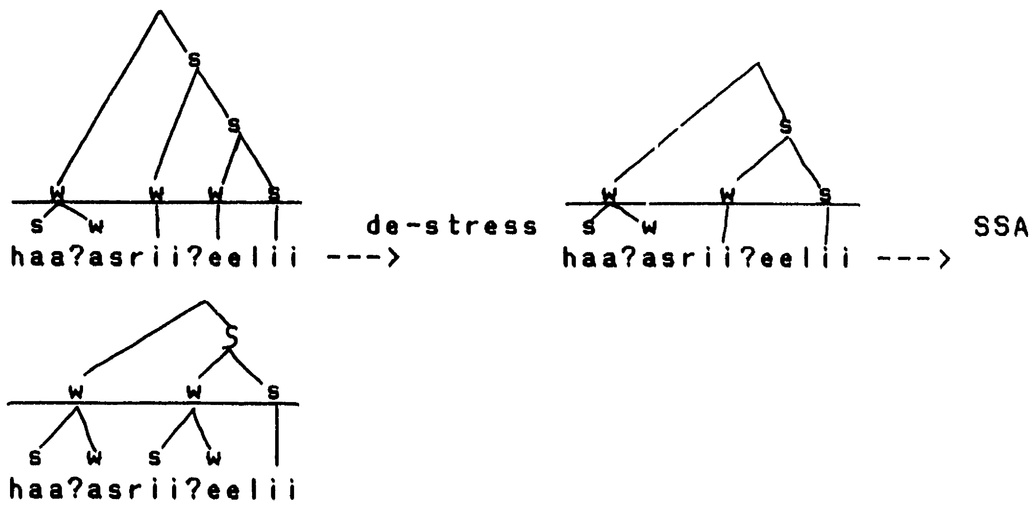
This rule, however, must apply iteratively from right to left , with Stray Syllable Adjunction (see Chapter 1) applying to each output, in order to get a pattern of alternating stress in cases like

(31)



where simultaneous application of the de-stressing rule would yield a word with *one* secondary stress only. On the iterative approach, after the first application of SSA, the antepenultimate syllable in (31) becomes the head of a branching foot, and so not eligible for destressing.

(32)



The complex derivation needed to obtain the simple pattern of alternating stress suggests that something is amiss. Furthermore, I have argued (1.1.2.3) that operations of SSA are entirely unnecessary for the process of building metrical structure. But SSA is crucial for obtaining the proper output under Hayes's analysis. It is therefore interesting to note that Dresher (1981,a,b) has found compelling evidence for a different interpretation of the secondary stress facts in which the alternating secondary stresses of (31) are obtained straighforwardly.

2.2.2.2 Dresher (1981a,b)

In an important piece of philological investigative work, Dresher adduces evidence that secondary stress in TH actually fell on every other full (i.e. not reduced) vowel preceding the main stress. In his study of the phonological conditions relevant for the assignment of textual accents, he notes that the rules governing the distribution of accents often make reference to the notion of "long word." Certain cliticization processes are blocked if one of the words involved is "long" and certain rules dividing accentual phrases apply only when a word in the relevant domain is "long" in the appropriate sense. (For an enlightening discussion of the system of textual accent assignment, see Dresher (1981a).)

From comparison of the examples of "long" words in (33a) with those of short words in (33b), it is evident that a "long" word may have fewer syllables than a "short" word.

(34)

A. Long words

a.	yeelkúu	"they will go"
b.	teed9úun	"you p. will know"
c.	?el-baaláaq	"to Balaq"
d.	lammaṭṭé	"to a tribe"
e.	hakkənaSǎníi	"the Canaanite"
f.	wayyədabbərúu	"and they spoke"

B. Short words

a. bənóo "his son"

b. moošé "Moses"

c. ?ăleehém "to them"

d. ?ăṭannəpéem "I shall soil them"

e. ?eekáakaa "how"

f. kuttónet "coat"

The generalization appears to be that a "long" word is one which either has a superheavy syllable before main stress, or else two full vowel before main stress.

Dresher's suggestion is that the domain to the left of the main stress foot is organized into binary constituents by trees which are rooted in reduction feet. The pattern of TH stress is then said to be similar to that of Passamaquoddy (see 1.1.1.5) which has been described as having two layers of metrical structure - a foot layer and a superfoot layer - beneath the word tree. His procedure for forming the superfeet (which he calls Accentual Feet, or A-feet) is as follows:

(35)

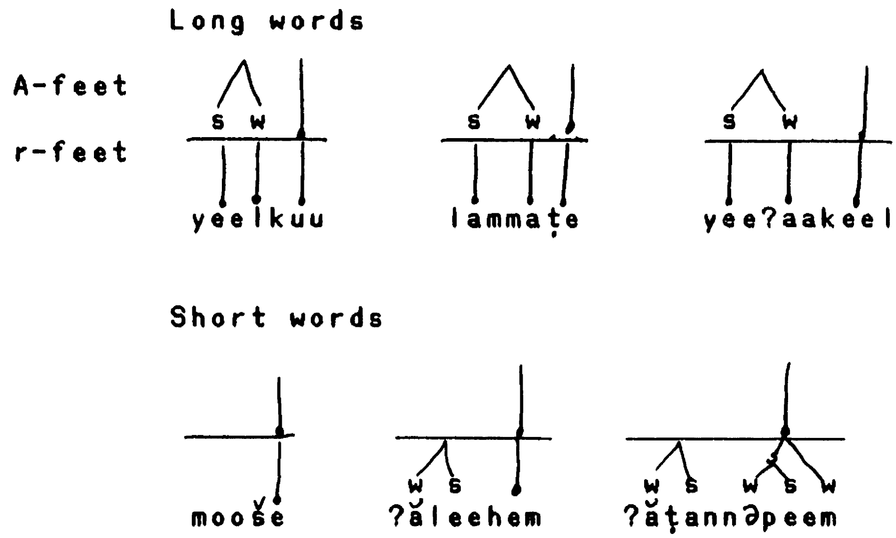
The Accentual Foot

Construct A-feet (r-->l) as follows:

i. The final foot is an A-foot
ii. Construct binary A-feet labeled [SW] on a projection from [reduction feet]

Sample outputs for "long" and "short" words are given in (36).

(36)



From these examples it appears that "short" words are those in which no binary foot can be constructed to the left of the main stress foot. A binary superfoot is said to be constructed over a superheavy syllable if the final C is taken to be an independent rime. The superheavy syllable in yèelkúu arises after deletion of the penult in yeelekuu, and in fact almost all word internal superheavy syllables result from vowel deletion. Presumably this analysis takes the syllable final consonant to be stray-adjoined to the left, producing a binary superfoot.

It is tempting to speculate that a "long" word is really one which bears secondary stress, and that secondary stress falls on the vowel in the strong position of a super-foot. Once again Dresher adduces strong philological evidence that this is so.

I have already pointed out that there are various traditions reflected in different manuscripts concerning the distribution of the meteg, the diacritic which is taken to signify, among other things, secondary stress. The tradition of accentuation and vocalization which is considered most authentic and true to the Tiberian pronunciation is that of the medieval accentuator Ben Asher. The treatise Diqduqee Haṭṭə9aamiím is attributed to Ben Asher, and, as such, is the only extant treatise by one of the accentuators. Ben Asher, like the later grammarians, made a classification of the different kinds of meteg, according to the phonological environments in which the meteg occurs. He calls the meteg which falls on a closed syllable a "minor" meteg, and includes the following rules governing its distribution:

(37)

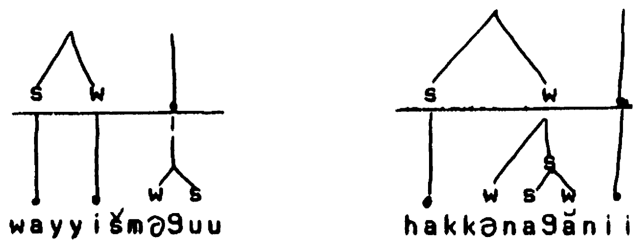
Assign a minor meteg to:

a. the third syllable before the main stress, if the main stress is immediately preceded by an ultra-short vowel, e.g. wayyiš̆mə9uú;

b. the fourth syllable before the main stress if the first and the third syllable preceding the main stress have ultra-short vowels, e.g. hakkənə9ă̌nii

As is apparent from the examples below, if we construct A-feet according to Dresher's algorithm in (35), the syllables singled out by the minor meteg rule are those which are in the strong position of an A-foot.

(38)



As Dresher points out, if secondary stress falls on every other full vowel, then it is a simple matter to derive the alternating secondary stress in words such as (31) without the complicated derivation needed in Hayes's analysis.

I find Dresher's interpretation of the orthographic record fully convincing and his analysis to be on the right track. I will point out here, however, that his analysis is not immediately translatable into the framework supported here, since the layer of A-feet is in some sense a mixed layer, in that the rightmost A-foot (the main stress foot) has rimes as its terminal elements, but the remaining A-feet are rooted in reduction feet. In the theory laid out in the introduction, each layer of metrical structure corresponding to a row in the grid must consist entirely of trees with the same set of terminal elements. It excludes a set of trees in which some trees have rimes as terminal elements and others have feet as terminal elements.

The analysis also presents a challenge to the claim that no trees are constructed non-iteratively, since this analysis requires the formation of a main stress foot, and only later in the derivation the formation of secondary stress feet to the left of the main stress foot.

Finally, Dresher's analysis treats the superheavy syllable as constituting two reduction feet. The reason for this is that while a full vowel normally receives secondary stress only if it is separated by at least one other full vowel from the main stress, the superheavy syllable receives secondary stress when it is adjacent to the main stress (see (36). Now, since, on Dresher's account secondary stress is calculated over reduction feet, with the stress falling on every other reduction foot, the superheavy syllable must constitute two reduction feet. The effect is derived by taking the final C to constitute a degenrate rime which itself counts as a reduction foot. But this surely trivializes the idea of a foot as a stress-bearing constituent, since a consonant is never the bearer of stress in Hebrew.

2.2.4 The Rhythm Rule

The TH Rhythm Rule is different from the rules of clash resolution in many languages with which we are familiar. In English, for example, as (39) demonstrates, a stress clash is resolved by retracting main stress to the nearest syllable with secondary stress.

(39)

Àpalàchicóla   Ápalàchicòla Fálls

Similar effects are reported for Italian by Nespor and Vogel (1979), Finnish (Hayes(1980)), and Persian (Bing (1980)).

In Hebrew, however, a stress clash is normally resolved by retracting stress one syllable, although the vowel onto which stress retracts often does not bear secondary stress (a more complete characterization of the Rhythm Rule is offered in Sections 3 and 5).

(40)

tookál léḥem ---> tóokal léḥem
(she will eat bread)

wayyeedá9 káyin ---> wayyéeda9 káyin
(and Cain knew)

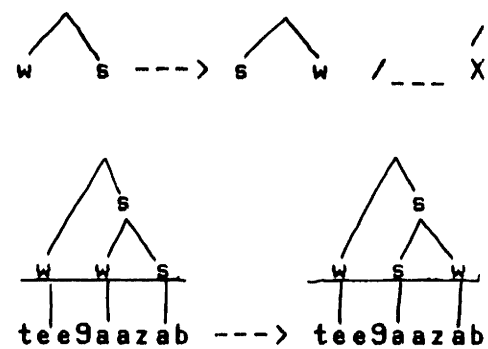
?iwwaaléd bóo ---> ?iwwáaled bóo
(on which I was born)

tee9aazáb ?érec ---> tee9áazab ?érec
(the land will be abandoned)

Under no one's interpretation of the secondary stress facts is any of the syllables bearing retracted stress assigned secondary stress by the regular procedure for foot formation. It is interesting to note that with the rules for foot formation given by Hayes, the Rhythm Rule has a simple formulation as an operation on trees. Below is Hayes's formulation and an example of how the rule would work on a word like tèe9aazáb.

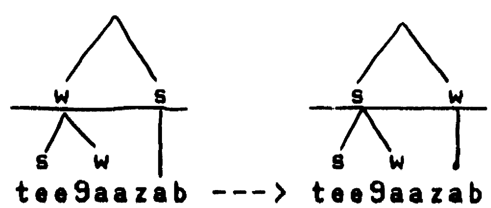
(41)

Hayes's TH Rhythm Rule (1982, p.96)



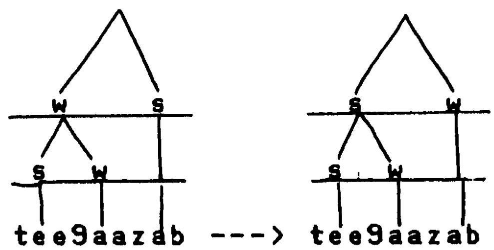
Note that under this formulation, the Rhythm Rule must apply before the rules of De-footing and Stray Syllable Adjunction, since otherwise stress would be retracted on to the antepenult.

(42)



However, accepting Dresher's interpretation of the facts, which calls for the construction of binary left-headed trees to the left of the main stress foot (ignoring for the moment the reduction feet), the Rhythm Rule has no apparent formulation in terms of an operation on tree structure. If the rule relabeled the top layer of metrical structure, stress would be retracted to the first syllable, contrary to fact.

(43)



The fact that the Rhythm Rule has no formulation as an operation on trees under the most plausible tree analysis suggests that a tree-only theory cannot handle all of the stress facts of TH. In section 3, I show that the Rhythm Rule has a simple formulation as an operation on a grid representation. Before I present my own analysis of the Hebrew accentual system, I give in the next subsection some additional facts about the operation of the Rhythm Rule in words containing hateph vowels. These facts were not only taken to support a tree formulation of the Rhythm Rule in previous analyses, but were said to motivate tree configurations not admitted by the restrictive tree theory supported here. Here I give a brief presentation of the facts. Section 5 gives an in-depth analysis of hateph vowels and the properties of the constructions in which they appear.

2.2.4 Hateph Vowels

As mentioned before, ultra-short vowels arise not only from the process of VR: certain epenthetic vowels also surface ultra-short. Below I repeat sample derivations illustrating the process of Post-Guttural Epenthesis.

(44)

he9miid ---> he9ĕmiid

ho9mad ---> ho9ŏmad

ya9mood ---> ya9ămood

Since previous metrical analyses have taken ultra-shortness to be a property associated with a vowel which is dominated by the weak branch of a reduction foot, each of the ultra-short vowels in (44) should, under these analyses, be in the left position of a reduction foot. If right-headed reduction feet are assigned on the surface representations of these words, then the medial vowel in each word would be in the desired position.

(45)

ya9amood

In fact, however, McCarthy (1979) claims that in each of the examples in (44), the ultra-short vowel is joined by a left-headed reduction foot with the vowel to its left.

(46)

ya9amood

There a number of reasons for assigning this structure. First, McCarthy claims that the reduction foot is the domain of vowel harmony in TH, and that the direction of the harmony is determined by the headedness of the foot. This matter will be fully discussed in Section 5. In the examples at hand, the harmony goes from left to right, and this is said to be explained by the left-headed reduction foot. Second, we saw that the Rhythm Rule in TH normally retracts stress only one syllable back, but in the case of the words under consideration, stress may be retracted two syllables.

(47)

?aḥărée kéen ---> ?áḥăree kéen
"afterwards"

Even more striking are cases in which stress is retracted over a closed syllable with a full vowel onto an open syllable with a short vowel.

(48)

na9ămdáa yyáḥad ---> ná9ămdaa yyáḥad
"let us stand together"

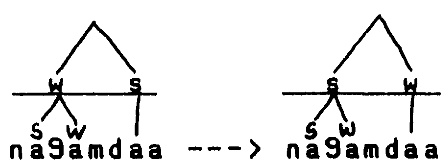
The first word in (48) is derived from na9modaa by Post Guttural Epenthesis and Vowel Deletion as in (49).

(49)

na9modaa	let us stand
na9amodaa	PGE
na9amdaa	VD

If the Rhythm Rule relabeled the topmost layer of metrical structure, positing a left-headed reduction foot would get the right results.

(50)



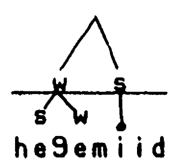
Furthermore, if right-headed reduction feet were assigned from right to left, the initial vowel in a word like na9amdaa would incorrectly be marked for reduction.

(51)

Positing the left-headed reduction foot seems to explain why the initial vowel in (51) is not marked for ultra-shortness.

