The Prosodic Hierarchy in Tiberian Hebrew

B. Elan Dresher
Department of Linguistics
University of Toronto

0. Introduction

The Hebrew Bible text is annotated with a complex system of diacritic marks called 'accents'. This system of representation was developed in and around Tiberias over several generations up until the ninth century. The nature and purpose of these accent marks have been much debated. I will argue that they provide what we would today call a prosodic representation, whose purpose is to indicate the correct phrasing of the text. I will show that there are interesting similarities between the Tiberian system and recent proposals concerning prosodic structure. Modern prosodic theory, in fact, sheds light on some problematic elements of Tiberian accentuation. Conversely, I will argue that prosodic theory can fruitfully incorporate some elements of that system.

1. The Tiberian Accents
1.1. Brief Description of the Accents

I will begin with a brief description of the Tiberian representation. The standard text of the Hebrew Bible developed in stages, where the first layer consisted only of a consonantal text, without indications for vowels or any prosodic or accentual information. To this original consonantal text, the Tiberians added symbols for vowels, represented by dots or lines written above and below the consonants; points inside or next to consonants which indicate gemination and spirantization; and a complex system of accents. There are 27 different accent symbols, and each word in the text is assigned one of these accents. The accents can be divided into two classes: disjunctive and conjunctive. A word assigned a conjunctive accent is part of the same phonological phrase as the word following it. Phonological rules such as spirantization, gemination, and rhythmic stress shifts apply to words in the same phrase. A word assigned a disjunctive accent is final in its phrase, and will not undergo or trigger any phonological effects involving a following word.¹

Consider the schematic verse in (1):

---

¹ Versions of this paper were presented at talks at the University of Maryland, Haifa University, and at the Annual Meeting of the Canadian Linguistic Association (May, 1989). I am grateful to P. Avery, E. Broselow, I. Eldar, D. Finer, N. Hornstein, S. Lappin, E. J. Revell, K. Rice, E. Selkirk, A. Weinberg, and Y. Yeivin for helpful discussion and suggestions. None of them should be held responsible for any errors of fact or interpretation that remain.

1. On the system of accents and the development of the Tiberian Bible text, see Cohen (1969), Gesenius (1910), Goshen-Gottstein (1963), Jouon (1947), Orlinsky (1966), and Yeivin (1980).
(1) Conjunctive and Disjunctive Accents

a. Schematic Verse: Words (W) Annotated with Accent Marks

\[
\begin{array}{cccccccccc}
C & D_1 & C & D_0 & D_2 & C & D_1 & C & D_0 \\
W_1 & W_2 & W_3 & W_4 & W_5 & W_6 & W_7 & W_8 & W_9
\end{array}
\]

b. Conjunctive Accents Indicate Absence of Phrase Boundary

\[
\begin{array}{cccccccccc}
C & D_1 & C & D_0 & D_2 & C & D_1 & C & D_0 \\
(W_1 W_2) & (W_3 W_4) & (W_5) & (W_6 W_7) & (W_8 W_9)
\end{array}
\]

c. Disjunctive Accents Indicate Hierarchy and Constituency

\[
\begin{array}{cccccccccc}
C & D_1 & | & | & C & D_0 & | & | & D_2 & | & C & D_1 & | & | & C & D_0 & | & | \\
(W_1 W_2) & | & (W_3 W_4) & | & | & (W_5) & | & | & (W_6 W_7) & | & | & (W_8 W_9)
\end{array}
\]

d. Tree Representation of (1c)

(1) represents a verse with 9 words (W1, W2, etc.). Suppose these words have been assigned the accents shown in (1a), where C represents a conjunctive accent and the D's represent disjunctive accents. Words 1, 3, 6 and 8 have conjunctive accents, and so are part of the same phrase as the words which follow them, as shown in (1b). The other words have disjunctive accents, meaning they end phrases. Disjunctive accents are themselves organized into hierarchical levels, from D0 at the top to D3 at the bottom, and indicate the hierarchical constituent organization of the phrases in (1b), as shown in (1c). A 0 level accent indicates a major break, and is found on the last word of the verse, word 9, and on word 4, which means that word 4 ends the first half of the verse. Words 2 and 7 have D1 accents, which indicate that they end a phrase which divides a D0 phrase. Finally, word 5 has a D2 accent, which divides a D1 phrase. The accents thus indicate that the verse in (1a) has the tree representation in (1d).

1.2. Purpose of the Accents

What is the purpose of the system of accents? A number of answers have been given to this question. Since the accent marks are usually placed over or under the stressed syllable of a word, it has been suggested that one of the functions of the accents is to mark the position of main stress. This can hardly be their principle function, however, since some accents are placed, not on the stressed
syllable, but on the first or last letter of a word. Moreover, an elaborate system of symbols is not needed just to mark the position of main stress, which is anyway largely predictable.

