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THE EMERGENCE OF FIXED PROSODY

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Abstract

The Emergence of Fixed Prosody

Adam Panter Ussishkin

This is a dissertation about prosodic structural restrictions in language. It investigates in detail the prosodic structure of Modern Hebrew, using the framework of Optimality Theory to analyze nonconcatenative word formation in prosodic morphology. Semitic languages have for some time been assumed to involve so-called "root-and-pattern morphology", whereby words are productively formed by interdigitating vocalic affixes among consonantal roots.

In this dissertation, I provide a detailed examination of the structure of the Modern Hebrew verbal paradigm in order to explain both the minimality and maximality effects evident in prosodic size. Other empirical domains studied include the verbal paradigm of Arabic and the active and passive verbal paradigms of the Austronesian language Mukah Melanau.

A major finding examined in this dissertation is that the consonantal root is reduced to an epiphenomenon of more basic principles having to do with the prosodic restrictions imposed on words in these languages. From a theoretical standpoint, this move results in another major consequence: the elimination of so-called templatic constraints from OT, thus simplifying the theory. Rather than resulting from templatic requirements, I argue that templatic effects in Modern Hebrew are a case of *fixed prosody*, a term which refers to the bisyllabic nature of surface forms in the verbal paradigm of the language.

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Chapter 1: Nonconcatenative affixation and prosodic morphology

1.0 Introduction

In the majority of the languages of the world, *concatenative morphology* is by far the most widely attested mode of affixation. This label describes the way morphemes are concatenated, or strung together, to produce a morphologically complex form. Examples of this process are pervasive; some of these are given below in broad transcription:[1]

(1) Some examples of concatenative morphology: plural formation in three languages

(a) *English*

Singular	*Plural*
kæt	kæts
pɛn	pɛnz
ki	kiz

(b) *Turkish*

Singular	*Plural*	*Gloss*
kedi	kediler	cat/cats
kalem	kalemler	pen/pens
anahtar	anahtarlar	key/keys

[1] All transcriptions are in the International Phonetic Alphabet (IPA).

(c) *Hebrew*	*Singular*	*Plural*	*Gloss*
	xatul	xatulim	cat/cats
	ʔet	ʔetim	pen/pens
	mafteax	maftexot	key/keys

The common pattern in the three examples is that in each case, the singular form is, with some degree of flexibility, contained in the morphologically complex plural form in English, Turkish, and Hebrew plural formation. In this sense, concatenative morphology is relatively simple, although as is evident from this small sample of data, alternations are present. For instance, we observe allomorphy in English between voiceless *s* and voiced *z* in the plural. In Turkish, the quality of the vowel of the plural suffix depends on the quality of the preceding vowel in the singular. And in Hebrew, the gender of the noun in question decides which allomorph (-*im* (singular) or -*ot* (plural)) is selected as the suffix. However, the basic form of the stem to which the plural suffix is attached does not change.[2]

1.1 Nonconcatenative morphology

Nonconcatenative morphology, on the other hand, describes a variety of strategies for word formation which do not involve the concatenation or appending of morphemes

[2] The one very obvious exception to this is loss of the vowel *a* at the end of the Hebrew form *mafteax* when this form is pluralized. This *a* is present in the singular because the word ends in a historically pharyngeal sound, which has been neutralized to the velar *x*. The rule epenthesizing *a* before pharyngeals applies only when the sound in question occurs syllable-finally, and when the plural suffix –*ot* is added this environment is destroyed, so the *a* is not epenthesized.

with independent segmental content. A clear example of this is provided by the formation of broken plurals in Arabic.

(2) Arabic broken plurals as nonconcatenative morphology (data from McCarthy & Prince (1990a)

Singular	*Plural*	*Gloss*
nafs	nufuus	‘soul’
qidħ	qidaaħ	‘arrow’
ʔasad	ʔusuud	‘lion’
xaatam	xawaatim	‘signet ring’

These few examples suffice to illustrate the nature of nonconcatenative morphology. They demonstrate that the morphologically complex forms, in this case, these plurals, cannot be easily decomposed into their corresponding singular forms on the one hand, and some affix marking ‘plural’ on the other. Rather, the formation of the broken plurals in Arabic involves changing the prosodic shape of the singular form, in addition to changing the quality of the vowels.

This type of word formation, as it turns out, is especially pervasive in Semitic languages like Arabic and Hebrew. In fact, such processes have long served as motivation for treating such languages very differently from concatenative languages. This difference has been implemented on a very fundamental level, based on the assumption that the architecture of the grammar of Semitic languages has at its foundation a morphological entity known as the *consonantal root*, a unit consisting of (usually) three consonants. A further examination into Semitic morphology reveals the nature of this entity, as the following data from Modern Hebrew illustrate.

(3) Paradigm for the root *g d l* in Modern Hebrew[3]

Hebrew verb	*Binyan*	*Gloss*
gadal	paʕal	'he grew' (intransitive)
gidel	piʕel	'he raised'
gudal	puʕal	'he was raised'
higdil	hifʕil	'he enlarged'
hugdal	hufʕal	'he was enlarged'

The consonantal root *g d l* may be attributed the meaning 'big' with additional meaningful elements present in each word so as to compose a more complex and specified meaning. The notion of the consonantal root emerges from the observation that the only material that remains constant among these words consists of the consonants *g d l*. The *Binyan* column serves as a templatic representation of the structure of each verb. The term *binyan* (plural = *binyanim*) comes from traditional grammatical descriptions of Semitic languages, and can be roughly translated as *verbal class*. I use the terms interchangeably here. Here, the consonants *p* (or *f*, by a spirantization process), ʕ, and *l* represent the first, second, and third consonants of the root, respectively. This provides the correlation between, e.g., *gadal*, and the name of the binyan it appears in, *paʕal*, which then serves as a convenient way to automatically know the binyan of any verb based upon the vowels and syllable structure of the verb.

The consonantal root is not a construct of modern generative linguistics. Of course, considerations regarding the consonantal writing system of Semitic languages certainly influenced early treatments of their grammars. Grammarians as far back as

[3] Not all the Hebrew binyanim are exemplified in the table; the root *g d l* is only instantiated in the five binyanim shown here. A fuller description is provided in chapters 3 and 4.

the middle ages, if not earlier, had based their work on various Semitic languages on the core idea of the consonantal root. A partial list of such works (or papers that cite such works) includes de Alcala (1505), Bopp (1824), Ewald (1827), Gaon (1932, 1942, 1969), Gesenius (1813/1910), Rousseau (1987), de Sacy (1810), Volney (1787 *et seq*.). In more recent approaches, the concept of the consonantal root was adopted as early as Harris (1941) and Chomsky (1951), and the first truly articulated and comprehensive study of Semitic phonology and morphology based on the consonantal root appears in the influential work of McCarthy (1979, 1981).

A goal of this dissertation is to question the morphological status of the consonantal root, in an effort to unify our understanding of nonconcatenative morphology with that of the more widely attested concatenative languages. The counter-traditional suggestion that the consonantal root does not serve as a lexical entry or morpheme is not an entirely novel proposal, although this work is the first to take this position within the framework of Optimality Theory (Prince & Smolensky 1993). Though relatively few in number, several researchers have provided evidence that Semitic languages have no need for consonantal roots. McOmber (1995) claims that in Arabic, lexical entries can be represented as CCVC (where C = consonant and V = vowel; e.g., *ktab*) rather than excluding the vowels, as does the consonantal root (e.g., *k t b*). Darden (1992) makes similar proposals for Cairene Arabic, arguing that full words (e.g., *katab*) rather than consonantal roots serve as bases from which other words are formed. Heath (1987) analyzes Moroccan Arabic as stem-based, thus eschewing abstract root representations. Ratcliffe (1998:50) clearly articulates a similar view, stating that "(phonologically possible) words rather than three-consonant roots are the primitive lexical entries of the Arabic lexicon."

The empirical focus of this dissertation is a related language, Modern Hebrew. The root-based approach has also been challenged for Hebrew. In a very well argued paper, Horvath (1981) proposes that the lexical entries of Modern Hebrew verbs include vowels and argues that the consonantal root is basically an epiphenomenon of the grammar. Both Bat-El (1994a) and Ussishkin (1999b) have shown that the process of denominal verb formation in Modern Hebrew is based on the noun from which the verb is formed and not on the consonantal root.[4] This view is not incompatible with the notion of the triconsonantal root; an approach incorporating the consonantal root-based view with a word-based view is fully possible (e.g., McCarthy & Prince's (1990) analysis of the Arabic broken plural, which clearly demonstrates a need for a word-based approach for plural formation while maintaining the consonantal root elsewhere). Extending the word-based approach to the totality of word formation in these languages is one of the goals of this dissertation.

1.1.1 Overview of the dissertation

In the remainder of this introductory chapter, I begin by presenting earlier theories of Semitic morphology as a point of departure. These include the root-and-pattern analysis of McCarthy (1979, 1981) and the development of the Prosodic Morphology

[4] Denominal verb formation is a process which takes a noun and uses it to form a verb, analogous to deriving the English verb *to blanket* from the noun *blanket*.

theory of McCarthy & Prince (1986, *et seq.*). I then present an overview of Optimality Theory (OT; Prince & Smolensky 1993), which is the basis for the further evolution of Prosodic Morphology. The chapter continues with a discussion of the phenomenon known as "The Emergence of The Unmarked" (TETU; McCarthy & Prince 1994b) in reduplication, an issue which has important consequences for the type of templatic morphology observed in Semitic. These consequences are the focus of the rest of the dissertation.

Chapter 2 introduces the issue of prosodic binarity, a central theme in this work. Prosodic binarity can be roughly described as requiring prosodic structures to contain two of some lower prosodic category. A theoretical approach to achieving prosodic binarity is provided in this chapter, and serves as the basis for the analyses that follow.

Chapter 3 analyzes the metrical system of the Modern Hebrew verbal paradigm. The goal of this chapter is to gain familiarity with the prosodic structure of Modern Hebrew, which has until now posed a problem for metrical theory.

Chapter 4 provides an account of the fixed prosody, or templatic effects, that are prevalent throughout the system of Modern Hebrew verbs. This chapter explains the restrictions on prosodic shape in the various verbal classes, and argues for a word-based view of Semitic, as opposed to an approach based on the consonantal root.

Chapter 5 supplies further evidence against the consonantal root. Here, a rigorous study of denominal verb formation in Modern Hebrew is undertaken. The analysis of the data examined clearly illustrate the inadequacy of the consonantal root.