Finally, McCarthy claims that secondary stress falls on a light syllable preceding a hateph vowel, since such syllables are consistently marked with a meteg in most manuscripts. Recall that on the McCarthy-Hayes analysis, the heads of secondary stress feet are syllables with long vowels. This is expressed in their systems by stipulating that the head of a secondary stress foot must branch, where a long vowel counts as branching. The branchingness of the harmony-reduction foot is taken then to satisfy the requirement that the head of the secondary stress foot branch.

(52)



In Section 5 I discuss some internal inconsistencies in this analysis of hateph vowels and the constructions in which they appear. Here I only mention the fact that this analysis cannot be translated into the theory of metrical structure being supported here because it involves a layer of metrical structure which contains both left- and right-headed feet.

2.3 Analysis I: Stress and Stress-Related Processes

2.3.1 Main Stress

In sections 1 and 2 we established the following partial ordering:

(53)

Main Stress Assignment (MS)
Pretonic Lengthening (PTL)
Vowel Reduction (VR)
Secondary Stress Assignment (SS)

The fact that the placement of secondary stress is determined by that of main stress might suggest that in TH a non-iterative foot is first formed at the right edge of the word - this foot destined to be marked as the main stress foot - and that the secondary stress feet fill the domain not covered by the main stress foot. I will return to this question later in the chapter. Right now we may ask what kind of structure MS erects. Recall that main stress in TH falls either on the ultimate or the penultimate syllable. Within the present theory there are a number of ways to derive penultimate stress in a language which has predominantly final stress. The first is to assume that in words with penultimate stress, the final syllables are added at a morphological stratum (in the sense defined Section

1.2) which is later than the one at which stress is assigned. It is well known that the set of English suffixes may be divided into those which are "stress-neutral" and those which are not. For example, when -al is affixed to "parent", the stress "shifts" from the first to the second syllable, but when -hood is affixed to the same word, there is no apparent stress shift. This is accounted for by assigning -hood to the second morphological stratum, and -al to the first, and applying stress in English at stratum 1.

So, one possibility worth exploring is that of affixing the morphemes which constitute the final syllables in words with penultimate at a stratum later than that at which stress is applied. This hypothesis is not really plausible, however, since one normally expects all morphemes of a particular class to be affixed at the same stratum. However, in a word like **šaábaa**, "she returns," the final syllable represents the feminine singular participial suffix. The other participial suffixes, those which end in consonants, bear final stress, as in **šaabiím** "they m. return" and **šaabóot** "they f. return." In **kaatábtii** "I wrote" the final syllable is the first person singular perfective suffix and is stressless, while in **kətabtém** "you m.p. wrote", the masculine plural perfective suffix receives final stress. Similar examples may be culled from all other morpheme classes. I conclude, therefore, that level-ordering has nothing to do with penultimate stress.

The second possibility is that of marking extrametrical the final syllables in words with penultimate stress, and forming a right-headed bounded foot for MS. Finally, we might take the general pattern to be that of a bounded left-headed foot, and mark each syllable which receives final stress with an accent. Since the phonological shape of the final syllable is generally sufficient to determine whether or not it gets final stress, the accent would be assigned, on this account, by rule. These two options are shown schematically below.

(54)

kata(buu)   malakiim

katabuu   malak<u>iim</u>

There is compelling reason to assume that the second option is the correct one. The evidence comes from the stress shift facts described in the previous section, which show that that VR does not consider an unstressed final syllable extrametrical.

(55)

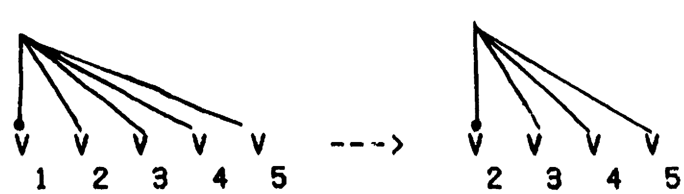
katabuu ---> kaatbuu

It was established in the previous section that in words such as the one in (3), stress is initially assigned to the penult which subsequently reduces and deletes. Since, following previous analyses, I take reduced and deleted vowels to be marked off by the recessive nodes of right-headed feet, the fact that the penult in (3) deletes indicates that it is joined to the ultima by a reduction foot as in (56). In order for this to be so, VR cannot consider the final syllable extrametrical.

(56)

More significantly however, postulating a left-headed foot can help explain the stress shift facts. As discussed in Chapter 1, there is evidence that foot structure is preserved even after the deletion of a vowel which is the head position of a foot, so that when the stressed vowel of a word deletes, the word is not left without any stress, but rather the stress appears on another vowel. The structure of the foot determines the direction of the stress shift.

(57)



In the hypothetical example in (57), if V_1 deletes the foot structure nonetheless persists, and since the foot is left headed, V_2 then becomes the head of the foot and is assigned stress. The effect of a rightward stress shift then follows without the need for a rule to accomplish it.

Returning to the example under consideration and ignoring for a moment the metrical structure which VR erects, we can see that postulating a left-headed foot predicts a rightward shift of stress after the deletion of the penult.

(58)

kaatabuu ---> kaat$\emptyset$buu

I therefore take (59a) and (b) to be the two rules relevant for the formation of the main stress foot.

(59)

a. Accent-word final closed syllables

b. Construct a bounded left-headed tree at the right edge of the word.

2.3.2 Vowel Reduction

We have already seen that Vowel Reduction operates in a manner similar to that of very common stress rules: quantity sensitively, iteratively and in a binary fashion.

Therefore, all previous metrical analyses have taken the rule of VR to be one which assigns binary right-headed quantity sensitive feet from right to left. The basic problem they have had to deal with is that of integrating these feet into the overall hierarchical metrical structure of the word and determining the interaction between the VR feet and the MS foot. In the previous section we saw that Hayes has the reduction feet placed under the main stress foot and most of them subsequently deleted, while Dresher talks of the reduction foot "overriding" the main stress foot in the cases of stress shift. I have shown that there are technical problems with all these analyses, but beyond the technical problems, they have all made use of devices not available to the theory advocated here.

One possiblity worth exploring is that of not forming a nested constituent structure of all the stress trees. Since trees are merely devices for calculating the appropriate placement of marks in the grid, the unified result of the stress rules need not be represented in a hierarchical representation of all the trees constructed by the different stress rules, since it is tabulated in the metrical grid. On this approach the language would have two sets of trees, both rooted in rimes, with a grid mark assigned for the head of each tree in both sets.

(60)

```
                     MS foot
wayyadabberuu
                     VR feet
```

If this were the case in Hebrew, however, and both reduction feet and the main stress foot were rooted in rimes, with a mark added to the grid for each foot head, we would still not get the right stress pattern in cases like tiktəbúu from tiktóbuu.

(61)

```
               MSF
tiktobuu
               VR feet
*    *    *
     *    *
```

In particular, each of the final two syllables will be marked with a foot row stress. But the final syllable should bear main stress, while the penultimate should bear none. This simple procedure of grid interpretation of the feet will not effect the stress shift.

Apparently, the assignment of the VR feet must be accompanied by some phonological rule besides the addition of a mark in the grid, which will have the effect of rendering the MSF in (61) non-branching. In section 5, I give phonological evidence that the phonemic melody unit of a vowel in the recessive position of a reduction foot is removed at some point in the derivation leaving behind a vacated core slot.

(62)

```
m a l a k  e  h e m
| | | | | / \ | | |   --->
X X X X X X X X X X
  |   |   \ /   \ /
  R   R    R     R
```

```
m a l   k  e  h e m
| | |   | / \ | | |
X X X X X X X X X X
  |   |   \ /   \ /
  R   R    R     R
```

A series of rules determines how the vacated slot is filled late in the derivation, if it is not deleted by the rule of VR. I have suggested in the introduction that for each set of trees constructed, the terminal elements must be specified. We saw, for example, that some languages take rimes to be the terminal elements of the stress trees, while others take them to be moras. Suppose that the process of melody unit removal renders the melodiless rime non-stress-bearing. In the case of the word in (61), the penultimate vowel, which was marked as the head of the MSF is rendered non-stress-bearing and as a result the MSF becomes non-branching. In the following derivation, I distinguish between the rule of Reduction Foot Formation

(RFF) and the rule of Melody Removal (MR).

(63)

```
tiktobuu      "you m.p. will write"

tiktobuu      MS

tiktobuu      RFF

tikt bu       MR
|||| ||
XXXXXXXX
```

I am assuming that the trees in the stress representations are only abstract markers used for calculating the placement of stress; they themsel es do not directly represent stress. Therefore the "stress shift" is not really a shift of stress, but rather an operation triggered by the effects of VR which changes the form of the abstract marker (the main stress foot). I will assume that grid-interpretation takes place after the application of VR, when the MSF in (61) has been rendered non-branching. In this way, no rule is needed to achieve the effects of stress shift.

But now let us recall the motivation for the formation of a binary foot which marks the penult in (63) as the head in the first place. One of the primary motivations was the rule of Pretonic Lengthening which we have taken to be responsible for the lengthening of the antepenult in words like (64). In the derivation below I represent the empty core slot which results from MR as V on the same line as the symbols which represent the phonemic melodies of the segments, but this is only an abbreviatory convention. It should be taken to represent a syllabified vacant slot in the skeletal tier.

(64)

katabuu	"they wrote"
katabuu	MS
kaatabuu	PTL
kaatabuu	Reduction Foot Formation
kaatVbuu	MR (stress shift)

If grid marks are assigned only after the main stress foot is rendered non-branching in cases such as (64), then PTL must be triggered not by a mark in the grid, but by the presence of the head of a foot. I therefore take PTL to be formulated as in (65).

(65)

Pretonic Lengthening (Preliminary)

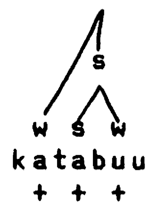
$$\emptyset \longrightarrow X / \underline{\quad}\,\underset{[-rd]}{\overset{R}{X}} \quad \overset{O}{R} \qquad \text{O=head of foot}$$

In other words, add a skeletal slot to a non-branching rime associated with the feature [-round] (this will exclude pretonic lengthening of /o/) before a rime which is marked as the head of a foot. Notice that at this point in the derivation, no other feet have been constructed, and so no reference has to be made to the fact that it is the main stress foot. I assume as well that the fact that the inserted slot becomes incorporated into the rime and becomes associated with the features of the vowel in the rime need not be specified in the rule. The general process of syllabification will incorporate the vowel into the rime and the principle of Hebrew that two tautosyllabic vowel slots must be associated with a single melody will guarantee that the inserted slot becomes associated with the correct melody.

It turns out that the analysis of Vowel Reduction and stress shift proposed here is remarkably similar to the one in Prince (1975). Prince's study of Tiberian Hebrew contains one of the first attempts at applying the principles of the then-emerging metrical theory of stress. The system with which Prince was working allowed for a segmental feature [+/-stress] assigned to vowels. The relative degree of stress among the the vowels marked

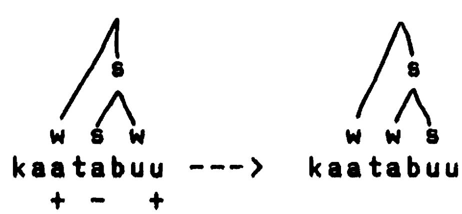
[+stress] was determined by the hierarchical metrical structure of the word. The representation of katabuu, for example, was given as:

(66)



where the pluses represent the feature [+stress], which is assumed to be an underlying feature of every vowel. Prince then formulated VR as a rule of Alternate De-stressing whose effect is to remove the feature [+stress] from vowels in the appropriate manner. A general principle is then invoked to ensure that an S node can never dominate a vowel marked [-stress], so that when the penult of katabuu is marked [-stress] the node dominating it is automatically relabeled as W, which in turn causes the node dominating the final syllable to be labeled S, since by the very nature of the metrical representation only one sister node may be labeled S.

(67)



The theory presupposed here, of course, makes no use of a segmental feature [+/-stress]. However, all vowels are potentially stress-bearing, and defining the stress-bearing units to be all the vowels of the language is analogous to Prince's marking all the vowels with the feature [+stress] underlyingly. Instead of wiping out the segmental feature [+stress] from certain vowels, I have a rule which removes all the segmental features of the affected vowels, but leaves a core slot, thereby rendering those rimes non-stress bearing, which is analogous to marking them [-stress].

It is important to note that since stress is not directly represented by the trees, the stress shift does not follow from the mere fact that the reduction foot marks the penult in (61) recessive. The reduction foot influences stress indirectly here; its direct effect is expressed in Melody Removal (MR) which renders the rime non-stress-bearing and the main stress foot non-branching. In this analysis the MSF and the reduction feet are simultaneously rooted in the same rimes. No nested constituent structure is formed from all the feet, and in no way do we consider the reduction feet to override the main stress foot. We also take advantage of the conception of the phonological representation as a three dimensional object. We can think of the different sets of trees as represented on their own "tiers", much as we saw different morphemes or different sets of features represented on distinct tiers.

I have argued that the vowel reduction feet are interpreted through the rule of Melody Removal. A natural question to ask at this point is whether the reduction feet are stress feet at all, as assumed in previous metrical analyses, whether or not they register marks in the grid. It will emerge from the discussion in the next section of grid construction in Hebrew that Melody Removal can be the sole phonological interpretation of the reduction feet. Secondary stress feet and reduction feet can be constructed independently of each other. Once the reduction feet are interpreted through Melody Removal, the proper stress configuration is derived through the interaction of independently motivated rules and conventions, assuming that rimes affected by MR are non-stress-bearing.

2.3.3 Secondary Stress and Grid Construction

The essential insight of Dresher's analysis is that the pattern of reduction determines the pattern of secondary stress. (This is in marked contrast to English in which the pattern of reduction is parasitic to the pattern of stress). We already have the means for formally incorporating this insight into the phonological derivation of Hebrew words. Assuming that the vowels affected by vowel reduction are non-stress-bearing, as we have already done in the discussion of the stress shift facts, we can define the terminal elements of the secondary stress trees to be the stress-bearing rimes, i.e. those rimes which are associated with phonemic melodies. Notice that in this way we avoid the central awkwardness of Dresher's analysis; in the present analysis the main stress foot and the secondary stress feet are essentially rooted in the same terminal elements, namely the stress-bearing rimes. The only difference is that the main stress foot is apparently formed before the application of VR, when all rimes have their melodies and are stress-bearing, while the secondary stress feet appear to be formed after it, when some of the non-branching rimes have lost their melodies. Once this assumption is made, the vowels affected by VR are essentially ignored for the construction of secondary stress trees, and the proper configurations are derived. Therefore, a preliminary version of the rule for forming secondary stress feet is:

(68)

Formation of Secondary Stress Feet

Form bounded left-headed feet rooted in stress-bearing rimes to the left of the main stress foot.

Below are sample outputs.

(69)

wayyadabberuu MS, PTL n.a. (closed syllable)

wayyadabberuu RFF

wayyVdabbVruu MR (stress shift)

wayyVdabbVruu Secondary Stress Assignment

hakkəna9ănii

What about superheavy syllables? Why does stress fall on a superheavy syllable even when it is adjacent to the main stress as in (70)?

(70)

kàatbúu ?òoklíim

Recall that in previous analyses, the final C of the superheavy syllable, considered a rime, was stray-adjoined to the preceding rime, which made the superfoot branching. In the present analysis, without an operation like stray adjunction, this option is not available. Before answering the question concering stress on the superheavy syllable, let's focus on the foot structure erected over words like ?ăleehém and ?ăṭannəpeém. According to the algorithm for tree construction presented in the introduction a tree will be constructed over the penultimate syllable of each.

(71)

?VṭannVpeem   ?Vleehem

But according to no interpretation do these syllables bear secondary stress. I suggest that TH has a rule of De-stressing which removes a stress from a syllable immediately preceding another stress.

There is in fact independent evidence for the rule of Pre-stress De-stressing. When a word like tèe9aazáb in (72) appears in a position of stress clash, the Rhythm Rule retracts stress to the penult, in which case the secondary stress disappears from the initial syllable.

(72)

tèe9aazáb   tee9áazab ?érec

We know that there are often constraints involving syllable weight which are placed on de-stressing rules. The constraint on the English de-stressing rule which forbids removing stress from a branching rime, for example, accounts for the reduction difference between banana and bandana. A similar constraint involving syllable weight and stress retraction is reported for Italian in Nespor and Vogel (1980). I will therefore build into the de-stressing rule formulated below the constraint that it may not remove stress from a superheavy syllable.