A more important function of the accents is to indicate musical values for chant. The Biblical text is chanted, and each accent is associated with a series of notes. When strung together, they make up a tune. It is generally supposed, however, that the musical aspect is secondary to the main function of the accents, which is to indicate the sense of the text by showing how the words are to be grouped together (i.e. the accents are a guide to the proper phrasing of the text).

1.3. The Accents as a Linguistic Object

Earlier students were inclined to think of the accents as problematic linguistic objects, for a number of reasons. First, it was unclear what sort of linguistic representation the accents were supposed to give. Because they are related to the syntax, it was sometimes supposed that the accents were intended to provide a kind of syntactic representation. In many cases, however, they deviate in gross ways from the syntax, by almost any theory of syntax. Also, the unit which serves as the starting point for accentual analysis is the Verse, itself a problematic unit which does not correspond to a well-defined syntactic constituent. While some verses consist of exactly one sentence, many verses contain both more and less than full sentences. Given the seeming arbitrariness of the Verse and the unclear status of accentual representations, there was a tendency to consider the accentuation system as artificial.²

But research on the phonology-syntax interface in the last few years has focussed attention on a level of linguistic representation that has just these properties, namely prosodic representation. The Tiberian accentuation turns out to be a system of prosodic representation with interesting parallels to current versions of prosodic theory.

2. The Nature of Prosodic Representation: The Prosodic Hierarchy

It was observed by Chomsky and Halle (1968) that many rules of phonology above the word level do not operate directly on surface syntactic structure. Rather, the syntax is subject to various types of adjustments which convert it into a suitable input for the phonology. The adjusted syntactic structure is prosodic structure.

Two central questions confront any theory of prosodic structure. These can be formulated as in (2):

(2) Issues in Prosodic Phonology
   1. What is the nature of prosodic structure?
   2. How is syntactic structure mapped into prosodic structure?

The first question concerns the phonological aspect of prosodic structure: the nature of prosodic representation and its role in phonology. The second issue

². See Aronoff (1985) for a recent statement of this view.
concerns the relation between prosodic structure and syntax. I will first look at the Tiberian accentual representations with regard to the first question, and then later turn to the mapping question.

The building blocks of prosodic structure, as the theory has been developed by Selkirk (1978; 1984; 1986), Nespor and Vogel (1982; 1983; 1986), Hayes (1984), and others, are a series of levels which take the form of a prosodic hierarchy. This hierarchy is commonly construed as in (3a): 3

(3) The Prosodic Hierarchy

a. The Modern Hierarchy
   Phonological Utterance   U   Biblical Verse   V
   Intonational Phrase      I   Disjunctive Phrase   Di i=0,1,2,3
   Phonological Phrase     P   Conjunctive Phrase   P
   Phonological Word       W   Phonological Word   W
   Foot                     F   Foot  F

Thus, surface syntactic structure, consisting of units with syntactic labels, is mapped into a prosodic structure whose constituents have labels drawn from the categories in (3a).

There are similarities between the Modern hierarchy and the Tiberian prosodic hierarchy, shown in (3b). In the Tiberian hierarchy, as in the Modern, we can find evidence for a level of Foot, which can be shown to exist though it is not marked explicitly, and Phonological Word, which is explicitly marked. Moving up the hierarchy, we can identify a constituent which we can call the Conjunctive Phrase: a word marked with a conjunctive accent is part of the same conjunctive phrase as the word which follows it; a word with a disjunctive accent ends such a phrase. These are the phrases bounded by parentheses in (1b). The Conjunctive Phrase forms the domain for rules of external sandhi, such as Spirantization, Gemination, and Rhythmic Stress Shift. 4 For example, in (4a), the initial consonant in the word bene is spirantized by the word-final vowel that precedes it; but in the syntactically parallel (4b), the same word is not spirantized, because the preceding word is not in the same phrase:

3. Following Hayes (1984), some writers also include the Clitic Group as a unit of the prosodic hierarchy above the level of the Word and below the Phonological Phrase. Clitic Groups are indicated in the Tiberian texts with a hyphen known as magqaf (see below). For our purposes, a Clitic Group counts as a phonological Word, W.