Finally, Chapter 6 goes beyond Modern Hebrew to examine fixed prosody in other languages. A word-based account of the Arabic verbal system is detailed, in addition to an analysis of fixed prosodic effects in the Austronesian language Mukah Melanau.

1.2 Root-and-pattern morphology

With McCarthy's (1979, 1981) "root-and-pattern" approach the consonantal root was accompanied by yet a further device specific to nonconcatenative morphology: the prosodic template. Root-and-pattern morphology is based on the assumption that words in Semitic are exhaustively decomposable into a consonantal root, marking more concretized meanings (analogous to Sapir's (1921) "material content"), and the vocalic pattern, whose purpose is to mark grammatical meaning or function (analogous to Sapir's "relational content"). The prosodic template mediates between these two other morphemes and determines where the various segments surface. Thus the Arabic verb *katab* 'to write' is represented by extending autosegmental notation (Goldsmith 1976) to the three morphological elements composing the verb:

(4) Representation of *katab*

(a)	the consonantal root	k		t		b
		¦		¦		¦
(b)	the prosodic template	C	V	C	V	C
			u		r	
(c)	the vocalic melody			a		

As descriptively adequate as this theory may be, its use of prespecified CV-prosodic templates poses difficulties. In particular, as addressed in the theory of Prosodic Morphology, such templates should be defined not on the basis of their segmental make-up (C vs. V) but rather through units of prosody. How this is implemented is covered in the following section.

1.3 Prosodic Morphology

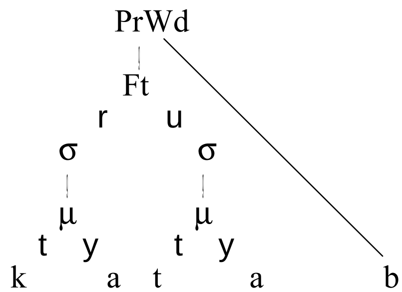
It is the issue of templates and templatic effects that the Prosodic Morphology program (McCarthy & Prince 1986, 1990ab, 1993a, 1995, 1999) set out to resolve. The core of the theory of Prosodic Morphology states that all templates are defined not as strings of consonants and vowels, but "in terms of prosodic units" (McCarthy & Prince 1995:320). Not only is this a potentially easily falsifiable claim, but it also greatly limits the range of possible templatic shapes by restricting them to prosodic units which are independently motivated elsewhere in the theory. These prosodic units are those of the Prosodic Hierarchy, adapted from work of Selkirk (1980ab), McCarthy & Prince (1986) and Nespor & Vogel (1986):

(5) The Prosodic Hierarchy

PrWd
|
Ft
|
σ
|
μ

In this way, the Arabic verb *katab* may be expressed as the unit of prosody known as the trochaic foot.

(6) Prosodic structure of Arabic binyan I verb *katab* (cf. McCarthy & Prince 1990ab)[5]



Another area in which templates have played an important role is reduplicative morphology. This domain has greatly shaped the development of Prosodic Morphology. In particular, partial reduplication, whereby a portion of a base is copied to form a morphologically complex form, is a prime example of templatic morphology. Just as in the Arabic case, these templates conform to prosodic units. Reduplication has served as a testing ground for the implementation of such templates, including the formal characterization of their nature.

This characterization is the focus of this dissertation. In order to understand the theoretical framework in which this characterization is developed, the next section is devoted to an explaining of the main points of Optimality Theory.

[5] The status of the extrametrical final consonant results from observations on stress in Arabic. This issue is further addressed in Chapter 6.

1.4 Optimality Theory

In this section, I proceed to set the stage for our discussion of nonconcatenative morphology within the theoretical framework of Optimality Theory (OT; Prince & Smolensky 1993).

OT is a framework in which all aspects of grammar are explained in terms of constraint interaction. This contrasts with earlier generative frameworks, in which an input form is subject to a series of rules that result in the production of a surface form. Optimality Theory rejects this sequential type of derivation and instead proposes that a grammar consists of a hierarchy of ranked constraints which evaluate the well-formedness of possible output forms. The most harmonic, or optimal, of these forms is the form which is selected by parallel evaluation by the ranked constraints.

Three components make up an optimality-theoretic grammar, according to Prince & Smolensky (1993). The first of these, *Gen*, is responsible for generating possible outputs as realizations of an input form. Gen produces an infinite set of candidate forms that are subject to *Con*, the set of universal constraints that compose a grammar. The feature of OT that allows and predicts differences among languages is the ordering imposed on the constraints that make up Con. This ordering is language-particular, and results in the necessity of the notion of *violability*: that universally all constraints may be violable, and in a particular language violation is tolerated, but only when this allows for the satisfaction of a constraint that is higher-ranking in the hierarchy of constraints. The actual selection of the optimal candidate from the infinite candidate set falls to the third component of the grammar, *Eval*. This is a function that evaluates candidates with respect to Con, and chooses the winning candidate.

An actual example illustrating an optimality-theoretic analysis is given below. Such analyses are concretely given in the form of a *tableau*, a graphic representation of the selection of the optimal candidate in a constraint evaluation. Several conventions apply to this representation. As seen in the tableau that follows, the upper left cell contains the *input* to the evaluation. Underneath this, in the left column is a list of potential outputs. Along the top of the tableau appears the constraint hierarchy, or the portion of it that is relevant to selection of the optimal form. The constraints are listed in order of dominance, from left to right. A solid line between constraint columns indicates that the constraint on the left dominates (i.e. is more important than) the constraint on the right; a dashed line indicates that no such dominance relation is established. An asterisk (*) in a cell indicates a violation of a constraint incurred by the candidate in the corresponding row. An exclamation point following an asterisk marks a *fatal violation* of a constraint. Such a violation removes a candidate from consideration in the competition. The optimal candidate, or actual output, is indicated by a pointing hand. Finally, shading in the tableau is used to indicate non-crucial constraint satisfaction or violation.

The (simplified) tableau that follows illustrates the formation of a denominal verb in Modern Hebrew. The input to this formation includes the base noun *tik* in addition to the affix *i e*.

(7) VERB = [σσ], MAX » IDENT

	$t_1i_2k_3$ - i_4 e_5	VERB = [σσ]	MAX	IDENT
	a. $.t_1i_2.i_4.e_5k_3.$	*!		
	b. $.t_1i_2.e_5k_3.$		*!	
☞	c. $.t_1i_4.j_2e_5k_3$			*

Three constraints are shown in this tableau, along with three competing candidates. The first constraint, VERB = [σσ], is a templatic constraint demanding that verbs be equal to two syllables in length. Examining how each candidate fares with respect to this constraint, it is clear that candidate (a) is in violation of VERB = [σσ], since it contains three syllables (syllable boundaries are indicated by periods). The second constraint, MAX, evaluates how well each output preserves the material specified in the input. Candidate (b) receives one violation mark for this constraint, because the segment i_4 in the input has no corresponding segment in the output.[6] Finally, the constraint IDENT demands that corresponding segments between the input and the output be featurally identical. Candidate (c) receives one violation mark for this constraint, since not all of the featural specifications of i_4 in the input are preserved in this segment's output correspondent. Given the constraint ranking illustrated in the tableau, this candidate is chosen as the winner, because even though it violates IDENT it satisfies the two higher-ranking constraints. Satisfaction of these constraints is more important, even at the cost of violating a lower-ranking constraint.

Some remarks are in order regarding the input and output forms in the tableau and the evaluation of the constraints MAX and IDENT. These constraints belong to a

[6] While it is the case that candidate (b) also violates the markedness constraint ONSET, this constraint is excluded from the tableau. This is done solely to facilitate the explanation of OT provided here.

family of constraints known as *faithfulness* constraints. A different type, *markedness* constraints, will be discussed shortly. With respect to faithfulness constraints, I follow McCarthy & Prince (1995) and adopt the approach to faithfulness known as Correspondence Theory. Correspondence-theoretic faithfulness constraints are responsible for identity between input and output forms, both in the sense of segmental content and featural make-up. Correspondence is a relation defined as follows:

(8) Correspondence (McCarthy & Prince 1995:262)

Given two strings S_1 and S_2, correspondence is a relation $\Re$ from the elements of S_1 to those of S_2. Elements $\alpha \in S_1$ and $\beta \in S_2$ are referred to as correspondents of one another when $\alpha \Re \beta$.

The correspondence relations between elements are indicated in OT tableaux by using subscript numerals, as seen in the example above. This is simply a notationally convenient way to mark correspondence, and is helpful in assessing violations of correspondence-theoretic constraints. Three basic types of correspondence constraints are defined below, following McCarthy & Prince (1995:264).

(9) MAX

Every segment of S_1 has a correspondent in S_2.

("No deletion of segments")

(10) DEP

Every segment of S_2 has a correspondent in S_1.

("No insertion of segments")

(11) IDENT(F)

Let α be a segment in S1 and β be any correspondent of α in S2. If α is [γF], then β is [γF], where γ ∈ {+,-}.

("Correspondents are identical with respect to feature F")

These three constraints may be implemented along various morphological dimensions. The most obvious of these is the input-output dimension, responsible for the mapping of input forms to surface forms. This relation is abbreviated "IO" and the IO-versions of these constraints are referred to as MAX-IO, DEP-IO, and IDENT-IO. However, other dimensional implementations of correspondence relations are possible as well, as introduced by McCarthy & Prince (1994b, 1995) for the domain of reduplicative correspondence. Under reduplication, the reduplicated portion of a word (known as the *reduplicant*, following Spring 1990) stands in a correspondence relation with the base of reduplication. Thus, the constraint MAX-BR requires that every segment in the base have a correspondent in the reduplicant, essentially mandating total reduplication. DEP-BR states that every segment in the reduplicant must have a correspondent in the base, while IDENT-BR demands featural identity between reduplicated segments.

In contrast to faithfulness constraints, which evaluate correspondence relations, OT makes use of a second constraint type as well. Constraints that fall into this second category are known as markedness constraints. These evaluate the phonological or structural markedness of output forms. The distinguishing characteristic of such constraints is that they are strictly *output-based*; that is, markedness constraints evaluate surface forms, not input forms. Markedness constraints include constraints on syllable well-formedness (e.g., ONSET (Ito 1989), and NOCODA (Prince & Smolensky 1993), as well as constraints banning the occurrence of phonological features (e.g., *PHARYNGEAL). Such featural occurrence constraints are typically organized in a universal hierarchy resulting from a markedness scale, and are useful in explaining, among other phenomena, default feature assignment.

McCarthy & Prince (1993ab) discuss a further type of constraint: the Alignment constraint family. Such constraints demand alignment of edges between phonological and/or morphological constituents. Following McCarthy & Prince (1993b), alignment constraints are defined through a general schema.