In fact this constraint against removing stress from a superheavy syllable is more general; the Rhythm Rule is also constrained in the same manner. Compare the examples below.

(73)

tookál léhem ---> toókal léhem
laacuúd cáyid ---> laacuúd cáyid

Returning to the rule of de-stressing, notice that in ?atann-peem the rule applies even though the stresses are not strictly adjacent; an ultra-short vowel intervenes between the the two stresses. The second type of rule which resolves stress clashes, the Rhythm Rule also ignores an ultra-short vowel between stresses.

(74)

9oosé pəríi ---> 9oóse pəríi
"fruit bearing"

A number of the facts of TH accentuation which we have been considering converge on a single conclusion: the rhythmic rules of the language ignore ultra-short vowels. Thus, secondary stress is assigned to alternate vowels disregarding the ultra-short ones, and the two rules for clash resolution - Pre-stress De-stressing and the Rhythm Rule - also ignore these vowels. These facts together suggest that the rhythmic rules of the language are formulated over a representation which doesn't include the ultra-short vowels. I propose that the relevant representation is that of the grid.

The grid is the representation of the rhythmic beat of the language (Prince (1983)) and as such, will represent only the stress-bearing units. Since we have already defined melodiless rimes as non-stress-bearing units, they will receive no representation in the grid. Thus, following the procedure set out in Chapter 1 , grid construction will place a grid mark for each stress-bearing rime and an additional mark for each marked as the head of a tree. But now notice that there is no reason to assume that the reduction feet are stress feet at all. If the only phonological interpretation given to these feet is Melody Removal, which renders the affected vowel non-stress-bearing, all the stress distinctions are derived. An ultra-short vowel is one with no place in the grid; a full stressless vowel has one grid mark; a vowel with secondary stress has two grid marks, and a vowel with main stress has three.

Below is a formulation of the De-stressing Rule.

(75)

Pre-stress De-stressing

$$\phi \Leftarrow \begin{matrix} * & * \\ * & * \end{matrix}$$

Condition: does not apply to remove secondary stress from a superheavy syllable.<2>

Below are derivations for sample words.

(76)

tee9azab	"she will be abandoned"
tee9az<u>ab</u>	Accent Assignment
tee9aazab	MS, PTL
tee9aazab	Reduction Foot Formation (MR, n.a.)
tee9aazab	Secondary Stress Feet
tee9aazab	Grid Construction

```
tee9aazab
 *   *  *
 *      *
```

(77)

?elehem	"to them"
?eleh<u>em</u>	Accent Assignment
?eleehem	MS, PTL
?eleehem	RFF
?Vleehem	Melody Removal (Vowel Deletion (VD) n.a.
?Vleehem	Secondary Stress Feet

?Vleehem
   * *
   * *
	Grid Construction

?Vleehem
   * *
     *
	De-stressing

?ăleehem	Lo Assimilation (see Sec. 5)

(78)

dabareka	"your word"
dabareka	MS
dabaareka	PTL
dabaareka	RFF
dVbaarVka	MR (stress shift)
dVbaarka	Vowel Deletion
dVbaarVka	Secondary Stress Feet

dVbaarVka
        *   *
        *   *
	Grid Construction

dVbaarVka
        *   *
             *
	De-stressing

dəbaarka	Default Schwa Insertion (see sec. 5)

(79)

```
tiktobnaa            "you f.p. will write"

tiktobnaa            MS (PTL n.a.)

tiktobnaa            RFF

tiktobnaa            MR (n.a.)

tiktobnaa            Secondary Stress Feet

tiktobnaa            Grid Construction
 *  *  *
 *  *

tiktobnaa            De-stressing
 *  *  *
    *
```

2.3.4 Main Stress and Secondary Stress Revisited

So far, I have assumed that in TH, the main stress foot is formed non-iteratively at the right edge of the word, and that only after the application of PTL and VR are the sec^ndary stress feet formed, even though the main stress foot and secondary stress feet are all bounded left-headed feet with the same terminal elements. This assumption has been made in all previous analyses since it appears that VR must apply before the formation of secondary stress feet because these feet single out every other vowel ignoring ultra-short vowels. But MS clearly precedes VR, since it preceds PTL which is triggered by MS. In (80), if all the feet were formed at once, the secondary foot would single out the wrong vowel for secondary stress.

(80)

wayyadabberuu

The correct output for (80) is wayyədabbərúu, with the second vowel reduced, not bearing secondary stress. Suppose that nonetheless all the left-headed bounded feet are formed at once. Let us see what would happen if we constructed reduction feet and applied Melody Removal to the representation in (80).

(81)

wayyadabberuu

wayyVdabbVruu   Melody Removal

MR will render the last two stress feet non-branching, and will single out the antepenult as the head of a secondary stress foot. Now our previously motivated rule of Pre-stress De-stressing will remove the stress from that syllable after the construction of the grid, resulting in the correct output.

(82)

```
wayyVdaabVruu
 *    *    *
 *         *
```

How will the de-stressign rule know to remove the stress from the medial vowel and not from the initial vowel? Clearly the rule must distinguish between main stress and secondary stress. So far, I haven't included a rule for word tree construction. The Hebrew word tree singles out the head of the final foot for main stress, so I take the rule of Word Tree Construction to construct a right-headed unbounded tree with the heads of the feet as its terminal elements. If all the metrical structure, including the word tree is assigned at once, the final syllable in wayyaddaberuu is made head of the word tree, grid construction yields (83) and the rule of de-stressing is revised as (84)

(83)

```
wayyadabberuu      Stress Tree Construction

wayyadabberuu      RFF

wayyVdabbVruu      MR ("stress shift")

wayyVdabbVruu      Grid Construction
 *    *    *
 *         *
           *

wayyəddabbəruu     Default Schwa Insertion
```

(84)

Pre-stress De-stressing

```
           *
 ϕ ← ⊛     *
     *     *     Condition: does not apply if
                     the secondary stress is
                     associated with a superheavy
                     syllable.
```

We can then build all the metrical structure (besides the reduction feet) in one fell swoop. Rules (59a) and (b) are collapsed, and we supplement our rules with one for word tree construction:

(85)

Stress Tree Construction (Final Version)

a. Accent word final closed syllables

b. Construct bounded left-headed trees from right to left rooted in stress-bearing rimes

c. Construct a right-headed word tree rooted in heads of feet.

This surely represents a major simplification of the system, analogous to the collapsing of the English Stress Rule and the Strong Retraction Rule (cf. Kiparsky (1982) p. 166, and Halle and Vergnaud (forthcoming)).

The final version for PTL will be:

(86)

PTL (Final Version)

```
                 R
                 /\    O
ø--->X/  ___     X     R      O = head of word tree
                 |
               [-rd]
```

Below is the derivation for wayyədabbəruu and four other representative words.

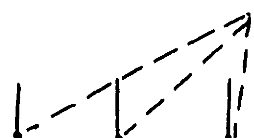
(87)

wayyadaberuu "and they spoke"

wayyadabberuu Stress Tree Construction

wayyadabberuu PTL (n.a.)

wayyadabberuu RFF



wayyVdabbVruu MR (stress shift)
VD n.a.

```
wayyVdabbVruu     Grid Construction
 *    *    *
 *    *    *
           *
```

```
wayyVdabbVruu     De-stressing
 *    *    *
 *         *
           *
```

wayyədabbəruu Default Schwa Insertion

(88)

katabuu "they wrote"

katabuu Stress Tree Construction

kaatabuu PTL

kaatabuu RFF

kaatVbuu MR (stress shift)

kaatbuu Vowel Deletion

```
kaatbuu        Grid Construction
 *   *
 *   *

kaatbuu        De-stressing (n.a.)
 *   *
 *   *
     *
```

(89)

```
raḥacaa                    "she washed"

raḥacaa                     Stress Tree Construction

raaḥacaa                    PTL

raaḥacaa                    RFF

raaḥVcaa                    MR (stress shift)

raaḥVcaa                    Vowel Deletion (n.a.
                             (guttural onset))

raaḥVcaa                    Grid Construction
 *    *
 *    *
      *

raaḥVcaa                    De-Stressing
 *    *
      *

raaḥacaa                    Lo Assimilation (see sec.5)
```

(90)

?išabberem	"I will break them"
?išabberem	Accent Assignment
?išabberem	Stress Tree Construction (PTL idiosyncratically doesn't apply)
?išabberem	RFF
?VšabbVrem	Melody Removal (VD n.a.)
?VšabbVrem * * * * *	Grid Construction

?VšabbVrem
*   *
     *
     *
	De-stressing

?ăšabbərem	Schwa Insertion, Lo Assimilation (see sec.5)

Although the ultra-short vowels have no grid representation, they do have an effect on the syllable structure of the language. This is seen in a word like raaḥǎcúu (89), which is analogous to kàatbúu (88) except that the penult does not delete because it is in a syllable with a guttural onset. Now, the accentual system treats such a word a "short," suggesting that it doesn't bear secondary stress. This is because the rule of de-stressing will remove stress from the initial syllable which is adjacent to the main stress syllable on the grid, and the initial syllable is not superheavy because the hateph vowel opens the antepenult.

Finally, I formulate the TH Rhythm Rule.

(91)

Rhythm Rule

```
* *
* *
* *
```

Retract asterisk not associated with a superheavy syllable to the nearest grid position.

Notice that the system set up as it is predicts that the Rhythm Rule can feed the Pre-stress De-stressing rule. A relevant case would be

(92)

```
    *    *
    *    *
 *  *    * *
tookal  leḥem

 *       *
 *  *    *
 *  *    * *
tookal  leḥem          Rhythm Rule

 *       *
 *       *
 *  *    * *
tookal  leḥem          De-stressing
```

Of course, it is not really possible to verify whether the final syllable in tookal would bear secondary stress in such an environment, since the orthographic record does not register such detail. It is nonetheless worthwhile pointing out the predictions made by the system.

* * * * * * * * * * * * * * *

And so we arrive at what I believe to be a maximally simple account of the core of the TH accentual system. Whereas previous accounts postulated three sets of stress trees, the present account postulates only one. Once we factored out the reduction feet, recognizing them to be defined independently of stress, the main stress foot and the secondary stress feet could be identified, and, moreover, could be formed by a single rule. The stress system is then represented by a single set of left-headed bounded feet, with an added restriction on the final foot in the form of an accent rule. In this way, the system resembles that of English, which is also characterized by bounded left-headed feet, with certain penultimate and final syllables accented (see Halle and Vergnaud (forthcoming) for a comprehensive account of the English stress system in a framework similar to the one proposed here).

The main peculiarity of the system is that it has a "dynamic" reduction rule, which appears to operate independently of stress, whereas in most languages the pattern of reduction is dependent on the pattern of stress.

Before going on to consider in further detail the words with hateph vowels, including their accentual properties, I turn my attention in the next section to the way in which a grid-only theory might handle the range of data we have considered so far.

2.4 Two Attempts at a Grid-Only Analysis

In this section I make two attempts to account for the Hebrew facts within a grid-only theory, such as the one articulated in Prince (1983) and briefly outlined in the introduction.

2.4.1 The First Attempt

The first thing that any analysis of TH will have to account for is a way to distinguish, on the surface, between long, short and ultra-short vowels. I take it that on anyone's account the long/short distinction is a segmental one expressed in the linking of a single melody to either one or two skeletal slots, and that the short/ultra-short distinction is a prosodic one. Since it is the ultra-short vowels which bear no degree of stress, the grid appears to be the most likely device for making the desired distinction. Besides a surface representation of ultra-short vowels, the theory must have a way to _derive_ the representation. In other words, there must be a way for the phonology to single out the underlying vowels which are destined for total stresslessness. In the account offered in section 3, the surface distinction was made in terms of grid marks; the ultra-short vowels were identified as those associated with no grid marks. In that account, however, it was not a direct operation on the grid which was used to derive the appropriate representation. Rather, abstract markers, metrical trees, were used to single out the vowels to be affected by a segmental rule which in turn had ramifications for the grid construction procedure.

We must then see how a grid-only theory will single out the vowels to be affected by reduction. A reasonable first attempt would take VR to be an instance of Perfect Grid (PG), as Prince seems to imply that all binary alternations are. Indeed, he cites the Tiberian Hebrew Vowel Reduction rule as an instance of a quantity sensitive alternation to be handled by PG. We might take VR to be a PG operation which endows every other syllable with a foot-level grid mark.

(93)

```
kotobeka        "your m.s. writing"
 * * * *

kotobeka         PG
 * * * *
   *   *
```

Vowel Reduction and Deletion would then be operations on vowels which bear no foot-level grid mark.

Recall, however, that the rule operates quantity sensitively: only light vowels are eligible for reduction. As seen in section 1.1.3, heavy syllables in languages with quantity sensitive alternations are endowed with an inherent foot-level grid mark in Prince's theory. If this is the case for Hebrew as well, the words such as kətabtem and malkeehem will have the following representation,

(94)

```
katabtem          "you m.p.wrote"
 * *  *
   *  *

malakeehem        "their m. kings"
 * * *  *
     *  *
```

and PG will fill in the domain without any inherent stress, imposing on the string maximal rhythmic organization, and VR and VD can, as before, affect the vowels without a foot level stress.

In the preceding sections we established an order MS-->PTL-->VR: MS triggers PTL, which bleeds VR. So we must consider the representation which is the output of the first two rules to which PG will apply. Below are the representations of words destined to be marked with final and penultimate stress respectively.

(95)

```
katabtem             "you m.p. wrote"
 * *  *
   *  *

yabaarekuunii        "they will bless me"
 * *  * *  *
   *    *
```

The heavy syllables have inherent stress.

The most plausible way for a grid-only theory to derive final stress is with the End Rule (see 1.1.3), and to mark as extrametrical the final syllables in words with penultimate stress. PG would apply on the foot row for Vowel Reduction and then once again on the cola row to derive secondary stress.

(96)

```
yabarrekuu(nii)
 * *  * *   *
   *    *   *        MS
        *
                     PG (foot) vacuous
yabaarekuu(nii)
 * *  * *   *
   *    *   *        PG (cola)
   *    *
```

PTL will then be made sensitive to word row grid mark. Presumably the process of lengthening would be accompanied by the addition of a grid mark to register inherent stress.

(97)

```
katab(uu)
 *  *  *                  underlying
       *

katab(uu)
 *  *  *                  MS
    *  *
    *

kaatab(uu)                PTL
 *   *   *
 *   *   *
     *
```

It is now that the foot-level PG applies, creating the environment for VR and VD. In the last two examples in (97), PG can easily apply, after which VR and VR can find their target vowels with no difficulty.

(98)

```
kaatab(uu)     katabtem      malakeehem
 *   *   *      *  *   *       * * *  *
 *   *   *         *   *           *  *
     *                 *              *
```

Turning our attention to cases like the representative katabuu, we can see that the rule is immediately presented with difficulties. It is not at all clear what kind of structure a foot-level PG can build on the representation of katabuu in (98); there is no domain for the rule to operate on, since every syllable has a grid mark already. This being the case, it is not clear how VR (in terms of the analysis in section 3, MR) will be able to single out the penult in kaatabuu for reduction.

Getting around this problem is no trivial matter for the grid-only theory. One avenue worth exploring would be that of taking the lengthening of the antepenult in words like katabuu to be the result of a rule strengthening light syllables independent of stress. It would be a lexically idiosyncratic rule of Light Syllable Strengthening. The facts cited in McCarthy (1981) concerning the occasional application of the rule to pro-pre-tonic syllables and the general idiosyncratic application of the rule to the vowel /e/ might be taken as evidence for this interpretation. If we took this approach, stress would not be assigned to the penult in (98) before PG applied, and PG would operate on a representation in which the penult in words like kaatabuu has no grid mark above the syllable row. VR could once again single out the antepenult for reduction.

I think, however, that this solution is not viable. First it would be an accident unaccounted for that in the majority of cases the putative Light Syllable Strengthening Rule operates on the antepenult when stress is penultimate (kaatábnuu) and on the penult when stress is final (malaakíim). Moreover, if stress were registered after Light Syllable Strengthening, as the analysis implies, there would be no apparent reason for assigning ultimate stress in kaatbúu, but penultimate stress in the morphologically analogous qáamuu. To get penultimate stress on qaámuu, the final syllable should be marked extrametrical. If that morpheme is extrametrical, it should not get stress by the End Rule in kaatbúu. The stress shift analysis, originating with Prince (1975), explains the divergence in stress pattern.