4. Cf. Rotenburg (1978), McCarthy (1981), Kaisse (1985). It has been claimed that external sandhi in Biblical Hebrew is limited to words which are sole sisters in a phrase. This is not the case: e.g. spirantization also applies within phrases of more than two words; examples can be found in Ex 5,15 (lammâ_ taşâse kô), Josh 5,1 (wayhi kîšmôa9 kol-malkî hâtemîrî), etc.
(4) Spirantization Within a P-Phrase

a. (yah\textsuperscript{-}n\textbar\textbar\textbar) b\textsuperscript{-}n\textsuperscript{-}yisr\textsuperscript{-}ä\textsuperscript{-}ż\textsuperscript{-}ēl\)D1
   encamped children.of.Israel
   'the Israelites remained encamped' Num 9,22

b. ((yisr\textsuperscript{-}ä\textsuperscript{-}l)D1 (b\textsuperscript{-}n\textsuperscript{-} yisr\textsuperscript{-}ä\textsuperscript{-}ż\textsuperscript{-}ēl))D0
   set.out children.of Israel
   'the Israelites would set out' Num 9,17

The phonological processes which are bounded by the Tiberian Conjunctive Phrase are paralleled by similar processes in other languages which are found in the domain of the Phonological Phrase, P (e.g. Raddoppiamento Sintattico in Italian, the Rhythm Rule in English, liaison in French, and so on). Therefore, we can identify this level of the Tiberian Hierarchy with the Phonological Phrase.

There is a discrepancy at the next level up, where the Intonational Phrase, I, of the Modern hierarchy is ranged against a series of Tiberian levels corresponding to the hierarchy of disjunctive accents. Here is where we find the main difference between the two systems. At the top of the hierarchy, the Utterance, U, in the Modern hierarchy plays the same role as the Verse, V, in the Tiberian. Like the Verse, the Utterance may contain both more and less than a sentence. We know that there are syntactic, semantic, and pragmatic factors which determine what may go into an Utterance, but what these factors are is only poorly understood. In practice, the Utterance is usually taken as given, and analysis proceeds from there.

Modern prosodic theory, then, has two characteristic properties of the Tiberian accent system: it has representations that are similar to syntax, yet distinct from it; and it has a unit, the Utterance, which corresponds to the biblical Verse. Therefore, we can conclude that the Tiberian system should be considered in the context of prosodic theory.

3. Comparing the Hierarchies

The Modern and Tiberian hierarchies imply somewhat different claims as to the nature of prosodic representation. In the Modern Hierarchy, there is no limit to the number of I-phrases in a U, as shown in (5a):

\begin{equation}
\begin{array}{c}
\text{U} \\
\text{I I I...}
\end{array}
\end{equation}

\begin{equation}
\begin{array}{c}
\text{V} \\
\text{DO DO}
\end{array}
\end{equation}

The Tiberian Hierarchy, by contrast, divides every verse into at most two DO phrases, which are roughly equivalent to I. There is some evidence bearing on I-phrases in Biblical Hebrew, involving pausal forms, which supports the Modern Hierarchy over the Tiberian in this regard.
3.1. Pausal Forms

At the ends of major breaks in a verse, we usually find pausal forms, which differ from contextual forms in ways that can be accounted for in terms of heightened stress or prominence. Pausal forms exhibit greater stress and vowel length - phonological characteristics which we find cross-linguistically at the ends of Intonational phrases. A successful prosodic theory would distinguish those phrases which end in pausal forms from those which do not. Most pausal forms in Hebrew are assigned D0 accents, as we would expect if D0 plays the role of I in the modern prosodic hierarchy. It turns out, though, that here the Tiberians did not have such a great theory of I-phrases. The problem is that they only had two of these per verse. Sometimes, though, especially in a long verse, we might want to distinguish more than two prominent phrases. Revell (1980) has observed that about 25% of the pausal forms in the Book of Deuteronomy occur on lesser accents. Most of these cases occur at the end of phrases which we recognize as I-phrases: lists, or major breaks in an Utterance. Some examples are given in (6):

(6) Pausal Forms with Accents below D0

a. Lists

'But the seventh day is a sabbath of the Lord your God; /D0 you shall not do any work - you, your son or your daughter,] your male-slave or your female-slave,] your ox or your ass, or any of your cattle]...' Deut 5,14

b. Major Pause

'And it was slaughtered. /D0 Moses dashed the blood against all sides of the altar.' Lev 8,19

And it was slaughtered. /D1 Moses took some of its blood and put it on the ridge of Aaron's right ear, /D0 and on the thumb of his right hand, and on the big toe of his right foot.' Lev 8,23

'And it was slaughtered. /D2 Moses took the blood and put some on each of the horns of the altar with his finger, /D1 cleansing the altar; /D0 then he poured out the blood at the base of the altar. Then he... Lev 8,15

We can draw two conclusions from these facts. First, the evidence from pausal forms supports the Modern Hierarchy, in which there is no upper bound to the number of I-phrases in an utterance, and reveals a shortcoming in the Tiberian system. At the same time, the discrepancies constitute internal evidence for the reliability of the Tiberian transcription. Thus, Revell (1980, p.177) concludes that "the masoretic [i.e. Tiberian/BD] tradition did preserve the pausal forms faithfully even in these apparently anomalous cases, and the fact that the patterns which gave rise to them can still be recognized constitutes an important testimony to the antiquity and reliability of the masoretic tradition." 5