(12) Alignment constraint family schema

ALIGN (Cat_1, Edge $_1$; Cat_2, Edge $_2$) $=_{def}$

$\forall Cat_1\ \exists Cat_2$, such that $Edge_1$ of Cat_1 and $Edge_2$ of Cat_2 coincide,

where Cat_1, $Cat_2 \in$ PCat $\cup$ GCat, and $Edge_1$, $Edge_2 \in$ {R(ight), L(eft)}

PCat stands for prosodic category, and GCat stands for grammatical (or morphological) category. Alignment constraints are widely used in OT analyses, especially within prosodic morphology. As will be explicitly detailed in the chapters that follow such constraints play a crucial role in the development of the analyses of fixed prosody examined in this dissertation.

A particular type of markedness constraint is the templatic constraint. The constraint VERB = [σσ], seen in the sample tableau above, is a case of such a constraint. This constraint imposes a particular prosodic shape (here, two syllables) on a particular morphological category, in this case, verbs in Modern Hebrew. Such constraints are familiar from many analyses of reduplication, where the prosodic shape of the reduplicant is determined by similar constraints.

However, important research has recently questioned such constraints. This includes work of Spaelti (1997), and McCarthy & Prince (1999). These authors conclude that the existence of constraints that explicitly define prosodic templates are problematic due to typological problems that follow from their existence. In the following sections, I describe the "Kager-Hamilton problem", which serves as the basis for the decision to rid the theory of templatic constraints.

1.5 An atemplatic approach to prosodic morphology

In this section, I describe the Kager-Hamilton problem, and motivate the use of non-templatic mechanisms for achieving templatic behavior. This discussion essentially recapitulates arguments developed extensively in McCarthy & Prince (1999).

Within correspondence theory, the domain of reduplicative morphology sets the stage for an articulated set of correspondence constraints regulating identity between base and reduplicant, as described earlier. This work, beginning with McCarthy & Prince (1995), has been quite successful at explaining a range of phenomena within reduplication, including overapplication and underapplication. An important distinction to be drawn, however, is that although featural identity may be strongly enforced (featural specifications may in fact be back-copied), prosodic shape is never back-copied from reduplicant to base. That is, although the base may be altered to match the reduplicant in terms of featural make-up, the templatic nature of the reduplicant is never imposed on the base.

1.5.1 Reduplicative templates and the Kager-Hamilton problem

Here, I use a case study to detail the arguments and claims against specifically templatic constraints. Consider the case of reduplication in the Austronesian language Diyari. As seen below, the reduplicant may be described as the first syllable of the base in addition to the next CV. As pointed out by McCarthy & Prince (1999), this corresponds to the minimal word (a bisyllabic foot) of the language:

(13) Reduplication in Diyari (McCarthy & Prince 1999, after Austin 1981, Poser 1982, 1989, McCarthy & Prince 1986, 1991ab)

Root	*RED - Root*	*Gloss*
wil̪a	wil̪a-wil̪a	'woman'
kan̪ku	kan̪ku-kan̪ku	'boy'
kuɭkuŋa	kuɭku-kuɭkuŋa	'to jump'
tʲilparku	tʲilpa-tʲilparku	'bird species'
ŋankan̪t̪i	ŋanka-ŋankan̪t̪i	'catfish'

Since the inception of Prosodic Morphology, the Diyari reduplicant has been defined as the minimal word, and within OT this was implemented with a high-ranking templatic constraint:

(14) RED=MINWD

In addition, the correspondence constraints MAX-IO and MAX-BR are necessary. Combined with the high-ranking constraint on reduplicant size, a possible analysis for Diyari appears in the following tableau:

(15) *tʲilpa-tʲilparku* in Diyari

	RED-tʲilparku	RED=MINWD	MAX-IO	MAX-BR
	a. tʲilparku-tʲilparku	*!		
	b. tʲilpa-tʲilpa		*!**	
☞	c. tʲilpa-tʲilparku			***

Candidate (c) is chosen as optimal under the ranking at hand. This candidate satisfies the two undominated constraints RED=MINWD and MAX-IO, at the cost of violating the low-ranking constraint MAX-BR. Thus, incomplete reduplication must be tolerated in order to meet the templatic requirements imposed on the reduplicant.

However, serious complications arise when we consider the typologies resulting from the mutation of the ranking above. Consider a hypothetical variant of Diyari, to be called Diyari', in which reduplication also occurs, but with a new twist: the templatic shape imposed on the reduplicant is reinforced on the base as well:

(16) Plural reduplication in Diyari' (from McCarthy & Prince 1999)

Root	*RED - Root*
wil̪a	wil̪a-wil̪a
kanku	kanku-kanku
kuɭkuŋa	kuɭku-kuɭku
tʲilparku	tʲilpa-tʲilpa
ŋankan̪t̪i	ŋanka-ŋanka

We can see that in Diyari', the minimal word template dictates not only the shape of the reduplicant, but also the shape of the base in reduplicated forms. Given just the three constraints employed above, Diyari' can be easily analyzed.

(17) *t^j^ilpa-t^j^ilpa* in Diyari'

	RED-t^j^ilparku	RED=MINWD	MAX-BR	MAX-IO
	a. t^j^ilparku- t^j^ilparku	*!		
	b. t^j^ilpa-t^j^ilparku		*!**	
☞	c. t^j^ilpa-t^j^ilpa			***

Of course, as McCarthy & Prince (1999) point out, nonreduplicated forms surface faithfully, because there is no base-reduplicant correspondence and thus, no template is enforced.

(18) *t^j^ilparku* in Diyari'

	t^j^ilparku	RED=MINWD	MAX-BR	MAX-IO
	a. t^j^ilpa			*!**
☞	b. t^j^ilparku			

Stepping back and surveying the emerging situation, let us compare the two grammars for Diyari and Diyari'. Diyari, in which only reduplicants observe the templatic requirement, involves the following ranking:

(19) Ranking in Diyari

```
RED=MINWD      MAX-IO
        \        /
         MAX-BR
```

Diyari', however, in which the base also must conform to the template imposed on the reduplicant, involves the following ranking:

(20) Ranking in Diyari'

```
RED=MINWD     MAX-BR
        \      /
        MAX-IO
```

Now, in the absence of empirical evidence, this may seem like a good result: through a relatively simple reranking between two faithfulness constraints, we are able to explain the difference between two grammars. But this is the fatal problem to which our attention is drawn by the Kager-Hamilton problem: there is no language like Diyari'.[7] This dilemma puts the theory in a rather uncomfortable position, because as long as constraints explicitly dictating the prosodic shape of templates exist, ranking permutations such as those above predict that languages like Diyari' should exist. McCarthy & Prince (1999) propose that therefore templatic constraints are to be dispensed with.

1.5.2 Fixed prosody as The Emergence of the Unmarked

Eliminating templatic constraints is a move that seems rather drastic at first, and in addition puts in question the force of the Prosodic Morphology program. However, it is important to keep in mind that within this research program the principal goal is to explain the prosodic restrictions on morphological elements with a set of general principles that act as an interface between phonology and morphology. As long as template-specific constraints are employed, this goal cannot be reached, because such

[7] As Armin Mester (p.c.) has pointed out, another way to avoid generating Diyari' would involve output-output correspondence (see Benua 1995, 1997), positing a fixed ranking such as MAX-OO » MAX-BR. This way deletion of segments in the base would be prohibited (modulo markedness considerations), given high-ranking MAX-OO. Such an approach is reminiscent of Steriade's (1996) Paradigm Uniformity or Kenstowicz's (1994, 1995, 1997) Uniform Exponence. The fixed ranking could not be generalized to all FAITH constraints, since overapplication effects that are widely observed indicate that IDENT-OO constraints may be outranked by IDENT-BR constraints.

constraints are necessary *only* to explain prosodic patterns emergent in templatic morphology.

The more attractive option is to explore how independently necessary principles and constraints of phonology, morphology, and their interface may be extended to templatic effects. This line of work, called Generalized Template Theory (GTT), has been pursued by many researchers, including McCarthy & Prince 1994ab, Colina 1996, Downing 1994, 1996, 1998, 1999, Futagi 1997, Gafos 1995, 1996, Ito, Kitagawa, & Mester 1996, Moore 1995, Spaelti 1997, Urbanczyk 1996ab. The appeal of GTT is that the effects of templatic behavior are achieved by constraints otherwise necessary in the theory. Within the domain of reduplication, templatic effects (fixed prosodic effects) are the result of a particular ranking schema known as The Emergence of The Unmarked (TETU; McCarthy & Prince 1994b). Thus, general Input-Output Faithfulness outranks some markedness constraint(s), which in turn outrank constraints on Base-Reduplicant Faithfulness. A TETU ranking can be schematized as follows:

(21) The Emergence of The Unmarked (TETU)

FAITH-IO » C » FAITH-BR

where C is some markedness constraint. Since this markedness constraint is outranked by FAITH-IO, its effects are not visible unless there is some reduplicative morpheme, in which case the correspondence relations between the base and the reduplicant is subject to C.

Returning to the concrete example of Diyari, I will present here the main point of McCarthy & Prince's (1999) reanalysis of templatic effects in reduplication. The analysis involves the following markedness constraint, familiar from much work on metrical theory and prosodic phonology, and essentially a constraint enforcing the Strict Layer Hypothesis of Selkirk (1984a) at the level of the syllable:

(22) PARSE-σ (Liberman & Prince 1977, Prince 1980, Halle & Vergnaud 1987, Hayes 1987, Prince & Smolensky 1993, McCarthy & Prince 1993ab, Mester 1994)

Every syllable belongs to some foot.

With the understanding that fixed prosodic effects are the result of the interaction between such constraints and not simply the result of templatic constraints, it is important to examine the metrical structure of the language at hand. As described by McCarthy & Prince (1999), Diyari places primary stress on the initial syllable of the word, with secondary stress on every odd-numbered syllable to the right. The one exception is that word-final syllables in words with an odd number of syllables are not stressed. This directional footing provides evidence for the ranking PARSE-σ » ALL-FT-L, such that as many syllables as possible are footed.

(23) ALL-FT-L

The left edge of every foot is aligned with the left edge of some prosodic word.

To achieve the minimal word (recall that this is the 'template' for the reduplicant), a structure must be a single foot that satisfies ALL-FT-L as well as PARSE-σ. These requirements are met by the following structure,

(24) PrWd
5
[Ft]

which can be either a bisyllabic foot or a bimoraic foot, depending on whether or not the language is quantity-sensitive.