Nor would it help to interpret VR as a rule of Alternating De-stressing as we saw Prince (1975) ultimately does. The VR rule could be construed as a rule which effected a kind of inverted perfect grid, removing the underlying grid mark from alternate light vowels.

(99)

```
malakeehem        "their kings"
 * * *  *
     *  *
        *

malakeehem         PG (inverted)
 *   *  *
     *  *
        *
```

But since stress is never removed from a heavy syllable, the rule must be restricted from removing a gri mark in a position with more than one mark (in other words, PG must know to begin its leftward sweep with the syllable /a/ in malakeehém, not before). But if this is the case, there is once again no way to effect the stress shift as a result of reduction in (8).

(100)

```
kaatabuu
 *  * *
 *  * *
    *
```

The problem is that grid-only theory can only represent stress directly in the grid, unlike the theory presupposed in the analysis of section 3. That theory can mark a syllable for stress with an abstract marker which can then be altered as a result of another rule. Both vowel reduction and stress assignment are binary alternations, but they are not perfectly aligned. The domains of the alternations are marked off independently in the tree theory and once the two sets of trees are interpreted appropriately, the correct stress pattern is derived. The grid-only theory has no way to single out a syllable which is in the "peak" position of one alternation and the "trough" position of another.

2.4.2 Second Attempt

In this subsection, I make one more attempt to account for the Hebrew data in a grid-only theory with an analysis developed from a suggestion by Paul Kiparsky (p.c.). This analysis too will fail for technical reasons, and I will conclude that the analysis presented in section 3 is at least on the right track, until a better one is presented.

Kiparsky first notes the oddness of the rule of PTL; the much more familiar pattern is that in which a light syllable in pretonic position reduces, as in English solidify (cf. solid). Second, he notes, as we have, that the TH Rhythm Rule differs markedly from Rhythm Rules of many other languages with which we are familiar in its strictly local effects; Rhythm Rules more often retract stress to the nearest syllable with the highest degree of stress. Finally, he notes that the account involves reduction and deletion of a vowel bearing main stress, and it is more often the case that the absence of stress induces vowel deletion, in which case stressed vowels are exempt from the effects of reduction and deletion.

The analysis he offers runs as follows. Suppose that the basic rule of TH is to assign penultimate stress so that in words like kaatáab (from /katab/) and kətabtém (from /katabtem/) stress is initially assigned to the penult. Words such as kaatbúu (from /katabuu/) which have on the traditional analysis been assigned penultimate stress at the beginning of the derivation will, on the new analysis, have their final syllables marked extrametrical, so that stress will initially be assigned to the penult.

(101)

```
katab          katab(uu)
 * *            * *
 *              *

katabtem       dabarek(aa)
 * *  *         * * *  *
   *              *
```

The rule of Pretonic Lengthening can then be construed as a rule of Tonic Lengthening, and the trigger for lengthening will then not be the stress of a following syllable, but stress in the syllable of the vowel undergoing the lengthening. VR will then apply as in my analysis with the added advantage that it will never have to affect a stressed vowel. ⟨3⟩

(102)

katábtem ---> kVtabtem

káatab(uu) ---> kaatVb(uu)

If words ending in closed syllables are assigned penultimate stress and words ending with open syllables are assigned antepenultimate stress, then extrametricality must be used to derive the antepenultimate stress and PR trough first - to derive penultimate stress.⟨4⟩Note, however, that on this grid-only account PG must interrupt its leftward sweep after the assignment of the first stress mark, in order to allow for the application of PTL and VR. As we saw in the previous section, the tree analysis allows all the trees to be constructed at once and all the grid marks to be assigned at once.

Finally, postlexically, a rule of Stress Shift will move the stress forward to the next stress-bearing syllable.

(103)

```
kaatab ---> kaatab
 *  *        *  *
 *              *


kVtabtem ---> kVtabtem
   *  *          *  *
   *                *
```

Assuming that segments lose their extrametricality as words exit the lexicon <5>, the stress shift for words which had extrametrical rimes will be as follows:

(104)

```
tiktVb(uu) ---> tiktVbuu
 *      *        *    *
 *                    *


kaatabt(ii)  ---> kaatabtii
 *  *   *          *  *  *
 *                    *
```

The stress shift will block, however, if its output results in a stress clash.

(105)

tee9aázab ---> tee9aazáb

tee9aázab ?érec --/-> tee9aazáb ?érec

On this approach, the local Rhythm Rule is spurious, its effects obtained when the general Stress Shift Rule is blocked by the principle of Clash Avoidance, and gets the stress shift without reduction or deletion of a stressed vowel. The analysis would, of course, make the traditional Tonic Lengthening rule (see 2.1.1) necessarily postlexical.

This initially plausible account fails for the following reason. Recall that on our account the Rhythm Rule may not retract stress off the final syllable if that syllable is superheavy (see 2.3.3). Thus, we assumed that for whatever reason, a stress adjacent to a superheavy syllable does not give rise to a stress clash. A stress-retaining superheavy syllable can be superheavy in underlying representation as in

(106)

laacúud cáyid "to hunt game"

But a stress-retaining superheavy syllable can also be the result of Tonic Lengthening as in (107) (the derivation in (107) follows the traditional analysis).

(107)

dabar	"word"
dabár	MS
daabar	PTL
daabáar	TL

When a superheavy syllable resulting from an application of TL is adjacent to a following stress, it always retains its stress, just as an underlying superheavy syllable does.

(108)

daabáar ráɂ --/-> dáabaar ráɂ
"an evil word"

Under Kiparsky's suggested analysis the derivation for daabáar is

(109)

dábar	MS
dáabar	TL
daabár	Stress Shift
daabaar	TL (postlexical)

Now, when daabáar is adjacent to a word with initial stress, the immediate output of the stress shift rule in (109) will yield a stress clash because the final syllable becomes superheavy only <u>after</u> stress shift.

(110)

daábar raˊ9   (postlexical)

daabár raˊ9   Stress Clash from Stress Shift

daabaár raˊ9   Stress Clash resolved by TL

In order for Kiparsky's suggestion to work, we must allow the forward stress shift, which normally blocks if its output yields a stress clash, to apply in (110) even though its output results in clash because the clash will be resolved as a result of the application of a subsequent rule. Principles such as Clash Avoidance have been proposed which allow rules to look at their immediate outputs in order to block if the output is unacceptable. But I know of no arguments or proposals for allowing a rule to block or not depending on the output of the application of some subsequent rule. There appears to be no motivation to allow a rule to "telescope" forward in such a way. I conclude, therefore, that stress is initially placed as in the traditional analysis, and that the stress shift is due to the reduction of the light penult.

2.5 Analysis II: Hateph Vowels

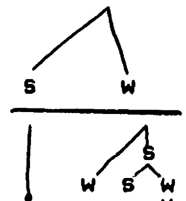
2.5.1 Introduction

We saw (section 2) that in earlier accounts open syllables preceding hateph vowels received special treatment. McCarthy (1979) assumes that a reduced vowel in Hebrew may be joined to the vowel either to its left or to its right under the recessive node of a reduction foot (which he calls a rho-structure).

(111)

In each case, he claims, the vowel in the recessive position is interpreted prosodically as ultra-short and harmonizes with the vowel in the dominant position. Implicit in this account, which has not been subsequently challenged, is the claim that we may admit a layer of metrical structure which has both left- and right-headed constituents. This has lead to representations such as

(112)



hakkəna9ănii (from Dresher (1981))

which cannot be translated into the framework supported here. I have claimed that each layer of metrical structure corresponding to a row in the grid is uniformly left- or right dominant; the theory excludes a hybrid representation. But barring such a representation from the theory is insufficient; I must still contend with the facts which motivated the hybrid structures.

Of course, it makes no sense to talk about such structures in a grid-only theory. As we saw in section 4, in such a theory an ultra-short vowel can be identified only by the number or absence of associated grid marks. The account given below relies on metrical trees to the same extent as the account given in the preceding sections. As such, this section contributes not so much to the tree/no tree debate as it lends support to a particular restrictive version of the tree-grid theory. I might add here that the traditional description of hateph vowels in Hebrew found in Gesenius (1910 p.51) and in fact quoted by McCarthy, lends support to two features of this analysis.

> "The vocal schwa stands under a consonant which is closely united as a kind of grace note with the following syllable."

Such a description embodies the intuition that the hateph vowel not only lacks the beat of a full vowel, a fact which I have represented by not endowing the hateph vowels with an associated grid mark, but also forms a prosodic unit with the following syllable. This intuition cannot be represented in a grid-only theory. But it is important to note as well that Gesenius, unlike McCarthy, has the hateph vowel always forming a constituent with the following syllable, never with the preceding one. The idea of a left-headed foot has no support, then, within traditional grammatical description.

Actually, I have suggested (Section 3) that the reduction feet are not stress feet, in that they do not contribute marks to the grid. The reason that the rho-structures were considered accentual feet is that they appear to play a role in the accentual system of the language. In this section I will show first of all that there are only right-headed reduction feet, and no left-headed ones. I will then show that the accentual properties of the words with hateph vowels can be explained without considering the reduction feet to be stress feet.

I will first review the facts which motivated the hybrid representation analysis. I will then point out some descriptive and conceptual problems with that analysis, and then go on to show how these motivating facts are easily handled in the more constrained theory adopted here. In the course of the exposition, I will formulate the principles determining the quality of ultra-short vowels in general, including the rule of cross-guttural vowel harmony.

The only structure studied by McCarthy and claimed to contain a left-headed reduction foot is created by the rule of Post Guttural Epenthesis, which idiosyncratically epenthesizes a vowel after a syllable which ends in one of the guttural glides (?,ḥ,h,or 9).

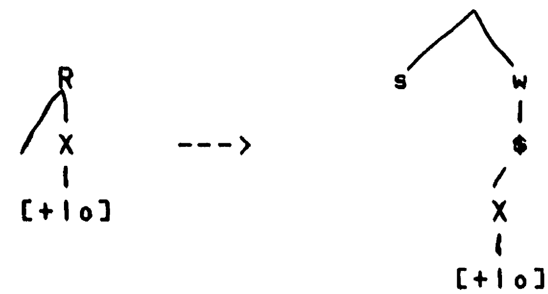
(113)

na9sé	--->	na9ăsé	"we will make
ho9bád	--->	ho9ŏbád	"he was worked"
heḥlíiš	--->	heḥĕlíiš	"he was weakened"
ne?dar	--->	ne?dar	"he was glorified"

The last example is representative of the words which do not undergo the rule. The exceptionality does not appear to be governed by any rules. In each case, as the examples show, the epenthesized vowel is identical in quality to the vowel to its left.

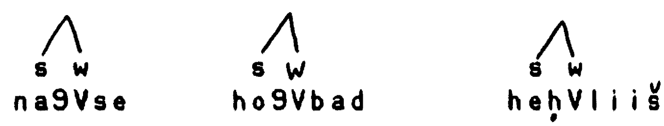
McCarthy formulates the epenthesis rule as a metrical one, in that the epenthesis triggers the creation of a left-headed reduction foot. Below is an adaptation of his formulation.

(114)



In other words, make a rime-final guttural the onset of a new syllable which is in the recessive position of a left-headed bounded foot. Sample outputs of the rule are given below.

(115)



The final quality of the epenthesized vowel is determined by a rule of Hateph Assimilation (p.196)

(116)

Hateph Assimilation

$$\text{In a reduction foot, } [\overset{s}{\alpha} F] \text{ percolates.}$$

The ultra-shortness of the epenthesized vowel is represented by its being dominated by the recessive node of a reduction foot, and the fact that it harmonizes with the vowel to its left is accounted for by the left-headedness of the reduction foot.

McCarthy also claims that the ultra-short vowels produced by Vowel Reduction and Vowel Insertion harmonize with the full vowels they are bound to by the reduction foot. Evidence for this claim comes from Greek transcriptions of the Old Testament which record Σολομων for what is represented as Tiberian šəlomóo, and Σαβαώθ for Tiberian cəbaa?óot. Recall that Vowel Reduction on all metrical accounts creates a right-headed reduction foot. The claim is thus that rule (116) accounts for the harmony facts in both instances and that the fact that the direction of harmony is different in both cases follows from the different metrical structures of the two word types.

Another reason for assuming that Post Guttural Epenthesis might create a left-haded foot has to do with certain light syllables with full vowels. Consider the words below.

(117)

naSamdáa　　　　neSermúu

The second vowel in each case is the product of PGE. If right-headed reduction feet were assigned from the right, we might expect the first vowel in each case to be ultra-short, contrary to fact.

(118)

naSamdaa   neSermuu

These words are, however, products not only of PGE, but of Vowel Reduction as well. The segmental derivation is given below.

(119)

naSmodaa	neSramuu	
naSamodaa	neSeramuu	PGE
naSamdaa	neSermuu	VR, VD

If Vowel Reduction created a right-headed foot, and PGE- a left headed one, the intermediate representation below would be derived.

(120)

naSamodaa   neSeramuu

Under the traditional metrical analysis only a vowel which is in the weak position of a reduction foot is eligible for ultra-short prosodic interpretation. Since the first vowel is, in this representation, dominated by the head of a reduction foot, it will not receive an ultra-short prosodic interpretation. The challenge is thus to derive the same facts without resort to left-headed reduction feet.

The last two sets of facts which motivated the left-headed reduction foot theory concern retracted stress. We have seen that the Rhythm Rule in Hebrew can normally retract stress back only one syllable, and, moreover, that the retracted stress is recorded only when the landing site is a syllable with a long vowel. It happens that words of the type under consideration are aberrant in both respects: they participate in stress retraction which moves stress back two syllables onto a syllable with a short vowel.

(121)

?aḥăree keen   na9ămdaa yyaḥad

We saw that in the McCarthy-Hayes analysis stress in Hebrew is retracted only when the domain to the left of main stress constitutes a foot. A foot is created only if its head branches, which normally means that a foot is created only if there is a syllable with a long vowel to the left of the main stress foot. Since stress is retracted in the manner displayed in (121), it has been assumed that the words in question have the following structure:

(122)

W   W
s w s   s w s
?aharee   na9amdaa

and that the reduction feet built over the first two syllables in both words satisfy the branching condition for the head of the foot. The Rhythm Rule reverses the labeling of the topmost metrical structure, and the output is displayed below.

(123)

Now let us examine each set of facts, starting with the examples of harmony.

2.5.2 Vowel Quality

Since an epenthesized vowel harmonizes with the vowel to its left, it has been assumed that a left-headed foot joins the two vowels participating in harmony. This account is compelling only to the extent that we cannot account for the direction of harmony by other means. After all, instances of metrical feet defining the domain of harmony are hard to come by, and it is by no means obvious that the headedness of the metrical foot is what determines the direction of harmony. Taken together with the cited facts of harmony involving ultra-short vowels produced by Vowel Reduction and Insertion, the story is a bit more convincing. If it were really the case that the ultra-short vowels prcduced by Vowel Reduction and Insertion consistently harmonize to the right, and the ultra-short vowels produced by PGE harmonize to the left and there were no other explanation forthcoming for the difference in the direction of harmony, the account including the left-headed foot would be convincing.

However, there is reason to doubt that the harmony reflected in the Greek transcrptions is to be unified with the Cross-Guttural Harmony arising from epenthesis. First, what we are calling Cross-Guttural Harmony is always, without exception, reflected in the Tiberian orthography, whereas the kind of harmony reflected sporadically in the Greek transcriptions is never recorded. Whatever is responsible for the sporadic facts reflected in the Greek, there is reason to doubt that it is the same rule which is resposible for the cross guttural harmony.

But there is even more compelling evidence. Recall that the Tiberian system never records a schwa in a light syllable with a guttural onset; the orthography always records a quality of one of the non-high vowels for an ultra-short vowel in such a position. Now, in words with ultra-short vowels produced by Vowel Reduction, where the light syllable contains a guttural onset, there are clear examples of harmony not taking place:

(124)

?ăšéer	*?ĕšeer	"which"
ḥămóor	*ḥŏmóor	"donkey"

One might want to argue that in words like cəba?oót and šəlomoó the Tiberian system registers a schwa to indicate ultra-shortness without specifying vowel quality. This, however, cannot be the case for the examples quoted above, since in this position a vowel quality is always specified.