---

5. Cf. Goshen-Gottstein (1963): "the work of the Masoretes...is to be understood as the invention and perfection of an ever more refined graphic
3.2. The Disjunctive Hierarchy

We have seen, then, that one difference between the Modern and Tiberian hierarchies concerns the number of I-phrases each allows in an Utterance, if we take DO as equal to I. There is another, more fundamental difference between the two systems of representation, shown in (7):

\[ (7) \text{ a. Modern: Strict Layers} \]

\[ \begin{array}{c}
I \\
\downarrow \\
P \\
P \\
P... \\
\end{array} \]

\[ (7) \text{ b. Tiberian: Nesting} \]

\[ \begin{array}{c}
D0 \\
\downarrow \\
A \\
\downarrow \\
B \\
\downarrow \\
P \\
P \\
P \\
P \\
D1 \ D2 \ \ D1 \ D0 \\
\end{array} \]

Whereas no level intervenes between I and P in the modern system, DO stands at the top of a hierarchy of disjunctive accents; i.e., in contradistinction to a standard contemporary view, P-phrases in the Tiberian system are nested, with the nesting indicated by the disjunctive accents. We already saw an example of this nesting in (1). Another schematic example is given in (7b). The Tiberian Hierarchy is thus more articulated than the Modern one, in that it assigns constituency to P-phrases under I. We can convert a Tiberian representation to a Modern one by flattening the tree under DO.

Modern theories lead us to expect that there may be two distinct phonological domains above the level of the word and below the level of the Utterance: phonology associated with I, and phonology associated with P. On the other hand, the Tiberian representation is consistent also with further levels of sentence phonology: say, phonological rules that apply at level D2 and below, or only at level D1. As predicted by the Modern Hierarchy, we can discern only two phonological levels above the word in Biblical Hebrew: the external sandhi rules associated with P, and pausal phonology in the domain of I.

But the further structure represented by the Tiberian system is not entirely superfluous. Although there is no phonology associated with the various disjunctive levels below DO, they nevertheless play a role in the mapping of syntax to prosody.

4. Mapping from Syntactic to Prosodic Structure

To see why this is so, we must turn to the second major issue of prosodic theory: how are syntactic structures mapped into prosodic structures? Most modern theories of prosodic representation are informed by the notion that there is some

---

notation for an age-old oral tradition which endeavored to note down with the greatest possible exactness the smallest details of the customary liturgical way of reading the Bible." Similarly, Orlinsky (1966): "All the Masoretes, from first to last, were essentially preservers and recorders of the pronunciation of Hebrew as they heard it."
fixed correspondence between selected nodes of the syntactic tree and the various prosodic levels. This theory of the correspondence between syntactic and prosodic categories has been called the Designated Category Parameter by Hale and Selkirk (1987), shown in (8a):

(8) From Syntax to Prosodic Structure (Hale and Selkirk (1987))
   a. The Designated Category Parameter
      For each level \( P_i \) of the prosodic hierarchy there is a single designated category \( DC_i \) in the syntactic structure with respect to which phonological representation at level \( P_i \) is defined.
   b. The End Parameter
      Only one end (Right or Left) of the designated category \( DC_i \) is relevant in the formation of a prosodic constituent \( P_i \); a \( P_i \) extends from one instance of the appropriate end of \( DC_i \) to the next.

Thus, in some languages the relevant syntactic category for defining the Phonological Phrase may be the maximal projection of a phrase or set of phrases \( X \), henceforth called \( X\text{-max} \); in others, it may be the head of \( X \), \( X\text{-head} \). Further conditions have been proposed as being relevant: whether or not the category is lexically governed, or whether it is an argument or adjunct.

In practice, it is recognized that the Designated Category Parameter applies less clearly in the formation of Utterances and Intonational phrases, where not only syntax, but a variety of rhetorical, semantic, and performance factors play a role (Nespor and Vogel (1986)). So let us restrict our attention to the formation of P-phrases, where the most work has been done.

There are a number of proposals as to how mapping from designated categories into prosodic categories should proceed. Selkirk (1986), building on proposals of Clements (1978) for Ewe, and Chen (1985) for Xiamen tone sandhi, proposes that prosodic domains are demarcated by either the left or right ends of the syntactic constituents selected in (8a) - thus, each language requires setting what Hale and Selkirk call the End Parameter, in (8b). For example, consider how the syntactic structure in (9) is mapped into phrases in two different dialects of Chinese:

(9) Parameter Settings for P-phrases in Shanghai and Xiamen
   a. Shanghai: \( X\text{-max} \) Left
   b. Xiamen: \( X\text{-max} \) Right

\[
\begin{align*}
\text{VP} & \quad \text{VP} \\
/ & / \\
\text{PP} & \quad \text{PP} \\
/ & / \\
/ & / \\
\text{NP} & \quad \text{NP} \\
/ & / \\
P & / \\
N & / \\
V & / \\
\end{align*}
\]

\[
\begin{align*}
[\text{Xmax}] & \quad [\text{Xmax}] \\
(\text{to}) & \quad (\text{ka} \text{ sio-ti} \text{ (kong)}) \\
\text{to Beijing go-ASP} & \quad \text{to little-brother tell}
\end{align*}
\]
In Shanghai (Shen (1986)), a phrase boundary is placed at the left end of a maximal projection, in this case, VP, PP and NP. By contrast, Xiamen phonological phrases are delimited by the right ends of maximal projections (Chen (1985)).

P-phrases delimited by X-max are what Selkirk (1986) calls 'large P-phrases'; when X-head is selected, the result is a 'small P-phrase'. French liaison, for example, is sensitive to small phrases delimited by the right edge of X-head. Although the two Chinese dialects in (9) have similar syntax but opposite settings of the End Parameter, Nespor and Vogel (1986) suggest that P-phrase formation tends to follow the direction of syntactic branching in a language. Thus, small P-phrases usually join a head to its specifiers on the nonrecursive side, while a large P-phrase usually includes also complements on the recursive side of the head.

Some languages have both small and large P-phrases. Nespor and Vogel (1986, 173), for example, propose that Italian has small P-phrases - i.e. delimited by the right edge of X-head, as in (10a), as well as a prosodic restructuring rule, in (10b), whereby a nonbranching P which is the first complement of X on its recursive side is optionally joined into the P that contains X:

\[(10) \text{ P Restructuring in Italian (Nespor and Vogel (1986))} \]
\[\begin{align*}
\text{a. Form small P-phrases by grouping a head with its specifiers on the } \\
\text{ left (Right end of X-head).} \\
\text{b. A nonbranching P which is the first complement of X on its } \\
\text{recursive side is optionally joined into the P that contains X.}
\end{align*}\]

This restructuring is posited to account for the optional occurrence of Raddoppiamento Sintattico in \textit{nani} in (11):

\[(11) \text{Restructuring of Nonbranching P} \]
\[\begin{align*}
\text{a. Right end of X-head: (I caribò) (nani) (sono estinti)} \\
\text{ 'Dwarf caribous are extinct'} \\
\text{b. Restructuring: (I caribò nani) (sono estinti)}
\end{align*}\]

The initial assignment of P-phrases to (11), according to (10a), is (11a), which would not permit Raddoppiamento Sintattico to apply to \textit{nani}, unless it is restructured as in (11b). Restructuring does not occur when the first complement branches, as shown in (12), where \textit{molto} does not undergo Raddoppiamento Sintattico:

\[(12) \text{First Complement Branches} \]
\[\begin{align*}
\text{a. X-head Right: (Hanno) (dei caribò) (molto piccoli)} \\
\text{ 'They have some very small caribous'} \\
\text{b. No Restructuring: *(Hanno) (dei caribò molto piccoli)}
\end{align*}\]

This example shows that geometry is also important in mapping from syntax to prosodic structure. Branchingness plays a role also in the formation of English P-phrases, as noted by Nespor and Vogel (1982) (and see also Hayes (1984)). The Rhythm Rule applies within phonological phrases which optionally include the
rightmost complement of the head, as in (13a) and (b), but not if the complement
branches, as in (13c) and (d):

(13) English Rhythm Rule (Nespor and Vogel (1982), Hayes (1984))

\[ \begin{array}{ccc}
2 & 3 & 1 \\
2 & 3 & 1 \\
2 & 1 & 2 & 1 \\
2 & 1 & 2 & 1 \\
\end{array} \]

a. John (perseveres gladly)

b. Rabbits (reproduce quickly)

c. John perseveres (gladly and diligently)

d. Rabbits reproduce (very quickly)

Cowper and Rice (1987) propose that P-phrase formation in Mende is
obligatorily sensitive to syntactic branching. They observe that Mende Consonant
Mutation applies within a phonological phrase that is delimited by the left edge of a branching X\textsubscript{max}:

(14) Mende P-phrases: Branching X-max Left (Cowper & Rice (1987))

\[
\begin{array}{ccc}
\text{a.} & S & \text{b.} & S & \text{c.} & S \\
\text{NP} & \text{VP} & \text{NP} & \text{VP} & \text{PP} & \text{NP} & \text{VP} \\
\text{V} & \text{V} & \text{NP} & \text{P} & \text{V} & \text{X} \\
\end{array}
\]

Thus, Consonant Mutation triggered by the subject affects the verb in structures
(14a) and (14b), since VP does not branch, but not in (14c), where the branching
VP forms a P-phrase on its own. Cowper and Rice propose that branchingness be
considered a parameter of P-phrase construction. Cheng (1987) argues that this
parameter applies also in the construction of Mandarin P-phrases.