In Diyari reduplication, this exact structure is the optimal shape for the reduplicant under a TETU ranking. Thus, although in nonreduplicated forms more than one foot is allowed, since the constraints mediating correspondence between base and reduplicant are outranked by the prosodic constraints above, the templatic requirement will be imposed on the reduplicant. This is illustrated in the following tableau, in which foot boundaries are indicated by '[' and ']'. For the sake of clarity, Max violations are indicated by the actual offending segments that incur them.

(25) *tʲilpa-tʲilparku* in Diyari

	Red-tʲilparku	Max-IO	Parse-σ	All-Ft-L	Max-BR
	a. [tʲilpar]ku$_{\text{PrWd}}$-[tʲilpar]ku$_{\text{PrWd}}$		**!		
	b. [tʲilpa]$_{\text{PrWd}}$-[tʲilpa]$_{\text{PrWd}}$	r!ku			
☞	c. [tʲilpa]$_{\text{PrWd}}$-[tʲilpar]ku$_{\text{PrWd}}$		*		ku

In this example, we see exactly the TETU effects described: the markedness constraint dominates the constraint on the relation between base and reduplicant, so the reduplicant is subject to its effects. In nonreduplicated forms this will never be the case because there is no base-reduplicant relation, as seen in the next tableau:

(26) *tʲilparku* in Diyari

	tʲilparku	Max-IO	Parse-σ	All-Ft-L	Max-BR
	a. [tʲilpa]$_{\text{PrWd}}$	r!ku			
☞	b. [tʲilpar]ku$_{\text{PrWd}}$		*		

Now that we have seen the templatic nature of the Diyari reduplicant explained in terms of GTT, we can examine some of the theoretical implications of this approach. The essential point is that no template-specific mechanism is necessary and therefore, the Kager-Hamilton problem is avoided altogether. With no templatic constraints, it is not possible to generate any ranking of the constraints under which an optimal form with a reduplicant involves back-copying of the reduplicant shape onto the base of reduplication. Instead, the templatic effects have been explained as an instance of TETU, in which markedness constraints that may be inactive in general are activated in specific morphological domains, such as reduplication.

1.5.3 Fixed prosody as minimality and maximality

From this point on, I will no longer refer to templatic effects as such. Rather, these effects will be referred to as *Fixed Prosody*, in order to emphasize the nontemplatic nature of the approach I argue must be right for such cases. Fixed prosodic effects are thus the same as templatic effects, but this new label avoids confusion because it does not imply any type of template-specific machinery. To briefly sum up our progress so far, in this section I have presented the fundamental theoretical and empirical arguments against templatic constraints. The reason for dispensing with these is that such constraints predict unattested typologies; thus, allowing templatic constraints involves a theory that is much too strong. As an alternative, McCarthy & Prince (1999) argue convincingly that such phenomena are instead to be analyzed as instances of TETU, under which markedness constraints are ranked between different domain-specific faithfulness constraints.

As satisfying as these results may be, up to this point most work on templatic effects in OT have been limited in its empirical focus. Partial reduplication has constituted the central and most well-understood phenomenon in which formal analyses have been developed. This type of morphological process can be seen as a case in which templatic restrictions are imposed on affixal material. By contrast, a more widespread case would be morphological processes in which templatic restrictions are imposed on the base. This distinction has been recognized within the Prosodic Morphology research program, but so far much less effort has been expended in attempting to formally characterize these languages.

It is to this end that I turn in this dissertation. One principal goal maintained throughout this work is to show that nonconcatenative morphology, in particular with respect to the type of system seen in Semitic languages, is not the result of a peculiar array of discontiguous morphological fragments, but rather follows from a particular constellation of properties that can each be seen cross-linguistically. These properties are formally captured through constraint ranking within the framework of Optimality Theory, thus integrating the structures of nonconcatenative morphology using familiar structures that the theory necessitates in any case.[8] Thus the Semitic languages may be better understood as much more similar to other languages than previously claimed.

[8] See Bat-El (to appear) for a similar articulation of this goal.

To briefly explain one of the leading ideas of this work, consider the fixed prosody so commonly associated with Semitic languages. Given the discussion above, it is a well-motivated goal to avoid capturing these effects through explicitly-templatic constraints. A natural question to ask at this point then is which constraints are responsible. I argue that the constraints actively at work in enforcing fixed prosody are constraints well-motivated elsewhere in the theory. In particular, we will see that constraints on minimal word size play a role. Many cases exemplifying these conditions have been documented, and a review of some of these appears in the following chapter.

However, this cannot be the entire story. While is it undoubtedly the case that word minimality requirements play an important role in fixed prosody in general, there remains the significant generalization that words in Semitic tend to not exceed a particular size. In fact, this is the fundamental difference between nonconcatenative languages and other systems, and is responsible, I claim, for the bulk of fixed prosodic effects. We can thus state with confidence that what makes these languages special is that in addition to word minimality requirements, another important factor is word *maximality* restrictions. Once we understand that both minimality and maximality requirements are at work in defining the optimal word structures in Semitic, a much more principled view of what sets these languages apart from other languages is possible. These maximality requirements are formalized as ranked constraints, and obviate the need for template-specific constraints on the one hand, and the special status of root-and-pattern morphology on the other hand. In fact, I will argue extensively in this work that the appearance of root-and-pattern morphology is epiphenomenal. What remains of root-and-pattern morphology is simply the 'pattern'; that is, only the affixal material is viewed as a truly motivated morphological entity. The consonantal root *qua* morpheme or lexical entry is simply the residue of what is enforced by fixed prosody, specifically, the process of melodic overwriting. Given the primitive nature of fixed prosody, as formalized through constraints on minimality and maximality, we can reach a deeper understanding of the organization of word structure in Semitic languages, one which is closer to what we know about the architecture of concatenative systems.

There is precedent in the earlier literature for the approach to Semitic advocated here. For instance, McCarthy (1993) analyzes the Arabic verbal paradigm as essentially word-based, as opposed to root-based. Other work has documented the clearly word-based nature of particular processes in various Semitic languages; for instance, the broken plural in Arabic depends on the prosodic pattern of the corresponding singular noun. Another example is the effect of consonant cluster transfer in the derivation of denominal verbs in Modern Hebrew (Bat-El 1994a). These processes can only be analyzed as output-based, and open up the line of inquiry concerning the extent to which such languages may be analyzed in this way. My aim here is to show that it is not a few cases of morphological processes which are organized in this fashion, but rather that all of these languages can be profitably viewed as word-based (cf. Aronoff 1976). Doing so removes a layer of abstraction unencountered in any other language: the notion of the consonantal root.

In the following chapter, I introduce the notion of prosodic binarity. After reviewing several case studies illustrating binarity effects, I move on to provide formal mechanisms for achieving the effects illustrated in the data. This sets the stage for the analysis of Modern Hebrew fixed prosody.

Chapter 2:
Prosodic binarity

2.0 Structural binarity

The bulk of this dissertation focuses on fixed prosodic effects in prosodic morphology. It turns out, as will be explored and discussed in much detail in the chapters that follow, that the core of fixed prosody examined here involves the imposition of prosodically binary restrictions on words. In this chapter, it is my intent to draw attention to the importance of the feature of prosodic binarity, the role it has played in previous analyses, and the mechanisms that have been invoked to implement it.

However, before discussing the purely phonological side of binarity, some background on this concept and how it has figured in grammatical theory is in order. The concept of binarity plays an important role in linguistic domains outside of phonology; for instance, syntactic representations are generally assumed to be constrained by the notion of binary branching. One implementation of this idea can be traced back to work of Kayne (1981, 1984), who observed that binary branching structures have special properties such as the fact that they permit the notion of c-command and government in terms of unambiguous paths between the categories in question. An unambiguous path is a path between two nodes in a syntactic tree "such that, in tracing it out, one is never forced to make a choice between two (or more) unused branches, both pointing in the same direction.”

The idea that binary structures play an important role has further developed in work within syntax, notably in work of Muyksen (1983), E. Hoekstra (1991), T. Hoekstra (1991), Kosmeijer (1993), and Reuland (1994). This has further led to the restriction that “counting” should not be part of any grammatical component; that no rule should be able to state conditions on the number of items. Rather, such restrictions should emerge as the effects of other more basic properties, such as in syntax, where this is accomplished through relations based on locality and economy.

Another consequence of this type of approach is that the mechanism of *counting* is avoided altogether. Throughout the sixties, syntactic theory focused on conditions on factorizations in the structural descriptions of transformational rules (e.g., Chomsky 1965, Ross 1967). Beginning in the seventies, a move was made away from such conditions; for instance, work of Chomsky (1973, 1976, 1977) showed that structural conditions on movement rules could be reduced to three-term factorizations, where only one of the three terms is unpredictable. This led to local determinacy as a condition on very general rules, such as “Move-α”.

2.1 Binary prosodic constituency

Within phonology, binarity has played a role in two distinct but seemingly not unrelated domains. The more familiar use of binarity concerns the role of contrast between features or categories, and harks back to the work of Saussure (1914). Thus, much work stemming from this concerns the idea of binary features. We will not concern ourselves further with binarity in this capacity, though it is interesting to study how this aspect of binarity relates to the aspect concentrated on in the remainder of this chapter.

2.1.1 Prosodic phonology and conditions on prosodic constituent structure

Structural relations among prosodic constituents make up another domain in which binarity plays a role in phonology. This is perhaps a more abstract version of binarity, since it deals with structure that is not directly manifested via phonetic features, but is concerned more with abstract and suprasegmental categories and the consequences these structures have in phonology. This area has its most obvious expression in the prosody of a language. Prosody may be defined as the manifestation of phonological categories above the level of the individual segment. Prosodic phonology is the study of the structural make-up and organization of these categories, and has its roots in work of many researchers, including Selkirk (1980ab, 1984a), McCarthy & Prince (1986 *et seq.*), Ito (1986, 1989, 1990), Nespor & Vogel (1986), Ito & Mester (1992) among many others. Work on prosodic phonology centers on the Prosodic Hierarchy, as discussed in chapter 1.

(1) The Prosodic Hierarchy[1]

PrWd
|
Ft
|
σ
|
μ

This structure illustrates the hierarchical organization of prosodic categories. A large amount of research in prosodic phonology has led to certain conditions on the structures that are instantiated by the Prosodic Hierarchy. Two of these are as follows:

(2) Conditions on prosodic constituent structure

(a) Proper Headedness (Ito & Mester 1992; cf. also Selkirk 1980ab; McCarthy & Prince 1986, 1991ab)

Every nonterminal prosodic category of level *i* must have a head; that is, it must immediately dominate at least one category of level *i-1*.