It is further instructive to note that it is not the case that only ultra-short vowels produced by PGE harmonize to the left. The harmonizing vowel may be an underlying vowel.

For examples of underlying vowels which harmonize to the left, we turn to the pronominally suffixed forms of the segholate nouns (see 2.1.2). The underlying unsuffixed forms of sample words of this type are shown below:

(125)

po9alíim "deeds" ?ohalíim "tents"

The application of Pretonic Lengthening yields:

(126)

po9aalíim ?ohaalíim

When these forms are pronominally suffixed, their underlying forms are:

(127) po9aleehem "their deeds" ?ohaleehem "their tents

The /a/ in each case, now being two syllables removed from the main stress, does not lengthen. It surfaces ultra-short and harmonized with the vowel to its left:

(128)

po9ŏleehém ?ohŏleehém

If the domain of harmony were defined by a metrical foot, then the metrical structure of these words would be

(129)

po9oleehem ?oholeehem

But these are not cases of vowels inserted by Post Guttural Epenthesis. The vowels surface ultra-short by the normal process of Vowel Reduction. We would then have to say that in certain circumstances the rule of Vowel Reduction also produces a left-headed reduction foot. What are these circumstances? Is it whenever the short vowel-to-be-reduced is in a syllable with a guttural onset? A priori we would not expect this to be the case since metrical systems typically disregard the nature of the onset and only look at the nature of the rime in determining tree structure. Moreover, in the following paradigmatic examples, when the vowel to the left of the guttural is long, no harmony takes place.

(130)

soo?eliím ---> šoo?ăliím "they are asking"

coo9eqiím ---> coo9ăqiím "they are crying

kooheniím ---> koohăniím "priests"

Whenever the ultra-short vowel of a syllable with a guttural onset fails to harmonize, it surfaces as /a/. This is handled by Prince's Schwa-to-A, identified as a rule which spreads the [+io] feature of the guttural to the neighboring vowel. My autosegmental reformulation is given below in (33). It also accounts for the fact that in words taken to be derived by Vowel Insertion, the ultra-short vowel in a syllable with a guttural onset surfaces as /a/.

(131)

ḥmoór ---> ḥămoór "donkey"

9zob ---> 9ăzób "you m.s. leave!"

In these cases no harmony can occur since there is no vowel on the other side of the guttural.

The fact that harmony does not take place when the trigger vowel is in a non-branching rime surely casts serious doubt on the claim that a metrical foot defines the harmony domain and that the vowel in the dominant position determines the vowel quality. If this were the case, then a very curious restriction would have to be placed on the construction of such a foot: the head may not be a branching rime. As we have seen, it is extremely common for languages to stipulate that syllables with branching rimes must constitute foot heads, but languages appear never to stipulate that syllables with non-branching rimes must be foot heads, let alone that only such rimes may be foot heads.

There are, in fact, cases of right-to-left harmony, where the vowel determining the quality is ultra-short. If there were a metrical foot joining the harmonizing vowels, then the vowel in the recessive position would be the one determining the quality. In section 1 we discussed the class of pro-clitics consisting of the prepositions b-, k-, l-, and the connective w-. Each obligatorily cliticizes to any word immediately following it. Traditionally, these morphemes have been considered to derive from underlying monoconsonantal forms via the rule of Vowel Insertion. When the word to which one of these forms cliticizes begins with a light syllable with a guttural onset, the epenthetic vowel harmonizes with the first vowel of the following word.

(132)

l#hamóor	--->	laḥămóor	"to a donkey"
w#ḥolíi	--->	woḥŏlíi	"and affliction"
b#?emet	--->	be?ĕmét	"in truth"

The harmony is blocked, however, if the trigger vowel is in a syllable with a branching rime, as the following examples demonstrate.

(133)

b#?armoón	--->	bə?armoón	"in a palace"
l#?aadaám	--->	lə?aadaám	"to a man"
k#9ammúud	--->	kə9ammuúd	"as a column"

This is the same restriction we found with the left-to-right harmony: in order for harmony to take place, the trigger vowel may not be in a syllable with a branching rime (see(130)) This would suggest that these are two instantiations of a single process. But now claiming that the domain of vowel harmony is defined by a metrical foot does us little service: it does not predict the direction of harmony, since there are cases of vowels in both the dominant and the recessive positions determining the vowel quality.

McCarthy claims an additional advantage for postulating the left-headed reduction foot in words like na9ǎsé. Recall that a reduced vowel is susceptible to deletion if it is preceded by an open syllable. Not so for words produced by Post Guttural Epenthesis, like na9ăsé. McCarthy suggests that the rule of Vowel Deletion is formulated as deleting the vowel under the left recessive branch of a reduction foot. The retention of the vowel in words like na9ăsé is then attributed to the fact that in these words, the ultra-short vowels are dominated by right recessive branches of reduction feet. But it is a fact that an ultra-short vowel in a syllable with a guttural onset will never delete, whether or not it participates in harmony. In words like kooḥăníim and ʕoo?ălíim, where there would presumably be no left-headed reduction foot on McCarthy's analysis, the vowels are still retained. Thus, we need in any event to build into the deletion rule the restriction that the onset of the syllable with the prospective deleted vowel cannot contain a guttural.

Before going on to consider the other accentual peculiarities of the word types under consideration, I will formulate the rule which is responsible for the harmony in these words, replacing rule (116). Recall that in two cases we have considered the harmonizing vowel is epenthetic ((113) & (132)). One idea which immediately presents itself is that the rule of epenthesis inserts an empty slot into the skeletal tier, and that the rule of harmony is one which spreads the phonemic melody of the vowel in the adjacent syllable to fill the empty slot. One obstacle in the way of this analysis is the class of words such as those in (134), in which the target vowel is not epenthetic.

(134)

po9aleehém ---> po9ŏleehém "their deeds"

to?areehém ---> to?ŏreehém "their appearances"

Notice, however, that in these cases the harmonizing vowel is ultra-short, in a position affected by Vowel Reduction. Suppose then that, as we have been assuming, the phonological interpretation of the reduction foot consists of the removal of the phonemic melody from the vowel in the recessive position of the reduction foot. One way the vacated slot can be filled is through the rule of Cross Guttural Harmony, which I take to be a case of familiar autosegmental spread. Somewhere late in the derivation (place to be located below) a vacated core slot which hasn't otherwise been filled receives the features of schwa by default. Below I formulate the rule of Default Schwa Insertion.

(135)

Default Schwa Insertion (DSI)

∅ ---> [ə]/ __

X
|
R

X =unassociated skeletal slot

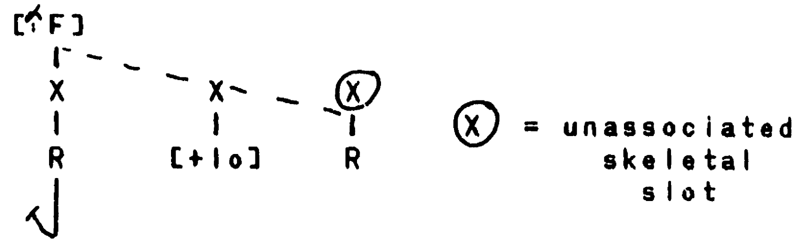
I will have more to say about this rule and its relation to the other rules which deal with empty core slots below. <6>

We can now safely say that the rule of Cross

Guttural Harmony is one which spreads the phonemic melody of a vowel onto an adjacent empty vowel core slot. It is a mirror image rule since the spread goes in either direction, as we have seen. Notice that if Vowel Reduction always results in an empty core slot, we cannot maintain that the vocalic autosegments spread automatically since, unless the conditions for spreading are met, the slot is filled not by spread of the feature of an adjacent vowel, but either by a rule which spreads the features of an adjacent consonant, or by a default rule which inserts the features of schwa. This much is consistent with the results obtained in Pulleyblank (1983) on the spreading of tonal autosegments by rule. The rule of Default Schwa Insertion can be seen as analogous to Pulleyblank's Default Tone Insertion Rules. We must still build into the rule the restriction that the onset of the syllable with the empty slot must be a guttural, and that the vowel which offers the spreading phonemic melody may not be a member of a branching rime. The vowel which receives the spread will initially always be in a non-branching rime, but this need not be built into the rule as a restriction. It follows independently from the fact that epenthesis always produces a light syllable, (even though the syllable may eventually be closed as a result of the deletion of a vowel in the following syllable) and only light syllables suffer reduction. Below is an initial formulation of the rule.

(136)

Cross Guttural Harmony



In (136) the √ symbolizes a non-branching rime. The consonantality of the segment with the [+lo] feature need not be specified. Since it is adjacent to a non-branching rime, it can only be syllabified as an onset, which in turn precludes it from being anything other than a consonant. [√F] stands for the features of the segment in the non-branching rime which spread to the empty core slot. The vocalic nature of the segment need not be specified since only a vowel may be the sole member of a rime in Hebrew. It may be possible to eliminate the [+lo] specification if the gutturals were represented on a separate autosegmental tier , perhaps a laryngeal tier, since then only if a guttural intervened between the vowels would the spreading not cause association lines to cross. However, I have been assuming, following McCarthy, that in Hebrew, as in other Semitic languages, the root consonants are all represented on a tier distinct from that on which the stem vowels are represented. If this is the case, then we may still have to specify [+lo] in rule (26).

There is one more restriction which must be built into rule (136). When the environment for Cross Guttural Harmony is met twice in a word, the harmony takes place only once.

(137)

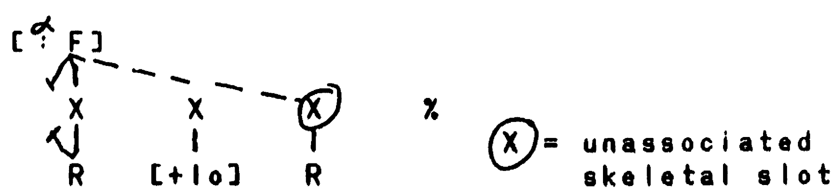
wVha9Vliitem ---> wəha9ăliitém

bV?ohVleekem ---> bə?ohŏleekém

These examples all involve cliticization of one of the monoconsonantal proclitics which have been said to trigger Vowel Insertion. We cannot say that clitics are excluded from the domain of vowel harmony, since we saw that the harmony does take place across clitic "boundary" in words like be?ĕmét and woḥŏlií. Rather, the rule is a binary one. It is only a vowel which is not multiply linked which will spread by the rule. I therefore revise (136) as

(138)

Cross Guttural Harmony (CGH)



Given that the rule may apply only once, what ensures that in the cited examples the output is bə?ohŏleekém and wəha9ăliitém and not bŏ?ohăleekém and wăha9ăliitém? If the rule started from the left edge of the word, the derivation for the first would be:

(139)

bV?ohVleekem	
bo?ohVleekem	CGH
n.a.	CGH
* bo?ohaleekem	Lo Assimilation (see 143)

In the second example, starting binary harmony from the left results in the same output as applying harmony twice.

(140)

wVha9Vliitem	
waha9Vliitem	CGH
waha9aliitem	CGH

(141)

wVha9Vliitem	
waha9Vliitem	CGH
waha9aliitem	LA

It is only if the harmony both starts from the right and is binary that the correct output is derived.

The direction of application, however, need not be stipulated. The relevant bracketing in the examples under consideration is

(142)

[wV[ha9Vliitem]] [bV[?ohVleekem]]

The correct results will be obtained if it is assumed that the rule applies to the innermost bracket first. In Chapter 3 I provide evidence that that the clitics are in fact affixed in the syntax. Then when the rule applies across clitic "boundary" it must be applying post-lexically. If it applies lexically as well, then it follows from the organization of the grammar that the inner application will precede the outer one. Once the harmony has applied lexically, the vowel is multiply attached and may no longer offer its features to any other segment. I will have more to say about these clitics and the rule of Vowel Insertion which their cliticization trigers in Chapter 3.

Before I go on to consider the accentual properties of words with hateph vowels, I would like to take a closer look at the rules which determine how a vacant core slot is filled and the relation between them. We have already seen the rule of Cross Guttural Harmony. If the vacated slot is in a syllable with a guttural onset, but the structural description of CGH is not met, then, as we have seen (130) the guttural spreads its [+lo] features to the adjacent core slot. I call this rule Lo Assimilation.

(143)

Lo Assimilation (LA)

```
[+lo]
 |
 X  - - - -  X        X = unassociated skeletal
             |            slot
             R
```

The fact that the two core slots are in a single syllable need not be incorporated into the rule. Since TH has no onsetless syllables, a segment adjacent to a rime must be the onset of the syllable dominating that rime. Moreover, the feature [+lo] need not be specified as a consonant, since only consonants may be elements of an onset. Furthermore, since /a/ is the only vowel in the language with the feature [+lo], nothing more need be written into the rule.

If the vacated core slot is not in a syllable with a guttural onset, then Default Schwa Insertion (135) applies. The ordering between the three rules under consideration which deal with empty vowel slots is clearly: CGH, LA, DSI. The structural description of DSI is met whenever there is an empty vowel slot. It is therefore met, for example, by the output of Post Guttural Epenthesis, as in (144).

(144)

```
h   9   b   d
|   |   |   |    DSI
X X X X X X X    --->      *hoʕəbad
  |       |
  o       a
```

If DSI did apply to the output of PGE, it would bleed CGH, since DSI would fill the skeletal slot, and CGH is triggered by an empty core slot. For the same reason, DSI must be ordered after Lo Assimilation. LA, in turn, must be ordered after CGH, since its structural description is met as well in (145), and its application would also bleed CGH, robbing it of an empty skeletal slot.

(145)

```
h   9   b   d
|   |   |   |    LA
X X X X X X X   --->     *ho9ăbad
  |       |
  o       a
```

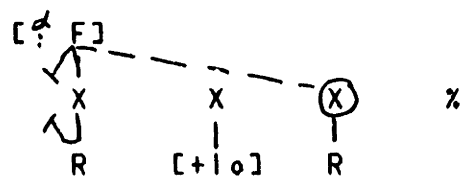
Notice, however, that this order does not have to be stipulated at all since there is an "elsewhere" relation obtaining between them. The Elsewhere Condition, originally proposed in Kiparsky (1973), and revised in Kiparsky (1982), states:

> If the structural descriptions of a two rules A, and B, are met by a string Φ, and the structural description A (the more specific rule) contains that of B (the more general rule), and the results of applying A and B to Φ are distinct, then the rules are disjunctively ordered, with A (the more specific rule) applying before B (the more general rule).

Examination of the rules in question, repeated here for ease of reference, reveals that the structural description of CGH contains that of LA, which contains that of DSI. By the Elsewhere Condition, the ordering has to be CGH-->LA-->DSI, which is what we have just ascertained is necessary. Careful formulation of the rules brings out the formal relation between them, and obviates the necessity of extrinsically ordering them.

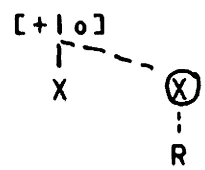
(146)

Cross Guttural Harmony



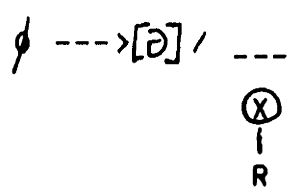
(147)

Lo Assimilation



(148)

Default Schwa Insertion



2.5.3 The Accentual Properties of Words with Hateph Vowels

In this subsection, I will deal with the accentual properties of the word types we are considering which were taken to motivate the left-headed reduction foot. The first thing to explain is why the vowel in the first syllable of the words in (149) are not ultra-short, as we would expect them to be, if right headed reduction feet are constructed.

(149)

ne9ermúu naSamdaá

I pointed out earlier that these words have a derivational history: their underlying forms are ne9ramuu and na9modaa, to which PGE and VD apply. Notice that these examples establish the ordering of PGE before VD, since the former provides the open syllable which is the context for the application of the latter.

I have claimed that the ultra-shortness of a vowel is the reflex of its complete stresslessness: ultra-short vowels are associated with no grid marks. These vowels have no associated grid mark since at the point of grid construction these vowels are non-stress-bearing because they lack phonemic melodies. The inserted vowels are epenthesized without melodies and the underlying vowel have been deprived of them by the rule of MR. This rule in turn applies after the construction of reduction feet. Now we must determine the exact point in the derivation at which these feet are constructed. It must obviously be before VD, since VD affects a subset of the vowels singled out for MR.