This brief survey of P-phrase formation in various languages reveals that it
is sensitive to substantive notions, such as X-max and X-head, as well as to
geometric ones, such as branchingness. In the cases reviewed above, geometry
appears to play a secondary role. In Tiberian Hebrew P-phrase formation, geometry
plays a predominant role, and not just geometry of the syntax, but also the
geometry of prosodic structure itself.

5. Mapping from Syntactic to Prosodic Structure in Tiberian Hebrew

Hebrew has a right-recursive syntax, with specifiers on the left of the head
and complements on the right. Therefore, we expect that phrases will be
delimited by the right edge of designated syntactic categories. This appears to
be generally true - the problem is in finding what the designated categories are,
for Hebrew exhibits big P-phrases and small P-phrases, and various other sizes
also. This is because geometry plays such an important role in the mapping to prosodic structure.

Consider, for example, the phrases in (15):

(15) Syntax and Phrasing in Genesis 3

a. Gen 3,19: X-max Right

```
S'  \\
    / \  \\
   /   \  \\
  /     \  \\
 PP   VP  \\
 /     /  \\
NP    /   \\
Co  P  N   V
```

(kI mimmenm3) (lukka3t3)
for from.it you.were.taken

b. Gen 3,16: Branching VP

```
S  \\
    / \  \\
   /   \  \\
  /     \  \\
 PP    VP  \\
 /     /  \\
NP    /   \\
P    N   V
```

(b9geceh)(t9ldI b6nI6m)
in.pain you'll.bear children

c. Gen 3,14: Phrase-internal

```
S  \\
    / \  \\
   /   \  \\
  /     \  \\
 PP    VP  \\
 /     /  \\
NP    /   \\
P  N   V
```

(9al-geh6n6k3 tel6k)DI
on.your.belly shall.you.crawl

(d. Gen 3,19: Phrase-final

```
S  \\
    / \  \\
   /   \  \\
  /     \  \\
 PP    VP  \\
 /     /  \\
NP    /   \\
P    N   V
```

(we?el-9ap6r) (t6sun)DO
and.to.dust you.shall.return

In (15a) and (b), we see phrasings consistent with setting the end parameter to the right edge of X-max, just as in Xiamen. However, (15c) unexpectedly has only one P-phrase; hence, the initial t of telek is spirantized by the preceding vowel. In fact, geometry and position in the prosodic tree also play a role in deriving all these phrasings. In (15c), the preposition has been cliticized to its object, as indicated by the hyphen - a clitic group is treated as a single phonological word by the accentuation. Since there are now only two words in (15c), they are combined into one phrase. Finally, consider (15d), which is identical to (c) in every way except in its position in the prosodic tree: while the phrase in (c) ends in a D1 accent, (15d) ends in D0, which is to say that (15d) is in a more prominent prosodic position than (15c). In prominent positions, words have more weight, and each word in (15d) forms a P-phrase of its own.

In fact, there are a series of prosodic adjustments that are sensitive to the position of a phrase in the prosodic tree, as indicated by the hierarchy of disjunctive accents. It follows that we cannot map syntax into prosodic structure
by the procedures we have discussed above, for that mapping produces flat trees, as in (5a). To properly apply the rules of prosodic adjustment, we must start out with articulated trees, as in (5b). To obtain such trees, we need a different mapping procedure.

5.1. The Continuous Dichotomy

We do not know the mapping theory of the Tiberians, or even if they had one; a number of proposals have been made for obtaining the phrasings indicated in the texts. On any account, mapping is best viewed as proceeding in stages: there is first an initial mapping, then a series of prosodic restructurings. The initial mapping has been characterized by Wickes (1887) as following what he called the Law of the Continuous Dichotomy:

(16) The Law of the Continuous Dichotomy (Wickes (1887))

Every verse is divided into two parts (dichotomy); each part is in turn divided by a minor dichotomy. This process is repeated until the conditions for division are no longer met.

That is, rather than finding all right edges of X-max and marking a phrase boundary, we must in every case find the one most prominent right edge, and make a break there, dividing the phrase into two. We keep making binary branching cuts until phrases of two words are reached.

5.2. Principles of Phrase Division

To do this, we need some principles of division which will indicate what the most prominent division is in every situation. Some cases are illustrated in (17):

(17) Assigning the Dichotomy

a. Above the level of the sentence, depends on syntax as well as rhetoric:

'Surely, he regards us as outsiders, now that he has sold us /1 and has used up our purchase price.' Gen 31,15

'Jehoshaphat constructed Tarshish ships to sail to Ophir for gold. But he did not sail /1 because the ships were wrecked at Ezion-geber.' 1 KI 22,49

b. In verb initial clauses: (((V X) Y) Z)...