(b) Strict Layering (Selkirk 1984a)

A prosodic category of level *i* immediately dominates a (sequence of) categories of level *i-1*, and no categories of any other level.

Proper Headedness remains relatively uncontroversial, and, as pointed out by McCarthy & Prince (1999), is potentially universally obeyed. Strict Layering, however, has been challenged in work of Ito & Mester (1992), who argue that based on the prosodic patterns observed in Japanese truncations, Strict Layering must be relaxed. They show that in fact, Weak Layering, whereby a syllable may be directly

[1] The following abbreviations are used throughout this work: PrWd = prosodic word, Ft = foot, σ = syllable, and μ = mora.

dominated by a prosodic word (with no intervening foot), is a necessary allowance in prosodic theory.

With this background on prosodic constituent structure, we are now in a position to examine the issue of binarity in prosodic phonology. The following section discusses this issue, and the subsequent sections go on to illustrate the enforcement of binarity conditions as minimal and maximal size restrictions.

2.1.2 Achieving prosodic binarity

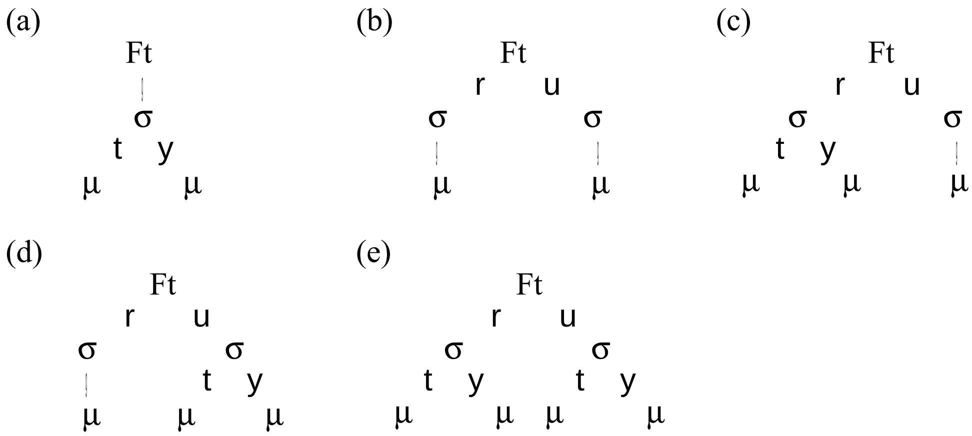
A useful place to begin our exploration of prosodic binarity comes from metrical theory, where it has long been recognized that binarity plays an important role in the structure of metrical feet (Prince 1976, 1980, Liberman & Prince 1977, Selkirk 1980ab, McCarthy 1979, Halle & Vergnaud 1978, Hayes 1980). Within OT, this has typically been formalized via the constraint FTBIN, which mandates that feet must be binary, and is usually defined as follows:

(3) F(OO)TBIN(ARITY)

Feet are binary at the syllabic or moraic level of analysis.

What this means is that a foot must contain two and only two moras, or else two and only two syllables. The constraint FTBIN thus permits the following foot structures:

(4) FTBIN-satisfying feet



However, the constraint FTBIN can be subjected to some criticism. First of all, the constraint is vague. It allows for satisfaction at two levels of analysis: the syllable and the mora. This fact in itself is not necessarily problematic, but what is difficult to accept is the way in which this constraint is opportunistically invoked. That is, in many analyses that take advantage of the power of FTBIN, its true strength is not in terms of what satisfies it but actually the one structure that it bans: the degenerate foot:

(5) Degenerate foot: banned by any interpretation of FTBIN

Of course, in addition to disallowing 'subminimal' structures, FTBIN also has the power to ban any structure that is greater than binary. A moraic FTBIN would ban any structure containing more than two moras, while a syllabic FTBIN would ban anything greater than two syllables. I will argue below that the dual function of FTBIN renders it too powerful, and that rather than rely on a single constraint for both minimality and maximality effects, two separate constraints must be introduced.

This idea has precedence in earlier work. For instance, Hewitt (1993, 1994) argues that FTBIN needs to be relativized to particular prosodic levels, thus distinguishing between binarity at the moraic vs. the syllabic level of analysis explicitly with the constraints FTBINσ and FTBINμ. A different but related approach is adopted by Everett (1996), who analyzes metrical structure in the Amazonian language Banawa. Everett distinguishes a minimality version of FTBIN from a maximality version of FTBIN, splitting up the two conditions into two separately rankable constraints. A more general version of this approach is pursued by Ito & Mester (1995bc), who derive binary branching as an upper and lower limit from conditions more basic than a constraint requiring a prosodic word or a foot to have exactly two immediate constituents.

Similarly, in the approach explored below, I argue that instead of a monolithic constraint dictating conditions on both minimality (banning degenerate structures) and maximality (banning supramaximal structures), the effects of FTBIN should instead be derived from constraints which separately encode maximality restrictions and minimality conditions. In the model I advocate, binarity is approached from a more general perspective, in the sense that general prosodic binarity is dealt with, rather than just binarity at the level of a single prosodic category such as the foot. The constraints that derive fixed prosody are fully generalizable to other prosodic categories.

The imposition of prosodic binarity as an upper and/or lower limit has figured prominently in much recent work: Ito & Mester (1992), Black (1993), Hewitt (1993, 1994), Ito & Mester (1995bc), Ola (1995), Ito, Kitagawa, & Mester (1996), Rifkin (2000). Below, I review several cases exemplifying word binarity phenomena.

2.2 Word binarity as a minimum

In this section, I discuss several cases illustrating word binarity imposed as a minimality condition. In each case, the word binarity in question specifically involves *bisyllabicity* as the crucial minimal prosodic shape. I first discuss the relevant data, and then propose a formalization to account for such cases.

2.2.1 Case studies in minimality

In German, infinitive forms of verbs are minimally binary. The following data come from Féry (1991).

(6) Bisyllabic minimum in German infinitives

Orthography	*Underlying*	*Syllabic n*	*Nonsyllabic n*	*Gloss*
sehen	/zeː-n/	.zeː.n̩.	? .zeːn.	‘to see’
bauen	/bau-n/	.bau.n̩.	? .baun.	‘to build’
fliehen	/fliː-n/	.fliː.n̩.	? .fliːn.	‘to flee’
wollen	/vɔl-n/	.vɔ.ln̩.	? .vɔln.	‘to want’

As Ito & Mester (1995c) point out, this minimality cannot be reduced to a case of foot minimality, because the quantity-sensitive stress foot adduced for German metrical structure only goes as far as to impose a bimoraic minimum. However, in these cases, words such as ill-formed *.ze:n.* clearly meet the bimoraic minimum. Rather, what is observed here is a bisyllabic minimum, which must be distinguished from the minimality imposed on feet. In addition, it is important to note that in contrast to the forms above, German does contain words in morphological categories other than the verbal infinitive which may be monosyllabic, as exemplified by the following data:

(7) Monosyllabic words in German, also ending in *n* (from Ito & Mester 1995c).

Orthography	*Underlying*	*Syllabic n*	*Nonsyllabic n*	*Gloss*
zehn	/t͡seːn/	*.t͡seː.n̩.	.t͡seːn.	‘ten’
Zaun	/t͡saun/	*.t͡saʊ.n̩.	.t͡saʊn.	‘fence’
Köln	/kœln/	*.kœ.ln̩.	.kœln.	‘Cologne’

Finally, for the sake of completeness, consider the following forms, which show that in German infinitives *n* is never syllabic in cases of verbs which already meet the bisyllabic minimality requirement:[2]

[2] A separate case of syllabic n̩ appears in *trompetn̩*, in which a final cluster is ruled out due to sonority sequencing restrictions.

(8) Nonsyllabic infinitival *n* in longer verbs (from Ito & Mester 1995c).

Orthography	*Underlying*	*Syllabic n*	*Nonsyllabic n*	*Gloss*
fordern	/fɔʀdʀ-n/	*.fɔʀ.d(ə).ʀn̩.	.fɔʀ.dəʀn.	'to demand'
segeln	/zeːgl-n/	*.zeː.g(ə).ln̩.	.zeː.gəln.	'to sail'

Turkish is another language that imposes word binarity as a lower limit. As documented by Ito & Hankamer (1989), monosyllabic forms resulting from appending consonantal suffixes to CV roots are rejected by many speakers as ungrammatical. The following inflectional paradigms illustrate this.

(9) Turkish word minimality effects (Ito & Hankamer 1989; see also Orgun & Inkelas 1992, Inkelas & Orgun 1995)

(a)		*Gloss*	*Inflection*
Stem	.do.	'musical note'	
	.do.lar.		*Pl.*
	.do.la.rɯm.		*Pl.1.poss.*
	***.dom**.		*1.poss.*
	.do.muz.		*1.pl.poss.*
	.do.mu.		*1.sg.poss.acc.*
	.dom.da.		*1.sg.poss.loc.*

(b)		*Gloss*	*Inflection*
Stem	.se.	'name of letter'	
	.se.ler.		*Pl.*
	.se.le.rim.		*Pl.1.poss.*
	***.sem**.		*1.poss.*
	.se.miz.		*1.pl.poss.*
	.se.mi.		*1.sg.poss.acc.*
	.sem.de.		*1.sg.poss.loc.*

When pressured to form the first person possessive forms of such nouns, speakers either create a compound (such as *benim do notam* 'my do-note') or lengthen the vowel to produce a bisyllabic output (*.do.om.*, *.se.em.*).[3] In contrast, nouns greater than two syllables do not encounter any difficulties in the first person possessive inflection:

(10) No problems with non-monosyllables

		Gloss	*Inflection*
Stem	.ha.ne.	'building'	
	.ha.ne.ler.		*Pl.*
	.ha.ne.le.rim.		*Pl.1.poss.*
	.**ha**.**nem**.		*1.poss.*
	.ha.ne.miz.		*1.pl.poss.*
	.ha.ne.mi.		*1.sg.poss.acc.*
	.ha.nem.de.		*1.sg.poss.loc.*

A third example of a bisyllabic minimum comes from Japanese. As Ito & Mester (1995c) discuss, instead of the expected citation form **su* of the verbal root *s-* 'do', *suru* is found:

(11) Bisyllabic minimum in Japanese verbal citation forms (Ito & Mester 1995c)

Underlying	*/-(r)u/ present*	*Gloss*
mi	miru	'see'
ne	neru	'sleep'
jom	jomu	'read'
hanas	hanasu	'talk'
s	*su → suru	'do'

[3] This observation is due to Berna Dalkınan (p.c.), Dilara Grate (p.c.) and Andrew Wedel (p.c.).