Let us assume that it also precedes PGE, which means that reduction feet are assigned to the following representations:

(150)

ne9ramuu   na9modaa

Given that these vowels are not in the weak position of reduction feet, they will retain their phonemic melodies, and as such will be associated with a mark in the grid, and will be ineligible for ultra-short interpretation.

On the other hand, PGE epenthesizes a skeletal slot associated with no phonemic melody and so there will be no grid slot corresponding to the syllables with the epenthesized vowels. Although the middle vowel in each of the examples in (149) is in a closed syllable, and hence not marked for ultra-shortness, it will still lack a place in the grid if we assume that the rules which fill the vacant skeletal slots apply after the construction of the grid.

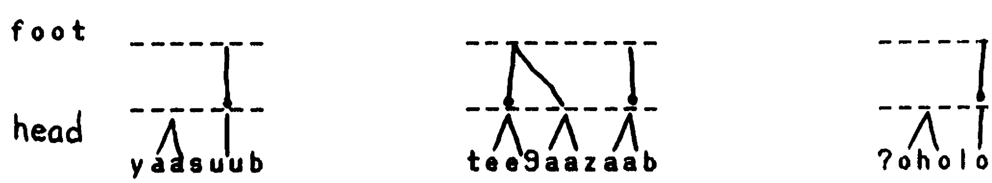
(151)

na9modaa	"let us stand"
na9mVdaa	Stress Tree Construction, RFF, MR
na9VmVdaa	PGE
na9Vmdaa	VD
na9amdaa	CGH
na9amdaa	Grid Construction

```
na9amdaa
 *   *
 *   *
     *
```

The second reason for postulating the left-headed foot has to do with a traditional interpretation of secondary stress. McCarthy (1979) assumes that vowels in open syllables preceding hateph vowels, such as the first vowel in ?ohŏlóo, bear secondary stress because they are usually marked with meteg in most manuscripts. But there is an internal inconsistency in the analysis which he gives to derive secondary stress on these vowels. On his analysis the head of a secondary stress foot must be branching because he assumes that in the normal case only syllables with long vowels bear secondary stress. The branchingness of what has been considered the harmony foot is taken to satisfy the requirement that the head of the secondary stress foot branch. But a long vowel immediately adjacent to the main stress, as in a word like yaaʕúub, does not, under anyone's interpretation, bear secondary stress, since the secondary stress foot must itself branch. (152) shows that although yaaʕúub has a syllable with a branching vowel, it may not head a secondary stress foot, since the foot itself must branch. tèe9aazáb, on the other hand, has a secondary stress foot, since the initial vowel branches and the secondary stress foot itself branches. If the branchingness of the harmony foot in ?ohŏló is taken to satisfy the condition that the head of the secondary stress foot branch, it cannot satisfy the requirement that the foot itself branch.

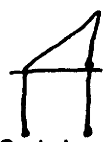
(152)



It comes then perhaps as no surprise that the accentual system treats words like these as "short," (Dresher (1981, p.28)) indicating that they bear no secondary stress. Notice that in (153) the initial syllable is assigned a foot level grid-mark. It will, however, be removed by the regular application of the de-stressing rule introduced in the preceding section.

(153)

?ohlo "his tent"



?ohlo Stress Tree Construction

?ohlo RFF, MR n.a.

?ohVlo PGE

```
?ohVlo        Grid Construction
 *   *
 *   *
     *

?ohVlo        PSDS
 *   *
     *
     *

?ohòló        CGH
```

Finally, it was seen that when the Rhythm Rule applies to words of the type we are considering, stress is retracted two syllables, onto a short vowel <7>. This deviates from the normal stress pattern in which the rule retracts stress only one syllable onto a heavy syllable. In words like na9amdáa, moreover, the stress is retracted over a closed syllable. Notice, however, that the syllables over which stress is retracted are precisely those which have no representation in the grid. Although the middle syllable of na9amdáa does not have an ultra-short interpretation because it is in a closed syllable, nonetheless it has no associated grid mark, since it is an epenthetic vowel which had no phonemic melody at the point of grid construction.

(154)

```
        na9modaa            "let us stand"

        na9modaa             Tree Construction

        na9mVdaa             VR, MR ("stress shift)

        na9VmVdaa            PGE

        na9Vmdaa             VD

        na9Vmdaa             Grid Construction
         *    *
         *    *

        na9Vmdaa             PSDS
         *    *
              *

        na9amdaa             CGH
```

With the Rhythm Rule formulated as in (39) of Section 3, when a word such as na9amdáa is in a position of stress clash we expect the stress to be retracted to the initial position. It appears then that the branchingness of the head of the foot, or any other geometric property, has nothing at all to do with whether or not stress may be retracted. What is special about these light syllables is that, unlike most short vowels which are affected by VR and MR, these vowels do not have their melodies removed and are hence associated with a mark in the grid.

I might point out that although most retraction rules retract stress to the nearest syllable with the highest degree of stress, retraction rules with strictly local effects are not unheard of. Halle and Vergnaud (forthcoming) report that in Lithuanian, stress, under conditions of clash, is retracted one syllable, onto an erstwhile stressless syllable as in Tiberian Hebrew.

Footnotes

1. Given the autosegmental notation introduced in Chapter 1, it might be possible to express Pretonic Lengthening and Gemination as one process. McCarthy (1981) argues extensively, however, that these processes are not to be identified as instances of a single rule. His arguments are based on subtle interpretation of the orthographic record, and as I have little to say on the matter, and it has no direct bearing on the issues discussed in this chapter, I will not consider it further.

2. There is actually a problem here concerning the appropriate way to refer to a superheavy syllable, for which I have no insightful solution. Phonological rules often make reference to the distinction between between light and heavy syllables. The heavies are those with branching rimes and the lights are those with non-branching rimes. We can use the notation to distinguish a non-branching rime from a branching rime in a rule. A phonological rule should not, however, be able to distinguish among the syllables with branching rimes according to the <u>number</u> of branches. The rules should not be able to count.

3. Without recourse to metrical trees, the VR rule would have to be formulated as an iterative rule, something like (i).

$$\text{(i)}\quad \begin{array}{ccccc} [\alpha F] & \dashrightarrow & \emptyset \; / & \_\_\_ & [\beta G] \\ & & & | & | \\ & & & X & X \\ & & & | & | \\ & & & R & R \end{array}$$

The rule states that the melody of a vowel in a non-branching rime is removed when it precedes a rime associated with a melody.

4. Not surprisingly, a similar suggestion appeared in the philological literature in 1939, spurring a debate about pretonic vowels in Hebrew. See Poebel (1939) and the rebuff in Blake (1951).

5. Kiparsky (1983) suggests that extrametrical elements lose their extrametricality either by losing their peripherality or else when they exit the lexicon. See Archangeli (1983a) for discussion.

6. The astute reader might have noticed that cases like be?ĕmet and woḥŏlî are problematic as well. The second vowel in each case is eligible for reduction, and in fact surfaces ultra-short, but nonetheless retains its melody.

We would expect these vowels to lose their melodies by MR, and surface as ba?ămet and waḥălii by Lo Assimilation. I will first point out that these cases are exceptional, and the norm is for a vowel, even in a syllable with a guttural onset to lose its phonemic melody in a position of reduction, and to surface as an ultra-short /a/ regardless of the quality of the underlying melody.

(i) a. 9enáb   "grape"
9eenaáb   PTL

b. 9enabiím   "grapes"
9ănaabiím   VR, MR, LA

This example shows that 9enab has an underlying /e/ in the first syllable which lengthens when adjacent to MS by PTL. When the vowel is two syllables removed from the stress, it doesn't surface as an ultra-short /e/, but rther the vowel loses its melody and surfaces as ultra-short /a/ by LA.

We must now ask how to deal with these exceptions to the rule of MR. Recall that I am assuming that it is the process of MR which renders the vowels non-stress-bearing, and allows them to surface ultra-short. I suggest that in these cases, the melody of the vowel does not delete, but rather de-links, so that the skeletal slots of these vowels are still unassociated at the point at which stress trees are constructed, and they are still considered non-stress-bearing. Later in the derivation, the melodies may re-link.

7. The fact that retracted stress is not normally recorded in the text when the landing site is a closed syllable with a short vowel has no explanation under my account. Dresher (1981b) adduces evidence that the stress was indeed retracted int hose cases, but not recorded. Perhaps, because the accents are used for cantillation, the restrictions on recording retracted stress have to do with musical, not linguistic factors.

Chapter 3

Triconsonantal Stem Shapes

In Chapter 1, I briefly reviewed the theory of autosegmental phonology developed by McCarthy and adopted here for Hebrew. In this chapter, without giving a full morphological analysis of the Hebrew verbal system, I focus on one aspect of that system: that of accounting for the regular alternation in the shape of triconsonantal stems.

We have seen that morphological derivation of words of the major lexical categories in Hebrew involves the pairing of a (tri-)consonantal root with a skeletal template and a vocalic melody. When we look at the templates of Hebrew verbs, we find that tri-consonantal roots may be paired with one of three templates: CVCVC, CVCCVC or CCVC. (Here, and throughout this chapter, I often represent the template shapes using Cs and Vs to signify the skeletal slots to which the vowels and the consonants can respectively link. This is an orthographic convention. It should be clear that I do not imply that the slots are themselves specified with features of syllabicity.) I argue in this chapter that many of the complex alternations in the verbal system can be accounted for if we assume that there are only two templates available for association with tri-consonantal roots:CVCVC and CVCCVC. The CCVC stem shape can be derived from the CVCVC template by rule. The analysis will lead to the postulation of two morphological strata (in the sense of Section 2 of Chapter 1) in the TH lexicon.

3.1 The Problem

Although Hebrew stems take one of the three forms CVCVC, CCVC and CVCCVC, traditional grammar recognizes only a a bipartite distinction among the seven most common Hebrew binyaniim: those whose stems have three consonantal slots, and those with stems which have four. The distribution between CCVC and CVCVC stems is fully predictable. Triconsonantal stems are bi-syllabic when unprefixed, or when prefixed with a closed syllable, and assume a CCVC shape when prefixed with an open syllable. This is illustrated in (1).

(1) Triconsonantal stems a. CVCVC
b. CVC + CVCVC
c. CV + CCVC

For example, the Nif9al binyan stipulates a triliteral stem and a preformative n. The perfect is formed by prefixation of a preformative na and the suffixation of the person/number inflectional endings. Since the prefix is always of the form na, the stem always assumes the shape CCVC in the perfect. Thus,

(2)	na+ktab+tii	(niktábtii)	"I was written"
	na+ktab+tem	(niktabtém)	"you m.p. were written"
	na+ktab+aa	(niktəbáa)	"she was written"

The imperfect prefix for the same binyan always assumes the form CVn, the /n/ being the marker of the binyan and the C ranging over ?,y,t, and n, which represent the prefixal person number markers. Since the prefix consists of a closed syllable in the imperfect, it always attaches to a stem of the shape CVCVC.

(3)	?a+n+kateb	(?ikkaatéeb)	"I will be written"
	ta+n+kateb	(tikkaatéeb)	"you m.s. will be written"
	na+n+kateb	(nikkaatéeb)	"we will be written"

Likewise, the infinitive absolute of Nif9al may assume one of two forms; one has the prefix na, the other the prefix hin. The first attaches to a stem of the form CCVC, and the second to one of the form CVCVC.

(4) Two forms of the Nif9al Inf. Abs.

a. na+ktob (niktób)

b. hin+kateb (hikkaateéb)

Qal, the underived binyan, provides further illustration of this regularity. As with the other binyaniim, the perfect is formed by suffixation of the person/number endings to the stem. Since the Qal perfect is not prefixed, the suffixes attach to stems of the form CVCVC.

(5) Qal perfect

a. katab+tii (kaatábtii) "I wrote"

b. katab+aa (kaatbaá) "she wrote"

c. katab+tem (kətabtém) "you m.p. wrote"

The imperfect is formed by prefixation of a light syllable, where the onset includes one of the consonants representing the person/number inflection. Predictably, the stem is of the form CCVC.

(6) Qal Imperfect

a. ta+ktob (tiktób) "you m.s. will write"

b. na+ktob (niktób) "we will write"

c. ya+ktob (yiktób) "he will write"

The Qal infinitive follows the same pattern, with a light syllable la attaching to a stem shaped CCVC.

(7) Qal Infinitive

a. la+ktob (liktób) "to write"
b. la+rkab (lirkáb) "to ride"

Thus, to determine the template shape of a given stem, one needs to know two things: the number of consonantal slots in the stem template, and the shape of the prefix, if there is one. If the stem has four consonant slots, its shape will be invariant. If it has three C slots, then its shape will be determined by the prefix. Without a prefix, or with a CVC prefix , the stem will have the shape CVCVC. With a light syllable prefix, the stem assumes the shape CCVC. Given this, we would not want to stipulate that, for example, in the Qal and Nif9al binyaniim the stem is sometimes of the form CCVC and at other times of the form CVCVC. Rather it would appear that there are only two templates available to the verbal system for morphological derivation; one with three consonant positions and one with four. The alternation between the two triconsonantal stem shapes should be handled by rule. In the next subsection, I will review Prince's (1975) attempt to arrive at a satisfactory way of relating the two triconsonantal stem shapes by rule. Prince's attempt fails, and he concludes that for the purposes of the phonology certain stems start with the form CCVC, and others with CVCVC. The glaring regularity is left unaccounted for. I will review his attempt here for two reasons. First, it provides a useful introduction to the relevant data. Second, Prince's attempt at capturing the generalization concerning stem shape founders because at the time he had recourse neither to the principles and mechanics of Lexical Phonology, nor to an autosegmental phonological representation which separates the phonemic melody from the slots of the skeletal tier. It is therefore enlightening to see just how these constructs are crucial for a resolution of the problem.

3.2 An Attempt at a Segmental Solution

Prince focuses his attention on the infinitive, imperfect and imperative forms of the underived binyan, Qal. TH has two kinds of infinitives: one with the infinitive marker la (cognate to the preposition l-), and one without the prefix. Briefly, the prefixed infinitive appears mostly as complements to Equi verbs or in adjunct clauses such as purposives. The unprefixed infinitive has the distribution of a noun and functions like a gerund, often appearing as the object of a preposition. In the previous subsection, we saw that the prefix la attaches to a stem of the form CCVC. The stem vowel is most frequently /o/, but sometimes /a/. In the unprefixed form, a schwa appears between the first two radicals.

(8) Qal Infinitives

1. prefixed: la+ktob (liktób) "to write"
   la+rkab (lirkáb) "to ride"
2. unprefixed: kətób "writing"
   rəkáb "riding"
3. unprefixed, as object of preposition:
   b#kətob (biktób) "when writing"
   b#rəkab (birkáb) "when riding"

The imperfect, as we saw above, has the form CV+CCVC where the prefix represents the person/number inflection. The stem vowel is most frequently /o/, but it may also be /a/ or /e/. The imperative has the shape CəCVC, along with the gender/number suffixes. The stem vowel of the imperative is always identical to that of the imperfect.

(9) Qal Imperfects

ta+lamad (tilmád) "you m.s. will learn"
ta+spor (tispór) "you m.s. will count"

Qal Imperatives

ləmád "you m.s. learn!"
səpór "you m.s. count!"

It happens that the stem shape CəCVC is very marginally attested in the language, apart from its frequent appearance in the imperative and the unprefixed infinitive. In order to banish the unaffixed CəCVC stem shape from the lexicon, Prince proposes to derive the unprefixed infinitive and the imperative from the prefixed infinitive and the imperfect respectively, via the truncation of the CV prefix. Whatever principle guarantees the CCVC stem shape of the forms with light syllable prefixes, will produce the same stem shape for the imperative and the unprefixed infinitive. Prince assumes that, after Truncation, a rule of Schwa Insertion, which we saw apply with the cliticization of the monoconsonantal clitics (Chapter 1 Section 1), will break up the initial cluster. The following is the assumed partial derivation for the imperative "you m.s. guard!"

(10)	ta + šmor	
	šmor	Truncation
	šəmor	Schwa Insertion

The derivation of the imperative form from the imperfect is quite plausible given the fact that in negative commands the untruncated form of the imperative is used.

(11) šəmor "you m.s. guard!"