'(He) purchased /4 the parcel of land /3 where he pitched his tent /2 from the children of Hamor, Shechem's father /1 for a hundred kesitahs.' Gen 33,19 (((V NP) S) PP) PP)

Within ordinary verb-initial clauses, the general procedure is to place the main division before the last constituent of the clause; outer constituents are successively peeled away until we have worked back inward to the verb. An example is given in (17b), where /1 represents the main division, with higher numbers representing successively weaker divisions.
Aronoff has proposed that the principle in (18) accounts for the usual patterns of division:

(18) The Masoretic Parsing Principle (Aronoff (1985))

Given a constituent Xi of category X, divide it into two continuous subconstituents such that one of them is the maximal continuous constituent of the same category X within Xi.

The principles for assigning the dichotomy say where to divide the syntactic tree, but they do not assign any prosodic labels. The actual assignment of accents, and hence of prosodic levels, is determined mechanically by the geometry of the prosodic tree, as indicated in (19). Although accents appear on words, it is useful to treat them as being assigned to phrasal nodes. An accent percolates down the rightmost daughter of the node it is assigned to.6

(19) Assigning Accents to Words

a. Accents are assigned to all nodes of the prosodic tree.

b. There are four levels of disjunctive accents, D0, D1, D2, and D3.

c. An accent assigned to a node percolates down its right branch.

d. The left branch of a node with accent Di is assigned accent Di+1; a D3 phrase is divided by D3.

e. At each level of Di except D0, there is one accent which may be repeated, and a terminal accent Dif (f-final).

f. When the left branch dominates a word, it receives a conjunctive accent.

6. Prosodic Readjustments

The mapping from syntactic to prosodic structure that we have seen to here is only the first stage in the derivation of the final prosodic structures. Once we have made the initial divisions and assigned labels, there are a series of readjustments which occur, depending on where a phrase is in the prosodic tree.

These readjustments are of two types: division of phrases, whereby a two-word phrase is further divided, and its opposite, simplification, in which a phrase boundary is removed so as to create a longer phrase. Each process can be broken down into a number of subcases; the basic idea is that division applies to phrases in prominent positions of the tree, while simplification applies to phrases that are not prominent. The disjunctive accents indicate how deeply embedded a phrase is, and, in the case of simplification, which phrases to join together. These readjustments are what we might expect of a prosodic representation: in many languages, words tend to get stretched out toward the ends of phrases, and are passed over more quickly in the middle of phrases. Let us now turn to some examples of these processes.

6. See Dresher (1981a) for a more detailed discussion.
6.1 Division

Some examples of division rules are given in (20):

(20) Division Rules (Breuer (1958))

1. When a D0 phrase consists entirely of a conjunctive phrase, it is divided.

2. A two-word phrase in a prominent position of a prosodic tree (in the domain of D0 or D1) is divided if one of the words is long.

Consider Division Rule 2, in (20b). I have argued elsewhere (Dresher (1981a, b)) that a long word is a word with two or more feet. Hence, the rule can be stated entirely in terms of units of the prosodic hierarchy. The rule applies in the derivation illustrated in (21):

(21) Division: Cant 5.3

a. Continuous Dichotomy

((テーマットイ ?et-kuttonti)D1f (؟كاكا ئلماًن))D0
I.had.taken.off acc-my.robe how was.I.to.don.it

((ṝṝ́�性トイ ?et-raglāy)D1f (؟كاكا ئاثاننپهم))D0
I.had.bathed acc-my.feet how was.I.to.soil.them

b. Division Rule 2

((テーマットイ ?et-kuttonti)D1 ((؟كاكا)D1f (؟لماًن))D0
((ṝṝ́�性トイ ?et-raglāy)D1f (؟كاكا ئاثاننپهم))D0

c. Division Rule 2

((テーマットイ)D2f (؟et-kuttonti))D1
((؟كاكا)D1f (؟لماًن))D0
((ṝṝ́�性トイ ?et-raglāy)D1f (؟كاكا ئاثاننپهم))D0

Here we have a verse divided into two parallel halves. The first division comes at the end of the first half, where we assign D0; another D0 goes at the end of the verse. Each half is in turn composed of two clauses, which mark the second division, D1. Each phrase now has two words, so we stop there. But the last word in the first half, ئلماًن, is prosodically a long word; since it's phrase is D0, it is divided, as in (21b). Recalling that a long word has at least two feet, we can give an elegant treatment of this division in terms of the notion of incorporation proposed by Jean-Roger Vergnaud: in prominent positions of the tree, the foot level is incorporated into the prosodic tree; thus, a word with two feet counts as branching in terms of the prosodic tree, and joining it with another word would result in a phrase that branches more than once. The word that ends the second half, ئاثاننپهم, looks long, but is not, because of its reduced vowels.
The readjustment does not end at (21b), though, since the division of the D0 phrase causes a reassignment of the accents of the words preceding it. The first phrase of the verse is promoted from D1f to D1, which is higher in the tree. Since its second word is long, it, too, is divided, yielding the final phrasing in (21c). Constituency is required in order to know which phrases are subject to Division.