In addition, Ito & Mester point out that the infinitival form *suu* is actually bisyllabic (.*su.u*) and not monosyllabic (*.*suu*.). This observation parallels the Turkish case examined above, where speakers pronounce a monosyllabic root plus a consonantal suffix as an augmented bisyllabic word.

The Bantu language Ndebele provides yet another case of prosodic binarity imposed as a minimum word size. As documented and discussed by Hyman, Inkelas, & Sibanda (1999) and Inkelas & Zoll (2000), Ndebele imposes a bisyllabic minimum on its words. This minimality requirement emerges only in the imperative form in the language, which, according to Inkelas & Zoll (2000:5) is the only verbal construction in the language which does not involve prefixation. This is illustrated by the following data.

(12) Bisyllabic minimum in Ndebele imperatives (Inkelas & Zoll 2000:5)

	Ndebele imperative	*Gloss*
(a)	**lim**-a	'cultivate!'
	nambith-a	'taste!'
(b)	yi-**dl**-a	'eat!'
	yi-**m**-a	'stand!'
	yi-**z**-a	'come!'
	yi-**lw**-a	'fight!'

The root in each form is indicated by boldface type. The final *a* in each of the forms is the final vowel typical of Bantu verbs. The interesting fact about these data is that in the (b) forms above, *yi-* is prefixed to the verbal stem in order to augment the resulting verb to two syllables. This *yi-*, according to Inkelas & Zoll, is a "semantically empty morph", and is appended only to satisfy the minimality condition. It is the only case in the Ndebele imperative of a prefix, though since it contributes no meaning its status as a true prefix is in doubt. It is there solely to augment the word to two syllables.

What all of these examples illustrate are cases in which monosyllabic forms are ill-formed. Interestingly, the languages do not all employ identical strategies to deal with such forms when they arise. In German, Japanese, and Ndebele, forms which would otherwise violate the bisyllabic minimum are augmented to two syllables, while in Turkish, such forms tend to be avoided altogether, with recourse to augmentation available only under extreme pressure. I now turn to a formal approach to implementing binarity as a prosodic minimum.

2.2.2 A formal approach to minimal binarity: Prosodic Branching

Note that in all of the cases discussed so far, the minimality in question requires bisyllabicity, which differs from the usual "Minimal Word" account of such effects. Under such an account, the minimal word of the language in question suffices to describe the facts. However, in the cases seen so far, the minimal word in the various languages will not necessarily rescue forms less than two syllables. For instance, it is well-known that the minimal word in Japanese consists of two moras (Kubozono 1989, Tateishi 1989, Ito 1990, Mester 1990, Poser 1990, McCarthy & Prince 1991ab, Perlmutter 1992, Ito, Kitagawa, & Mester 1996) so a single heavy syllable should suffice to meet whatever minimality requirements are imposed.

Here, I introduce a relatively simple formalization to encode the minimality requirement. This formalization can be thought of as doing some of the work that a constraint like FTBIN is meant to do; namely, that part of FTBIN which rules out subminimal forms. The following constraint, called PROSODICBRANCHING, is a structural constraint that requires a prosodic category to branch.

(13) PROSODICBRANCHING (PRBRANCH; generalizing from Ito & Mester's (1992:21) "Word Binarity")

A prosodic category *i* must branch at level *i* or *i-1*,

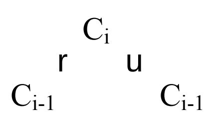
where "branch" is defined as follows:

A prosodic category branches if and only if it contains more than one daughter.

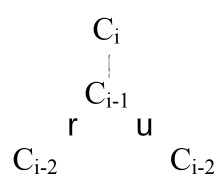
The constraint is illustrated in a very general way by the following diagrams, which show structures that satisfy PRBRANCH.

(14) PRBRANCH ("C" stands for a prosodic category)

(a)



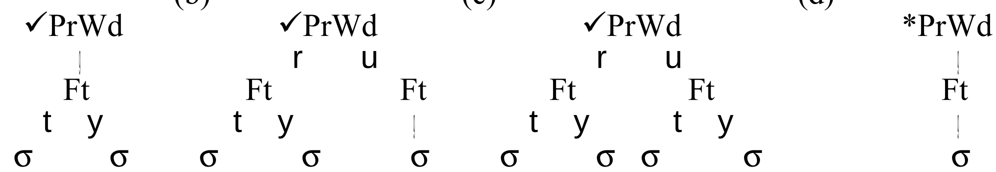
(b)



For instance, applied at the level of the prosodic word, PRWDBRANCH requires that the word contain either at least two feet, or, if it only contains one foot, that this foot contain at least two syllables. Note that PRBRANCH says nothing about the number of branches required; it simply requires that there be branching. The following diagram illustrates forms subjected to PRWDBRANCH and how they fare with respect to this constraint.

(15) PRWDBRANCH

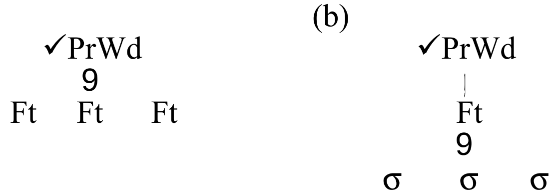
(a) (b) (c) (d)



As seen here, (a), (b), and (c) all branch at either the level of the PrWd or the Ft; that is, they all contain either two feet or two syllables. (d), however, does not branch at any of the relevant levels of prosodic structure, and is therefore marked as violating the constraint PRWDBRANCH. Note that binary branching is not required by this constraint; the following forms satisfy PRWDBRANCH:

(16) PRWDBRANCH

(a) (b)



These structures all contain either a branching prosodic word or a branching foot, so PRWDBRANCH is satisfied. This approach maintains the intuition explored here that minimality and maximality conditions are separate issues, and that therefore each should be accounted for separately. PRWDBRANCH is truly a minimality requirement, and only a minimality requirement, in that it only restricts how *small* a structure may be. It says nothing about how big a structure can be. The issue of maximality is left to another constraint, which is explored in the subsequent section following a number of case studies illustrating maximality effects.

2.3 Word binarity as a maximum

In addition to its status as a minimality condition, prosodic binarity at the word level may also be invoked as a maximal size restriction. Here I discuss several cases illustrating such size restrictions, followed by a formal proposal to implement the restriction.

2.3.1 Case studies in maximality

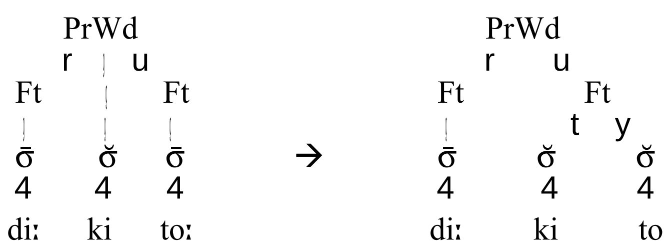
Mester (1994) discusses the phenomenon of cretic shortening in Latin preclassical dramatic verse. In the examples that follows, final heavy syllables are treated as light in words that end in a heavy-light-heavy, or *cretic*, sequence.

(17) Binary maximum in Latin: Cretic shortening (Mester 1994, Ito & Mester 1995c)

Without shortening	*With shortening*	*Gloss*
([σ̄] σ̆ [σ̄])$_{PrWd}$	([σ̄] [σ̆ σ̆])$_{PrWd}$	
.diː.ki.toː.	diː.ki.[to]$_{\breve{\sigma}}$	'you shall say'
.mak.su.meː.	.mak.su.[me]$_{\breve{\sigma}}$	'most, adv.'
.k^{w}oː.mo.doː.	.k^{w}oː.mo.[do]$_{\breve{\sigma}}$	'in what way?'
.eː.ni.kaːs.	.eː.ni.[kas]$_{\breve{\sigma}}$	'you murder'
.tur.bi.neːs.	.tur.bi.[nes]$_{\breve{\sigma}}$	'whirls'
.veː.ne.rant.	.veː.ne.[rant]$_{\breve{\sigma}}$	'they had come'

The prosodic effect of cretic shortening, according to Ito & Mester (1995c), is that binary word structure is restored. This is illustrated by the following diagram:

(18) Cretic shortening: restoration of binary word structure



Crucially, no cretic shortening takes place in the final syllables of forms such as ([*faki*] [*toː*])$_{PrWd}$ since they are already binary (i.e. composed of two and only two feet). Thus, cretic shortening takes place to avoid potentially ternary structures in favor of binary structures, exemplifying a bisyllabic maximum word size effect. This case study is complicated by the fact that the motivation for the structurally binary outputs could also be related to a demand for every syllable to belong to a foot, thus satisfying the constraint PARSE-σ, as in Mester (1994).

Japanese also shows binary upper limit effects, which can be illustrated in several different morphological domains. Following work of Ito (1990) and Ito & Mester (1992), we observe that in Japanese loanword truncations, only binary structures are permissible. As the structures and data below show, different instantiations of binarity can satisfy this upper limit.

(19) Binarity in Japanese loanword truncations: permissible structures[4]

(a) PrWd *Two feet*
r u
Ft Ft

(b) PrWd *Foot plus light syllable*
r u
Ft σ̆

(c) PrWd *One foot: two light syllables*
|
Ft
r u
σ̆ σ̆

[4] A fourth possibility, which is excluded, is the following structure:

*PrWd
r u
σ̆ Ft

This structure is discussed below.

(20) Binarity in Japanese loanword truncations: examples of each permissible structure (unpronounced portion in angled brackets; data from Ito & Mester 1992, 1995c. The symbol *N* stands for the moraic nasal.)