?al tišmor "you m.s. don't guard!"

The derivation also accounts for the fact, mentioned earlier, that the stem vowel of the imperative is always identical to that of the imperfect.

Given the regularity of the alternation of the stem shapes, however, one might want to assume that the derivation in (10) is incomplete, and that in the underlying forms of the the infinitives and the imperfects we have been looking at, a vowel originally resided between the first and second radicals of the root. An additional reason for assuming that this might be so is that, in fact, a non-reduced vowel does sometimes make an appearance there in certain forms of the imperative and the infinitive. For example, the infinitive may be pronominally suffixed. In such cases, a copy of the stem vowel appears between the first and second radical. The following is the paradigm.

(12) Pronominally Suffixed Infinitives

kotbíi	"my writing"	kotbéenuu	"our writing"
kətobkáa	"your m.s..."	kətobkém	"your m.p..."
kətobéek	"your f.s..."	kətobkén	"your f.p..."
kotbó	"his writing"	kotbám	"their m.p..."
kotbáh	"her writing"	kotbán	"their f.p..."

This paradigm raises the possibility of setting /kotob/ up as the underlying form of the infinitive stem. The words in (12) can be derived, assuming that (kotob) is indeed the underlying form of the stem, by the regular application of Vowel Reduction, Vowel Deletion and Spirantization. This last rule spirantizes all non-geminate, non-emphatic oral stops (that is: p,b,t,d,k, and g) post-vocalically. In the transcription, henceforth, spirantized consonants are underlined. See the sample derivations in (13).

(13)

kotob + ii	"my writing"
ko$\underline{t}$o$\underline{b}$ii	Spirantization
ko$\underline{t}$o$\underline{b}$ii	Reduction Foot Formation
ko$\underline{t}$V$\underline{b}$ii	Melody Removal
ko$\underline{t}\underline{b}$ii	Vowel Deletion

kotob + e +ka "your m.s. writing"

koṯoḇeḵa Spirantization

koṯoḇeḵa Reduction Foot Formation

kVṯoḇVḵa Melody Removal

kVṯoḇka Vowel Deletion

kəṯoḇḵa Default Schwa Insertion

Along these lines, we could assume that the underlying form for the prefixed infinitive is /lakotob/ and a rule will be postulated to remove the first stem vowel when the stem is prefixed with a light syllable. This is a very general rule which operates throughout the language, since whenever a stem with three consonantal slots is prefixed with an open syllable, no vowel appears between the first two stem consonants. Prince calls this putative rule "the 3-Syllable Rule," formulated as follows:

(14) Prince's 3-Syllable Rule

S.D. CV + CV CVC]$_{\text{stem}}$

1 2 3

S.C. 1 0 3

With such a rule in the grammar, the following derivation may be postulated for kətob (you m.s. write!):

(15)	ta + kotob		
	ta k tob	3-Syll Rule	
	ktob	Truncation	
	kətob	Schwa Insertion	
	kəṯoḇ	Spirantization	

Prince abandons the solution because of a number of problems it entails. First, the 3-Syllable Rule appears to mimic the rule of Vowel Deletion motivated Chapter 2. Both have the effect of deleting a vowel in a light syllable if the preceding syllable is open. What was not recorded in the transcriptions of the last chapter, is that a vowel deleted by that rule, always leaves a trace in the form of the spirantization of a following stop. The vowel deleted by the putative 3-Syllable Rule does not. Maintaining the 3-Syllable rule entails having two identical rules of syncope which cannot be collapsed, since one must be ordered before spirantization and the other after it. Compare the derivations in (16) and (17).

(16)	malakeehem	"their m. kings"
	malak̲eehem	Spirantization
	malk̲eehem	VD
(17)	takotob	"you m.s. will write"
	tak tob	3-Syllable Rule
	tik̲tob̲	Spirantization, others

Another major problem Prince had in positing a grammar with the 3-Syllable Rule involved determining the identity of the vowel which the rule removes. I mentioned that the /o/ in the first syllable of the stem appears also in the pronominally suffixed forms of the imperative. But this is not the case for all such forms.

(18)	šomréenii	"you m.s. guard me!"
	šimrúunii	"you m.p. guard me!"

The problem with setting up /šomor/ as the stem for the imperfect/imperative is in explaining the alternation between /o/and /i/. There are no other alternations in the language involving these two vowels. However, the epenthetic vowel /ə/ does alternate with /i/, as it appears as /i/ when it finds itself in a closed syllable as we shall see soon. Thus, Prince takes the underlying stem shape of the imperfect/imperative and of the infinitive to be CCVC and assumes that for the purposes of the phonology there is no 3-Syllable Rule. The derivation of the imperative is as in (18), where the first vowel is epenthetic. Where an /o/ appears in the first syllable, this is assumed to be derived via a rule which Prince coins the Echo Rule, which copies the stem vowel in the appropriate context.

(19) Prince's Echo

S.D.	[C v-stem	C	V [-lng]	C + pron
	1	2	3	4
S.C.	1	3	2	4

Notice that the morpheme following the last stem consonant must be a pronominal suffix. The rule doesn't apply in the plural imperative in (18), so that we get šimrúunii, not šomruunii, because what immediately follows the last stem C, /uu/, is the plural inflectional morpheme, not a pronominal. In the case of the singular imperative of that example, the morpheme /ee/ is a pronominal augment, not an inflectional morpheme. Prince assumes that in such cases, when Echo does not apply, the initial cluster is broken up by /ə/ and then raised to /i/ when it finds itself in a closed syllable.

The following example shows that a long vowel is either copied short or not copied at all. We cannot tell which it is, since, if it were copied short, it would in any event reduce.

(20) rə?oóṯ "seeing"

rɔ?ooṯíi "my seeing"

This is true both for stem vowels which are underlyingly long, such as the one in (20) and those which are lengthened by rule. Prince therefore adds the feature [-long] to the structural description of the rule to ensure the shortness of the copied vowel.

There is a further complication in the segmental formulation of the rule. Recall that we found "echo" in the imperative and in the infinitive. Since the imperative is derived from the imperfect via truncation, we would expect to find echo operative in the imperfect. Curiously, the rule does not operate in the imperfect.

(21) ta + šmor + oo "you m.s. will guard him"

tišməróo VR, other

If the rule did apply here, təšomróo would result. Prince writes a condition on the rule to the effect that it does not apply in the imperfect. This is surely curious, given that the imperative is derived from the imperfect.

Prince's solution entails that the language has stems with underlying initial clusters, and as such includes a complication of the morpheme structure constraints of the language. The assumption is that when such a stem surfaces unprefixed, the rule of Schwa Insertion breaks up the initial cluster. The rule is employed not only to break up the initial clusters of the imperative and the unprefixed infinitive, but also in the derivation of the marginal class of words of the form CəCVC, such as dəb̲aš. It is also invoked for the much larger class of words of the form CəCVVC, such as gəb̲uul, where the schwa never alternates with any other vowel.

The analysis fails to account fully for the distribution of the CCVC stem shape. In particular, it fails to account for why stems of that shape never appear with closed syllable prefixes. There is no evidence for a verb with the underlying form analogous to hitktob. There are forms like hitpallel, but the /a/ gives no evidence of being epenthetic, and there is certainly no justification for setting CCCVC as a possible underlying stem.

The rule of Schwa Insertion can be seen as one which renders an unsyllabified consonant syllabified: Hebrew allows no onset consonant clusters. We might formulate the rule as

(22) $$\emptyset \longrightarrow \underset{\substack{| \\ \mathrm{R}}}{\mathrm{X}} \,/\, \mathrm{C}\ \_\_\_\_$$

C = unsyllabified consonant

Prince actually suggests that this rule can be collapsed with another rule which deals with unsyllabified consonants. As I briefly mentioned in the first chapter, Hebrew has a very large class of nouns, called segholates, of the form CV́CVC. We saw that these nouns which have penultimate stress even though they end in closed syllables, are generally taken to be of the underlying form CVCC. The final consonant remains unintegrated into the syllable structure which is in turn the input into the stress representation. For the purposes of stress, these nouns are monosyllabic. At some late point in the derivation, the unsyllabified consonant is made part of a branching rime by a rule of epenthesis.

(23)

```
          R                R   R
         /|                |\  |\
       mal    k   --->   mal   ek
```

Later, a process of resyllabification joins the second consonant with the final rime to form a CVC syllable.

Now, Prince formulates a single cluster break-up rule which deals with the consonant clusters at either periphery of the word.

(24) Prince's Cluster Break-up

$$0 \; ---> \; //\#C\_\_C$$

(He assumes that, although the orthography indicates that the vowel which is inserted into the final cluster is /e/, it was merely an orthographic convention of the scribes to transcribe the inserted reduced vowel as such.)

It should be obvious that if we formulate both rules in syllabic terms, they cannot be collapsed. While the rule which deals with the initial consonant cluster is formalized as in (22), the rule which deals with the final consonant clusters is formulated as in (25):

(25)

$$\emptyset \; ---> \; \overset{\displaystyle e}{\underset{}{\overset{|}{X}}}/\_\_\_ \; C \qquad C = \text{unsyllabified consonant}$$

The two epenthesis rule are different in two respects. The most obvious one is that one rule makes an unsyllabified consonant a rime, and the other makes such a consonant an onset. But there is another difference. When an initial epenthetic vowel surfaces in a closed syllable, it is realized as /i/, not /e/. See the derivation in (26).

(26)

kmalakiim	"as kings"
kmalaakiim	MS, PTL
kmVlaakiim	VR (Melody Removal)
kVmVlaakiim	Epenthesis
kVmlaakiim	VD
kimlaakiim	output

It is possible that a language would employ two separate rules to deal with unsyllabified consonants, one for either end of the word, but this is surely not the ideal state of affairs. What is more expected is for a language to break up final clusters and deal with initial clusters by inserting a vowel before the initial consonant. This state of affairs obtains in Iraqui Arabic, studied by Broselow (1980) and Selkirk (1981).

(27) katabt ---> katabit

qmaaš ---> iqmaaš

The other expected pattern, where the initial clusters are broken up and the final ones are dealt with by inserting a vowel after the final consonant, is exemplified by Harari, cited by Halle and Vergnaud (1978).

(28) t+ sạbr ---> tisạbri

In fact there is some evidence that Tiberian Hebrew dealt with rare initial clusters by prosthesis. For example, the word for the number two is štayiim. The absence of spirantization in the /t/ suggests that there was no vowel between the first two consonants. Gesenius (p.288) records an alternative pronunciation for the form - ?eštayiim. Notice that in this case the epenthetic vowel is identical in quality with that inserted in words like mélek̲. Another word which displays this kind of alternation is the word for "yesterday" - ?etmol or tmol. Brown, Driver and Briggs state that the name of the Biblical queen ?ester (note the unspirantized /t/) is the Hebraicized form of the Persian ster. They record a number such alternations.

Is there another possible source for initial schwa besides epenthesis? (I assume that the derivation for words with final clusters is essentially as in Prince). In the previous sections we found two sources for schwa: Vowel Insertion and Vowel Reduction. I argued that each rule resulted in an empty core slot which was filled by a rule of Default Schwa Insertion. Thus, we really have two possible sources for the intial schwa in kət̲ob̲ and šəmor. If the empty slot is not produced by epenthesis, it may be produced by VR, assuming that there is an underlying vowel between the first two consonants. This is the possibility I will explore in the next section.

Let's first pause and see what the features of a desired analysis of the data presented here should be. First, the alternation in stem shape must be accounted for by rule. This entails setting up one of the triconsonantal templates as basic. If CVCVC is set up as basic, the CCVC template can be banished from the lexicon altogether. Moreover, we can dispense with one of the epenthesis rules and maintain only one rule in the language to deal with unsyllabified consonants.

If the CCVC are derived from CVCVC stems, a rule of Vowel Deletion must be postulated to produce CCVC stems. Ideally, this rule would be identified with the familiar rule of VD which operates in the same doubly open context. If the rules are to be identified, then it must be explained when the deleted vowel spirantizes a following stop and when it does not.

Moreover, the problem of identifying the first stem vowel must be solved. The main problem is to explain why it is that the vowel usually shows up as /o/ in certain verb forms when not reduced, but shows up as /i/ in some related verb forms. An /o/ in the first syllable suggests an underlying /o/, but an /i/ points to either /a/ or epenthetic /ə/, both of which regularly raise to /i/ in an initial closed syllable. <1>

Next, it must be determined when it is that the first vowel in a word of the underlying shape CVCV may reduce. In nouns and verbs (aside from the the imperative, the unprefixed infinitive and the small class of nouns referred to above) reduced vowels aren't found in that position since underlying vowels in that position usually lengthen under Pre-tonic Lengthening or induce Pre-tonic Gemination. This is one of the motivations for assuming that the schwa in a surface CəCVC sequence is epenthetic. The epenthetic vowel is precisely the one which undergoes no form of Pretonic Strengthening. But if these vowels are not taken to be epenthetic, an explanation for why they may reduce must be found.

Finally, an explanation has to be found for why the Echo rule applies in the infinitive and in the imperative, but not in the imperfect, even though the imperative plausibly is derived from the imperfect.

Before offering my solution, let me dismiss one which might immediately suggest itself. One could deal with the problem of stem shape by positing an underlying

```
29   t a  k    t o b
     | |  |    | | |
     X X  X  X X X X
```

for forms like the imperfect tik̲tob̲, where the first stem vowel slot is associated with no phonemic melody, and formulate spirantization in such a way so that only a V which is associated with a phonemic melody will spirantize a following stop. The vowel slot in (29), which is not associated with a phonemic melody, will delete by the rule of VD motivated in the previous sections without spirantizing a following stop. We would then be faced, however, with the unexplained generalization that the first V slot of the stem is linked to no phonemic melody if and only if the stem is triconsonantal and is prefixed with a light syllable, and would be in no better a position than before.

3.3 Morphological Strata

3.3.1 Spirantization

For the reasons outlined above, I would maintain that all triliteral stems have the underlying form CVCVC. If this is so, what is the identity of the vowel in the first syllable? I will identify this vowel as /a/ in the case of the verbal forms under consideration for the following reason. It was pointed out in note 1 of Chapter 1 that in all active forms when a vowel surfaces after the first stem consonant, it appears as /a/ or a vowel derived from /a/ by rule. In all passive forms, the vowel appears as /u/. I therefore take /a/ to be the active melody associated with the first stem vowel slot in every active form of the verb and the deepest forms of the imperfect to be ta+katob, ya+katob etc. But if this is so, I must explain why it is that the first stem vowel does not spirantize a following stop as all other deleted vowels. Another problem concerns the forms in (30)

(30) takatobuu ---> tiḵtəḇúu

yakatobuu ---> yiḵtəḇúu

nakatobaa ---> niḵtəḇáa

If VR were applied in the manner described in the previous sections, the wrong vowel would delete.

(31) ta̲kato̲búu

The underlined vowels are those which would be affected by VR applied in this manner. But it is the first vowel of the stem which we want deleted. The morphological bracketing suggests a possible solution.

(32) [[ta[katob]]uu]

That (32) represents the proper bracketing for this word is proven by the fact that tiḵtoḇ is an independent word, but kitḇúu is only an independent word when it is derived, on the accepted analysis, from [takatobuu].

When Vowel Reduction is applied cyclically to (32), the right vowels are affected by reduction and deletion.

(33)	[takatob]	cycle 1
	[taktob]	VR, VD
	[taktobuu]	cycle 2
	tiktəbuu	VR, Default Schwa Insertion, others

Although cyclic application gets the right vowel deleted, it does not solve the problem of why some deleted vowels spirantize a following stop, and others do not.

A more fruitful approach makes use of positing different morphological strata in the Hebrew lexicon. As mentioned in the introduction, both morphological and phonological facts can motivate the postulation of different morphological strata. In English, for example, two sets of converging properties are associated with the class II affixes; they always appear on the outside of class I affixes and they fail to trigger certain rules, such as Trisyllabic Laxing. Both properties are seen to follow from a particular conception of the structure of the English lexicon. Assuming that English has (at least) two morphological strata, that Class I affixes, but not class II affixes, are added at the earliest stratum, and that rules such as Trisyllabic Laxing are restricted from applying at any later stratum, then Class II affixes will always appear outside of Class I affixes, and will never trigger rules like Trisyllabic Laxing.