6.2. Simplification

Constituency also plays a crucial role in Simplification, whereby two phrases are combined. The observations in (22) are taken from Breuer (1958):

(22) Simplification (Breuer (1958))

1. A phrase of the form \(((W_1 W_2 W_3))A\) is simplified to \((W_1 W_2 W_3)A\), for A=D1 or D2 nonfinal.

2. A phrase of the form \(((W_1...W_n) W_{n+1})A\) is simplified to \((W_1...W_n W_{n+1})A\), for A=D2 final.

3. A phrase of the form \(((W_1...W_n) (W_{n+1} W_{n+2}))A\) is simplified to \((W_1...W_n W_{n+1} W_{n+2})A\), for A=D3 final.

4. A phrase of the form \(((W_1...W_n) (W_{n+1}...W_{n+m}))A\) is simplified to \((W_1...W_n W_{n+1}...W_{n+m})A\), for A=D3.

As we proceed down the prosodic tree, the conditions on simplification become more liberal. An example of Simplification is given in (23), where two conjunctive phrases are combined into one in the domain of a D2 accent by Simplification Rule 1 in (22):

(23) Simplification: Lev 5,15

a. Continuous Dichotomy

\(((ʔayI I tāmīm) (min-haccōʔn))D2\)

ram without.blemish from.the.flock

b. Simplification Rule 1

\(?ayI I tāmīm min-haccōʔn)D2\)

We would not know which phrases are subject to Simplification if we did not have a highly articulated tree which can distinguish the various levels of embedding. Simplification can also be achieved through cliticization, whereby two words become one for purposes of the phonology. Cliticization is indicated in the texts by a hyphen known as maqqaf:

(24) Prosodic Cliticization (Maqqaf) (Breuer (1958))

Cliticize two words in a conjunctive phrase which is a right sister to a phrase consisting of a single word: \(((W_1) (W_2 W_3)) \longrightarrow (W_1 W_2-W_3)\)

This kind of cliticization leads directly to Simplification by reducing the number of words in the phrase. The rule applies to a phrase like the one in (25),
the mirror-image of the structure in (23). Again, what is important here is how
the various P-phrases are organized:

(25) Cliticization: Gen 13,7
    (rō9ē (miqnē ?abrām)) ---+ (rō9ē miqnē-?abrām)
herdsmen cattle Abram         'herdsmen of Abram's cattle'

It is interesting to compare these simplifications with the Italian and English
examples of restructuring in (10)-(13) above. Adoption of a version of the
Continuous Dichotomy and nested P-phrases leads to a more elegant formulation
of this restructuring entirely in terms of prosodic structure, along the lines of
Simplification.

7. Conclusion

The multi-stage mapping from syntactic to prosodic structure in Tiberian
Hebrew, and the associated nested representation of phonological phrases, appears
to be fairly complex when compared with the mappings proposed for other
languages. One reason for this may be the formal character of public recitation,
for which the phrasings were devised. However, to the extent that such recitation
deviates from ordinary speech, it is likely in the direction of exaggerating
tendencies that already exist, rather than in the emergence of wholly new
properties with no counterpart in ordinary language. Second, there may be musical
influences which create some additional complexity, but again we would not expect
this to lead to wholesale distortion of natural phrasing, which the chant was
intended to serve.

Finally, it is likely that Tiberian Hebrew only looks exceptionally complex
because we have just begun to seriously investigate phrase phonology, and the
mapping from syntax to prosody. The data discussed in many modern languages which
have been looked at with regard to this question has been relatively restricted
when compared with the data of Biblical Hebrew. It might be expected that further
study of the prosodic structure of modern languages will reveal similar
phenomena, which will also require the richer apparatus of the Tiberian prosodic
hierarchy.

References
University of California at San Diego.
Chomsky, N. and M. Halle (1968) The Sound Pattern of English, Harper and Row,
New York.


Revell, E. J. (1980) "Pausal Forms in Biblical Hebrew: Their Function, Origin 

Rotenburg, Joel (1978) The Syntax of Phonology, unpublished Doctoral 
dissertation, MIT, Cambridge.

Nordic Prosody II, TAPIR, Trondheim, 111-140.

Selkirk, E. O. (1984) Phonology and Syntax: The Relation between Sound and 

Yearbook 3, 371-405.

University of Massachusetts, Amherst.

Wickes, W. (1887) Two Treatises on the Accentuation of the Old Testament, 