(a)

Truncated form: two feet	*Gloss*
[.a.su.][.pa.ra.] <gasu>	'asparagus'
[.ri.ha.][.bi.ri.] <teeʃon>	'rehabilitation'
[.koN.][.bi.ni.] <eNsu>	'convenience store'
[.baa.][.teN.] <daa>	'bartender'
[.to.ri.][.ku.ro.] <roent͡ʃireN>	'trichloroethylene'

(b)

Truncated form: foot plus light syllable	*Gloss*
[.dai.].ja.<moNdo>	'diamond'
[.paa.].ma. <neNto>	'hair permanent'
[.koN.].bi. <neeʃon>	'combination'
[.siN.].po. <d͡ʒuumu>	'symposium'
[.a.ru.].mi. <ɲuumu>	'aluminum'
[.a.ni.].me. <ʃoN>	'animation'

(c)

Truncated form: one foot, two light syllables	*Gloss*
[.su.to.] <raiki>	'strike'
[.o.pe.] <reeʃoN>	'operation'
[.ra.bo.] <ratorii>	'laboratory'
[.ne.ga.] <t͡ʃibu>	'negatives'

Again, these data illustrate that prosodic maximal binarity is observed in Japanese truncatory morphology. Yet another case from Japanese comes from the language game *Zuuzya-go*, as analyzed in detail by Ito, Kitagawa, & Mester (1996). This language game involves a special type of word-reversal, and, like the cases of Japanese truncations, places strict conditions on the output shapes it permits. Specifically, in this system only two prosodic shapes are attested:

(21) Binarity in Japanese *Zuuzya-go*: permissible structures

(a) PrWd — *Two feet*

r u

Ft Ft

(b) PrWd — *Foot plus light syllable*

r u

Ft σ̆

(22) Binarity in Japanese *Zuuzya-go*: examples of permissible structures (data from Ito & Mester 1995c, Ito, Kitagawa, & Mester 1996)

(a)

Reversal: two feet	*Base*	*Gloss*
[.çii.][.koo.]	kooçii	‘coffee’
[.ʃii.][.ta.ku.]	takuʃii	‘taxi’
[.d͡ʒaa.][.ma.ne.]	maneed͡ʒaa	‘manager’
[.ba.na.][.i.ke.]	ikebana	‘flower arrangement’
[.boɴ.][.to.ro.]	toroɴbooɴ	‘trombone’

(b)

Reversal: foot plus light syllable	*Base*	*Gloss*
[.zuu.].d͡ʒa.	d͡ʒazu	‘jazz’
[.ʃii.].me.	meʃi	‘food’
[.ja.no.].pi.	pijano	‘piano’
[.meɴ.].ɸu.	ɸumeɴ	‘score’
[.ii.].ha.	hai	‘yes’
[.ee.].me.	me	‘eye’

The Uto-Aztecan language Southern Tepehuan provides a further case of prosodic binarity enforced as a maximum, as documented in work of Black (1993). This language exhibits a complex pattern of truncation in its nominal forms.[5] The

[5] Since we are primarily interested in the effects of prosodic binarity, the following discussion will ignore the parts of Black’s analysis that are not relevant here.

crucial data involve forms that undergo truncation to yield prosodically binary structures, as illustrated below:

(23) Binarity in Southern Tepehuan stems (Black 1993; data originally from E. Willett (1981, 1982, 1985) and T. Willett (1991)[6]

Underlying	*Surface*	*Gloss*
suisuimari	$[\text{suis}]_{\text{Ft}}[\text{mar'}]_{\text{Ft}}$	'deer, pl.'
hin-nuunuutisV	hin'-$[\text{n'uun}]_{\text{Ft}}[\text{c'is'}]_{\text{Ft}}$	'my brothers-in-law'
giogiotɨrV	[gio'ŋ]$_{\text{Ft}}$[tɨr]$_{\text{Ft}}$	'plains'
piipiipiri	$[\text{piip}]_{\text{Ft}}[\text{pir'}]_{\text{Ft}}$	'chicks'

Black describes the surface forms in all of these cases as manifesting "Stem binarity"; that is, their prosodic structures involve binary branching. For instance, rather than surfacing as *[*pii*]$_{\text{Ft}}$[*pii*]$_{\text{Ft}}$[*piri*]$_{\text{Ft}}$ the underlying form *piipiipiri* surfaces as [*piip*]$_{\text{Ft}}$[*pir'*]$_{\text{Ft}}$. Black makes use of a constraint called Stem Binarity, to be illustrated below, to explain this phenomenon.

As a final case of a binary word maximum, I present some preliminary data from Modern Hebrew. The detailed analysis of these data is reserved for subsequent chapters; the goal here is simply to illustrate how these forms parallel the previous examples of maximally binary word size restrictions.

The Modern Hebrew verbal paradigm can be roughly characterized as involving a maximally binary prosodic word size. This is illustrated here with sets of related verbs, all of which are two syllables long.

[6] C' in the following data represents a palatalized consonant. *r'*, according to Black (1993), is a voiced palatal lateral fricative. 'C represents a preglottalized nasal. "V" represents an underlying vowel of unknown quality.

(24) Binarity in Modern Hebrew verbs

(a) *gamar* — *Gloss*

Past	gamar	'he finished'
Present	gomer	'finish, masc.sg.'
Future	yigmor	'he will finish'

(b) *gadal* — *Gloss*

paʕal	gadal	'he grew, intransitive'
piʕel	gidel	'he raised'
hifʕil	higdil	'he enlarged'

Here, two stems, *gamar* and *gadal* are illustrated. For *gamar*, I have provided a snapshot of its inflectional morphological paradigm, demonstrating that in each tense in which it appears (only third person forms are provided), the surface forms are always two syllables long. Similarly, I have illustrated in the case of *gadal* that the same holds in the derivational morphology, which relates forms that exist in different binyanim.[7]

2.3.2 A formal approach to maximal binarity: Hierarchical Alignment

There are (at least) two formal approaches to capturing the word binarity effects under discussion here. The two approaches differ in their respective degrees of stipulative character. The first approach is to incorporate some constraint that demands that every word have exactly two immediate prosodic constituents. This is

[7] The term *binyan* (plural = binyanim) refers to the verbal class of a particular verb. This term is discussed in greater detail in subsequent chapters.

essentially the approached developed in Ito & Mester (1992) to capture the binarity effects in Japanese loanword truncation and hypocoristics. The following condition is proposed by Ito & Mester (1992):

(25) Word Binarity (Ito & Mester 1992:21)
P-derived words must be prosodically binary.

Under this formulation, "P-derived" refers to words that are prosodic derivatives of other words, and can be seen as an important predecessor to the notion of "The Emergence of the Unmarked' (TETU; McCarthy & Prince 1994a) in that it imposes a markedness condition on output-derived forms. A related attempt at achieving binarity is proposed by Black (1993), who modifies the Word Binarity constraint above as a Stem Binarity constraint to account for the Southeastern Tepehuan data examined above.

(26) Stem Binarity (Black 1993:60)
Stems must be prosodically binary.

While this type of formulation captures the binarity effects observed in the data above, it remains a stipulative mechanism. In addition, such formulations are suspicious because they require counting, which, as discussed above, requires a rather complex mechanism. This therefore begs the question of whether prosodic binarity can be derived from more fundamental factors, within an approach where the effects of being able to count are achieved via simpler tools, this enabling binarity to be broken down into significantly more basic considerations. This, in fact, is the argument put forth by Ito & Mester (1995c) in favor of a second approach to deriving prosodic binarity.

Under this second approach, which we will adopt here, binary words are emergent under the pressure of more general, already established constraints. Recall that the goal is to permit binary prosodic structures, while excluding anything greater than binary in structure. The intuitive idea behind this approach is that in prosodic structures that contain only binary branching (as opposed to more), every constituent is aligned to one edge (either the left or right edge) of some larger prosodic constituent, and is therefore prominent within this larger constituent. Ito & Mester (1995c) thus propose that in a maximally binary structure, constituent prominence is expressed as alignment within a higher constituent. This view is formalized through a particular type of alignment constraint, named *Hierarchical Alignment*, which essentially demands that each prosodic constituent is aligned with some properly containing prosodic constituent at a higher level.

Hierarchical Alignment is thus defined as follows:

(27) Hierarchical Alignment (Ito & Mester 1995c; Ito, Kitagawa, & Mester 1996:242)

$\forall$PCat1 $\exists$PCat2 [PCat2 $\supset$ PCat1 & ALIGN (PCat1, PCat2)],

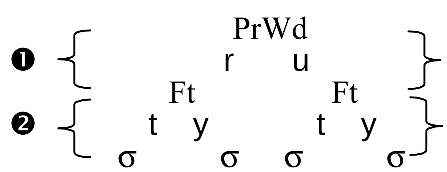
($\equiv$Every prosodic constituent is aligned with some prosodic constituent containing it.)

In this formulation, "PCat" stands for a string that is a prosodic category (though it is never the root of a prosodic tree, which would allow infinite recursion). As Ito &

Mester (1995c) point out, this constraint is defined only for constituents that are in a dominance relation. Because of this, there is no need within the formalism of the constraint to stipulate that the alignment in question involves same-edge matching. Same-edge matching is the only type of alignment possible under this type of dominance relation, because if constituents are aligned at opposite edges, no dominance relation can hold between them.

Let us illustrate the force of this constraint with some prosodic structures. The PrWd in the diagram below satisfies Hierarchical Alignment at all levels:

(28) Hierarchical Alignment illustrated



Key

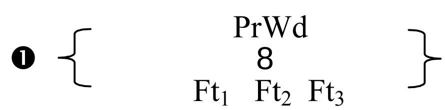
❶ Hierarchical Alignment of *foot*: maximally binary *prosodic word*.

❷ Hierarchical Alignment of *syllable*: maximally binary *foot*.

What Hierarchical Alignment punishes are structures such as the following, which each involve on misaligned prosodic category:

(29) Hierarchical Alignment violated

(a)



(b) ❷ { Ft 8 σ_1 σ_2 σ_3 }

Key

❶ Ft_1 and Ft_3 are hierarchically aligned, but Ft_2 violates Hierarchical Alignment.

❷ σ_1 and σ_3 are hierarchically aligned, but σ_2 violates Hierarchical Alignment.

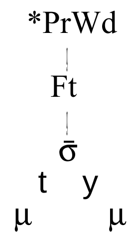
Hierarchical Alignment thus captures the binary word size observed in Japanese templatic formations. However, there remain some gaps, as pointed out by Ito (1990), Ito & Mester (1992), and Ito & Mester (1995c). These gaps are as follows: no truncatory or reversal forms ever begin with an unfooted syllable. That is, the structure below is banned:

(30) No initial loose syllables in Japanese truncatory or reversal forms

*PrWd
r u
σ̆ Ft

This restriction is formulated as a condition named "Left-Edge Matching" in Ito (1990) and "Foot Alignment" in Ito & Mester (1992). Additionally, monosyllabic forms are prohibited, even though they clearly satisfy Hierarchical Alignment:

(31) No monosyllables in Japanese truncatory or reversal forms



This restriction plays an important role, as will become clear in the analysis of binarity restrictions in Modern Hebrew as developed in the following chapter. For Japanese, Ito & Mester (1995c), Ito, Kitagawa, & Mester (1996) propose to exclude the above structures using the constraint NONFINALITY.