I would like to propose that the binyan prefixes and the person/number inflectional prefixes of Tiberian are added at the earliest morphological stratum of the TH lexicon. All suffixes, including number/gender agreement markers, pronominal clitics and derivational suffixes are added at a later stratum. To explain the spirantization facts, I will assume that the Spirantization rule does not apply at this earliest stratum, and so vowels deleted before the addition of any further affixes will never spirantize a following stop. In fact we know that Spirantization must be a late rule since it applies between words in close contact. <2>

(34) mii k̲aamoók̲aa "who is like you?"

This suggests that the rule operates postlexically. It has been suggested (Mohanan (1982)) that when a phonological rule applies at various strata, it must apply at contiguous strata. If this is true, it is indeed plausible to suggest that Spirantization applies postlexically and lexically, after stratum 1.

(Since I claim that all prefixation takes place at stratum 1 and the suffixation later, I cannot offer any evidence for this picture based on order of morpheme affixation.)

The derivations for nik̲tob̲ and tik̲təb̲úu are shown below.

(35)	stratum 1	na+katob	ta+katob
	VR, VD	naktob	taktob
	stratum n	naktob	taktob+uu
	Spir., VR others	nik̲tob̲	tik̲təb̲uu

3.3.2 Echo

We might want to find other evidence that a vowel is present underlyingly between the first and second stem consonants, and is removed by rule at the earliest morphological stratum. I believe that we find evidence for this in the forms derived by truncation, and the rule which Prince called Echo.

In (36) I repeat Prince's derivation of the imperative.

(36)	ta + šmor	
	šmor	Truncation
	šəmor	Cluster Break-up

While deriving the imperative from the imperfect via truncation is plausible, we have seen that there is reason to believe that the reduced vowel in the first syllable of the imperative is not a product of epenthesis. Can it be the product of Reduction? To answer this question, let's first take a closer look at the truncation rule. Prince is vague about when this rule takes place exactly. He writes a condition on the rule to the effect that the inflectional prefix may be removed only if the word is in the appropriate syntactic context (a positive, not negative, command). This suggests that the truncation rule takes place after insertion into syntactic trees. Given the assumptions of lexical phonology, however, this is not possible, since after insertion into syntactic trees the morphological bracketing is no longer present (see Chapter 1) and the morpheme to be truncated cannot be identified. In fact, given the assumptions of lexical phonology, there is only one stratum at which truncation may take place: the stratum at which the to-be-truncated morpheme is affixed. (If we maintain that Lexical Insertion of the phonological shape of words takes place at S-Structure (cf. Pranka (1983)), then the fact that the form of the word depends on the syntactic context is no problem). This locates the truncation, on my account, at stratum 1. As such, the rule may be ordered among the rules applying at that stratum. In particular, it may be ordered between the rules of VR (or, more precisely, Melody Removal) and Vowel Deletion. After the melody has been removed from the first stem vowel, the truncation process will protect the empty skeletal slot from deletion by VD, since the rule will not operate unless the skeletal slot is preceded by an open syllable. The proposed derivation appears in (37).

(37)	stratum 1:	ta + katob		
		ta	kVtob	VR (MR)
			kVtob	Truncation; VD-n.a

It is perhaps interesting that, if the analysis presented here is correct, we have an example of a rule of truncation ordered among the rules of phonology. In outlining the principles of Lexical Phonology, Kiparsky (1982) suggests that there are no truncation rules. I might point out, however, that the kinds of truncation rules which have been cited and which Kiparsky rejects, are of a different nature from the one we are considering here. One putative rule of truncation which Kiparsky rejects is the rule which Aronoff (1976) suggests truncates the adverbial suffix -ly before a comaparative suffix.

(38)	quickly	quicker	*quicklier
	soft	softly	*softlier

All the truncation rules which Kiparsky rules out involve the truncation of a suffix B triggered by the affixation of a suffix C, as in (39).

(39) [[A + B] C] ---> [A C]

In contrast, the rule suggested here is not triggered by the subsequent affixation of another morpheme, and I know of no principle in current theory which should rule out such a process.

Ordering the truncation rule between VR and VD allows us to maintain a single epenthesis rule to deal with unsyllabified consonants (one which makes such consonants a part of the rime of a new syllable) and take care of the reduced vowels in forms like the imperative with rules which are independently motivated in the grammar. If there were no underlying vowel between the first and second stem consonants, this analysis would not be available.

As for the class of words like dəḇáš, zəmán, and gəḇúul, these can have underlying forms in which the first vowel slot is associated with no phonemic melody and gets filled through the rule of Default Schwa Insertion.

(40)
```
d   b a š  --->  d ə b a s
|   | | |        | | | | |
X X X X X        X X X X X
```

[Short excursus on Arabic. It is interesting to note that an almost identical pattern is displayed in Classical Arabic. In that language, as in TH, negative commands employ the imperfect form and positive commands - a truncated form of the imperfect. Brame (1970) points out that this helps explain the peculiar stem shape of the imperative of the underived binyan. In that binyan, a rule of Vowel Deletion creates an alternation between the unprefixed perfect, which has a CVCVC stem shape, and the prefixed imperfect, which has the form CV+CCVC. The imperative has the unprefixed form of CCVC, and, although there are no other unprefixed verb stems of this form, the shape can be accounted for by deriving the imperative from the imperfect via truncation, as Prince suggests for Hebrew. Now, in Arabic, as far as I know, there is no independent evidence for separate rules of vowel reduction and vowel deletion, and this can, perhaps, help explain a difference between the Arabic and the Hebrew forms. In Hebrew, if I am right, truncation takes place between reduction and deletion, and in Arabic , after deletion. Thus, the Arabic forms display an initial consonant cluster which is rendered syllabified by epenthesis of a vowel before the consonant cluster, while Hebrew does not end up with that cluster, but rather with an empty V slot which gets filled by a default rule of Schwa Insertion.

ta+daras ---> tadras---> dras ---> ?idras

End excursus]

For the derivation of the unsuffixed imperative, the rule of Default Schwa Insertion fills in the empty core slot vacated by MR. There are, however, cases in which the slot gets filled by other means. These are the forms which Prince derived through the application of the Echo rule. I take this rule to be one which spreads the melody of the second stem vowel onto the vacated slot of the first stem vowel. (41) is the derivation of a pronominally suffixed imperative, derived from the imperfect via truncation.

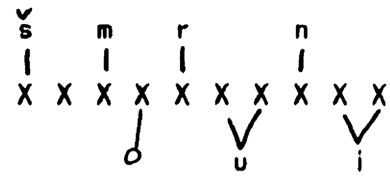
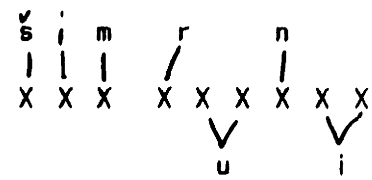
```
(41)        stratrum 1            [ta[katob]]
              VR (MR)              takVtob
              Truncation             kVtob
            -------------------------------
            stratum 2              k t b
                                   | | |
             Echo                  XXXXX    XX
                                    \/      V
                                     o      i

             Spirantization        kot̲b̲íi
```

The fact that a long stem vowel is copied short need not be due to an extrinsic ordering relation between PTL and Echo, or due to a [-long] feature built into the rule. It follows from the fact that there is only one V slot in the first syllable for the melody to spread into.

The next problem Prince had with assuming that all triliteral stems have the underlying shape CVCVC concerned forms like šimrúunii. Since Prince could not separate the phonemic melody from the skeletal tier, he had to assume that if a word like kot̲bíi had an underlying CVCVC form, the first vowel was /o/. But then he could not explain the appearance of /i/ in forms like šimrúunii, since there are no alternations between /i/ and /o/ in the language. Thus, he concluded that all the forms under consideration have a CCVC stem shape and that there are two epenthesis rules: Echo, which breaks up the cluster with a copy of the stem vowel, and operates when the pronominal suffix is immediately adjacent to the stem, and Cluster Break-Up, which operates when Echo does not. The appearance of /i/ in šimrúunii is then explained, because, as we have seen, schwas regularly raise to /i/ in closed syllables.

Equipped as we are with an autosegmental representation, we have no problem maintaining an underlying V slot (vacated after MR) in the stem. When the rule of Echo is applicable, the melody from the second stem vowel spreads to fill the first. When the spread rule is inapplicable, the Default Schwa Insertion rule applies and the schwa raises to /i/ in a closed syllable. There is thus only an indirect alternation between /o/ and /i/; no rule actually changes the melody of /o/ to /i/. Below is the proposed derivation for simruunii (cf. the derivation in (41)).

(42)	stratum 1		[ta[šamor]]
		VR, MR	[tašVmor]
		Truncation	šVmor
	stratum 2		[š mor]uu]nii]
		Echo (n.a.)	
		VR, VD	
		DSI, ə --> i	šimruunii

There are, as seen in the previous subsection, other cases where the Echo rule does not apply. These are all the pronominally suffixed imperfects. Recall that the imperative is derived from the imperfect, and yet the former, but not the latter, undergoes the rule.

(43)	tiktob	"you will write"
	tiktəbéenii	"you will write me"
	*təkotbéeni	
	kətób	"write"
	kotbéenii	"write me"

All Prince could do was baldly state a restriction on the Echo rule to the effect that it doesn't apply in the imperfect.

My account actually explains why the rule doesn't apply in forms like (43). Since the Echo rule is triggered by the pronominal suffixes, it must apply at the second stratum. But in a word of the underlying form /tasamor/, where the prefix is not truncated at the first stratum (as is the case with the imperfects) not only is the stem vowel removed at stratum 1, but the first stem vowel slot as well. Thus, at stratum 2, there is no vowel slot for the second stem vowel to spread its melody to.

(43)

```
        stratum 1          t   š   m   r
                           |   |   |   |
                           X X X X X X X
                             |   |   |
                             a   a   o

                            t   š   m   r
          MR, VD            |   |   |   |
                            X X X   X X X
                              |      /
                              a     o
        -------------------------------------------
        stratum 2     [tašmor[ee[nii]]]

          Echo n.a.        t   š m   r     n
                           |   | |   |     |
                           X X X X X X X X X X X
                             |     |  \/    \/
                             a     o  e     i

          VR, others      tism reenii
```

3.3.3 Pretonic Lengthening and the Word Level

There is now a plausible account for why the first vowel of the imperative stem doesn't undergo PTL. Assume that PTL operates on stratum 2. When the form enters stratum 2, the first vowel slot no longer has the features of a phonemic melody (due to the operation of MR). A core slot will geminate by PTL only if it is associated with the feature [-round] (see Chapter 2. Section 1). Clearly if the slot is associated with no feature, then the rule will not apply.

(44)	stratum 1	takatob
	VR, MR	takVkob
	truncation	kVtob
	VD	n.a.
	stratum 2	kVtob
	PTL	n.a.
	DSI	kə$\underline{t}$o$\underline{b}$

The astute reader will, I hope, have noticed that I have left unresolved a problem concerning the proper application of PTL. I have claimed that the stem /a/ in /takatob/ doesn't undergo PTL because it is removed by MR at stratum 1, and PTL is postulated to apply at stratum 2. But then the question arises as to how any /a/ in the context for reduction gets lengthened by PTL. We saw that PTL usually bleeds VR and robs it of vowels to reduce as in (45).

(45)				
katab	"wrote 3p.m.s."	dabar	"word"	
katáb		dabár	MS	
kaatab		daabar	PTL	
káatáb		dáabár	RFF	
kaatab		daabar	?	MR (n.a.)

Thus, VR and MR should always bleed PTL. Why does MR not affect the first vowels in dabar and katab, allowing them to reach the second stratum with their melodies in tact, able to be lengthened by PTL? Before we answer this question, we might ask another. What purpose does the derivation of the imperative from the imperfect via truncation serve in my analysis? First, it accounts for the fact that the stem vowel, although not predictable, is always the same in the imperfect and in the imperative. But in Prince's account, it also served to derive an underlying CCVC stem shape for the imperative. On my analysis, the imperative never has a stem shape CCVC, and we can account for the identity of the stem vowel merely by assuming that both imperative and the imperfect are built on a CVCVC stem with the same stem vowel.

I believe that the affixation of the light syllable prefix in the derivation of the imperative serves to bring the stem out of the status of a morphologically underived stem to that of a morphologically derived form ("derived" here should not be confused with the same term in the phrase "derived environment"). The assumption here is that, at least in Hebrew, the morphologically underived stems are phonologically inert. It is only after they undergo some morphological derivation that phonological rules may appply to them. In fact Kiparsky (1982) suggests that the lowest bound for the domain of cyclic rules is the domain the major lexical categories, so that cyclic rules will not apply to underived stems. There is no evidence for the cyclicity of the rules of VR and VD at stratum 1, because there is at most one layer of affixation at that stratum. However, instead of restricting the domain of cyclic rules to items of major lexical categories we might take the restriction to apply to lexical rules in general.

This principle holds until the word level, at which time all stems become phonologically activated by default. I will identifv stratum 2 as the word level, so that words like those in (45) are phonologically inert until they enter stratum 2. Kiparsky (1983) suggests that the word level has properites which distinguish it from other lexical strata. Among other things, he suggests that the word level may not be a cyclic stratum. It is perhaps worthwhile pointing out then that no rules hve ever been suggested to apply cyclically at what I an calling stratum 2, and identifying as the word level.

Below is a picture of the Hebrew lexicon as I see it.

(46)

	morphology	phonology
stratum 1	binyan and infl. prefixes	VR, MR, VD, truncation
stratum 2	infl. and deriv. suffixes	Stress Tree Constr PTL, Spiran. VR, VD

In Chapter 2, Section 5, while discussing the rule of Cross Guttural Harmony, I noted that, for proper application, the rule must take the bracketing of the following words into consideration.

(46) [hV[?oholeekem]] [wV[ha9Vliitem]]

We saw that the harmony rule, which may only apply if the trigger vowel is not multiply attached, must apply first to the inner bracket after which it is inelligible to apply across the clitic "boundary." But this looks suspiciously like positing an additional morphological stratum, while I have claimed that stratum 2 is the final lexical stratum, having 'word level' properties. I suggest that the proclitics under consideration are cliticized in the syntax, not in the lexicon. In previous work, I thought that these clitics attached in the lexicon, because Cross Guttural Harmony and Vowel Insertion were rules which applied lexically and across clitic boundary. Recent studies in Lexical Phonology, however, have been suggesting that rules may in fact apply both lexically and post-lexically. Certain differences in mode of application will follow from general principles governing the application of rules. Now, it is true that we never find CGH applying across words, but this is because its structural description is never met in such contexts; by the time words are concatenated, there are no empty skeletal slots in the individual words, and CGH is a rule which fills in empty core slots.

I have already noted that Spirantization must apply post-lexically since a word final vowel may spirantize the first consonant of a following word in close contact. There is evidence that the application of the rule which leads to the spirantization of stops word medially must be lexical. Recall that Spirantization must precede VD, since in words like malkeehem from malakeehem the deleted vowel spirantizes a following stop. The VD rule itself must be lexical since it is followed by a lexically idiosyncratic rule which determines the quality of an underlying /a/ when it surfaces in a closed syllable. This is the A-->I rule of the first note in CHapter 1. So, Spirantization is then another rule which applies both lexically and post-lexically.

I should also point out, that, unlike previous studies which took these clitics to be of the form b-, k-, l-, I take them to be of the form

(47) $\begin{array}{l} b \\ | \\ X\,X \end{array}$, $\begin{array}{l} k \\ | \\ X\,X \end{array}$, and $\begin{array}{l} l \\ | \\ X\,X \end{array}$.

The empty skeletal positions wil be filled by the rules of CGH or DSI, whichever is applicable. Historically, these forms derive from ba, ka, and la. Thus, I claim that the change they underwent invloved loss of the vowel melody, but not of the core slot.

Footnotes

1. The A-->I rule is responsible for the alternation in the vowel of the infinitival and inflectional prefixes. So from ya+ktob we get yiktob via A-->I. The same rule is supposed to account for the /i/ in the first syllable of all pi9el perfects, so that from underlying šabber, we get šibber via A-->I. Finally, the same rule is responsible for the alternation of the first stem vowel in words like dibreehem from dabareehem.

2. Words are in "close contact" when they are joined by a conjunctive accent in the accentual system, in the sense of Dresher (1981a). The Rhythm Rule operates also only when a clash arises between two words in close contact.

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