(32) NONFINALITY (Prince & Smolensky 1993:52)
No head of PrWd is final in PrWd.

Thus, although a potential monosyllabic truncation in Japanese satisfies Hierarchical Alignment, it clearly violates NONFINALITY because the sole syllable in such a form would have to be the head of the PrWd containing it. In addition, the cases of "initial loose syllables" are also ruled out because the final syllable would have to be the head.

This approach accounts for the "loose templatic requirements" imposed on Japanese truncations and reversal forms. The term "loose template" refers to the fact that the templatic requirement is rather general; that is, it does not fully restrict the prosodic form of such words. It only limits forms to a particular size, within which there are various ways to satisfy the limitation. This contrasts clearly with true "templatic" requirements that dictate not only the number of feet a form may have, but in addition, the syllable structure of such forms. More to the point, under the approach advocated by Ito & Mester (1992) and Ito, Kitagawa, & Mester (1996), forms obeying both minimal and maximal size requirements must obey the simple requirement that "they be well-formed prosodic words, nothing more, nothing less" (Ito & Mester 1992:16). With respect to minimality in particular, this idea is further enforced by the simple requirement of Proper Headedness, reviewed above, which requires every nonterminal prosodic category to have a head. Thus, every prosodic word must contain at least one foot, each foot must contain at least one syllable, etc. As demonstrated by McCarthy & Prince (1986, *et seq*.) and Ito & Mester (1992), this is a sufficient condition to ensure that every prosodic word meets whatever prosodic requirements are imposed on subordinate constituents. This is in contrast with an approach that imposes more detailed restrictions on prosodic categories, such as the CV-structure words may have, since such an approach is not strictly limited to a prosodic basis of restrictions. This may be fruitfully illustrated with further cases involving prosodic morphology.

2.4 Prosodic morphology, again

For instance, in McCarthy's (1979, 1981) analyses of Arabic verbal morphology, templatic shape in the verbal classes was specific at the level of segment type (consonants and vowels). The following templates are proposed there:

(33) Examples of Arabic prosodic templates in the binyanim (McCarthy 1979:248, 250)[8]

	Template	*Binyan*
(a)	CVCVC	faʕal (I)
(b)	CVCCVC	faʕʕal (II), ʔaktab (IV)
(c)	CVVCVC	faaʕal (III)
(d)	CVCVCCVC	tafaʕʕal (V)
(e)	CVCVVCVC	tafaaʕal (VI)
(f)	CCVCVC	nkatab (VII), ktatab (VIII), ktabab (IX)
(g)	CCVCCVC	staktab (X)
(h)	CCVVCVC	ktaabab (XI)

As previously discussed, under the prosodic morphology framework of McCarthy & Prince (1986, *et seq.*), such templates are not defined by their segmental make up; rather, they must be defined by their prosody. Relying strictly on the prosodic units already familiar to us, the Arabic verbal forms may be reanalyzed as follows.

[8] Each verbal class, or binyan (plural: binyanim), is represented following work of traditional Semitic grammar: the consonants *f*, *ʕ*, *l* are used to represent each verb; the stem *faʕal* means ‘ to act.’ Thus, each form can be abstractly represented using this stem as a base. The Roman numerals following each binyan name refer to the number assigned to each binyan in traditional grammar.

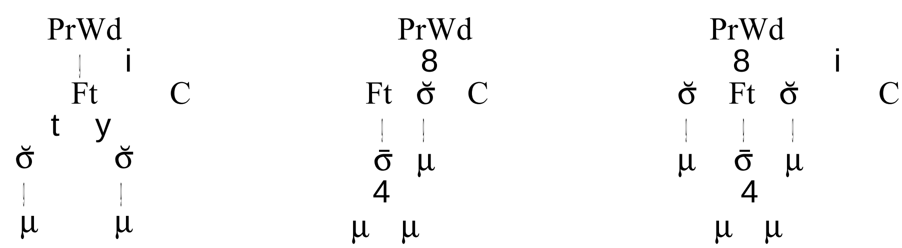
(34) Arabic prosodically-defined templates (parenthesis refer to prosodic word boundaries; brackets indicate foot boundaries; angled brackets indicate extrametrical material.)[9]

	Template	*Prosody*	*Binyan*
(a)	CVCVC	([CVCV]<C>)	faʕal (I)
(b)	CVCCVC	([CVC]CV<C>)	faʕʕal (II), ʔaktab (IV)
(c)	CVVCVC	([CVV]CV<C>)	faaʕal (III)
(d)	CVCVCCVC	(CV[CVC]CV<C>)	tafaʕʕal (V)
(e)	CVCVVCVC	(CV[CVV]CV<C>)	tafaaʕal (VI)
(f)	CCVCVC	([CCVCV]<C>)	nkatab (VII), ktatab (VIII), ktabab (IX)
(g)	CCVCCVC	([CCVC]CV<C>)	staktab (X)
(h)	CCVVCVC	([CCVV]CV<C>)	ktaabab (XI)

The clearest feature that all these forms share is that they are all single prosodic words. The following structures describe the various shapes these prosodic words take.

(35) Prosodic shapes of Arabic verbs

(a) I, VII, VIII, IX (b) II, III, IV, X, XI (c) V, VI



[9] These structures are created based on the important (and empirically justified) assumption that final consonants in Arabic are extrametrical; that is, a final consonant must be parsed by the prosodic word or a higher category, but never by a foot.

Like the Japanese cases examined earlier, the Arabic verbal prosody turns out to be quite limited. Every prosodic word contains one foot, and each foot contains two moras. In addition, there may be up to one light syllable on each side of the foot contained in each prosodic word.

We will return to the Arabic verbal paradigm in chapter 6, where an analysis of these prosodic shapes is proposed. The basis for this analysis comes from a close examination of the verbal paradigm of Modern Hebrew, to be presented in chapter 4. However, before delving into the details of the prosodic characteristics of the Modern Hebrew verbal system, the following chapter presents a detailed analysis of the metrical structure of Modern Hebrew. To date, no comprehensive analysis of stress in the Modern Hebrew verbal paradigm has been proposed in the framework of OT. One reason for this might be the fact that Modern Hebrew appears to be an example of a quantity-insensitive language that nonetheless makes use of iambic feet. Such a system, though, contradicts claims made in earlier research on metrical structure (e.g., Hayes 1985, 1987, 1995), in which, according to the "Iambic-Trochaic Law" metrical systems involving right-headed feet are claimed to be universally quantity-sensitive.

The next chapter presents the facts regarding Modern Hebrew stress, illustrating that it is indeed a quantity-insensitive system. However, the seemingly iambic nature of the system, as I demonstrate, does not necessarily require that iambic feet be stipulated in the constraint hierarchy responsible for generating the rhythmic structure of the language. As will be made clear, iambic feet can be said to emerge as optimal under the pressure of constraints that do not specify any particular foot type (an idea that has precedence in work of van de Vijver (1998).

Such an analysis, which makes no reference to foot type, could be viewed as preferable to one that does impose a formal requirement on foot headedness. It turns out that for Modern Hebrew, no such requirement is necessary. This result is satisfying, since Modern Hebrew makes use both of iambs and trochees, as the following chapter discusses.

Chapter 3:
Stress in the Modern Hebrew verbal system

3.0 Introduction

The first section of this chapter begins by presenting facts concerning stress in the Modern Hebrew verbal system. These facts are summarized in the second section. Following the generalizations regarding stress, I develop an analysis of stress using standard constraints of OT. I will argue for an account of Modern Hebrew stress that does not call for any particular foot type; rather, the foot typology of the Modern Hebrew stress system is emergent. That is, the metrical feet of Modern Hebrew arise through the interaction of basic constraints which do not specify if feet must be right-headed (iambic) or left-headed (trochaic).

This chapter focuses solely on verbs in Modern Hebrew. Verbs display a much more regular stress pattern than nouns do in Hebrew. The cause for this is at least two-fold. Verbs are not subject to affixation by morphemes that bear underlying accents, which means that the stress patterns exhibited in the verbal system reflect the true default metrical hierarchy active in the language. What's more, verbs, unlike nouns, display little or no irregularity in their stress pattern. One reason for this may be that faithfulness to nouns is higher-ranking than faithfulness to verbs, an idea preceded in the literature by Smith (1997). As described by Smith (and see the references therein), there is an abundance of evidence that cross-linguistically, nouns are more salient than other categories, most notably verbs, and that this motivates a distinction between noun faithfulness and general faithfulness. Therefore I concentrate here on the verbal system of Modern Hebrew, which displays remarkable regularity in its stress pattern.

Before presenting the details regarding the metrical structure of Modern Hebrew, a few words are in order about this language, since it forms the empirical basis of the theoretical advances proposed in this dissertation. Modern Hebrew belongs to the Semitic sub-branch of the Afro-Asiatic language family. It is part of the Northwest Semitic branch, and is one of the official languages of the state of Israel (the other being Arabic). Modern Hebrew is spoken by roughly five million native speakers in Israel. The descriptions and data in this dissertation are taken from the dialect spoken by Jewish native speakers of Ashkenazic background.

Modern Hebrew contains the following consonants.

(1) Modern Hebrew consonants

	Bilabial	Labiodental	Alveolar	Alveopalatal	Palatal	Velar	Laryngeal
Stop	p b		t d			k g	ʔ
Fricative		f v	s z	ʃ		x	h
Affricate			t͡s				
Nasal	m		n				
Liquid			l			r	
Glide					j		

This list may appear surprising, given the lack of certain sounds that are generally thought of as typically Semitic. In the dialect of Modern Hebrew examined here, for instance, the voiced pharyngeal fricative ʕ has been neutralized to a glottal stop; in the case of many speakers it has been lost altogether. The voiceless version of this sound, *ħ*, has been neutralized to a velar fricative. In addition, the uvular stop *q* has been neutralized to a velar stop. Another feature present in other Semitic languages (e.g., Arabic) and that was present in earlier forms of Hebrew that Modern Hebrew lacks is geminate consonants.

Modern Hebrew has a five-vowel system, with an unsurprising distribution of vowels:

(2) Modern Hebrew vowels

	Front	Back
High	i	u
Central	e	o
Low		a

Similar to the consonant length distinction that has been lost in Modern Hebrew, the language also lacks a vowel length distinction.

3.1 Metrical structure in Modern Hebrew

In this section, I develop an analysis of stress in the Modern Hebrew verbal system. Representative data are provided throughout the chapter, and examples from every tense and binyan are provided in the appendix at the end of the chapter.

3.2 Generalizations regarding stress

The following generalizations regarding stress hold on Modern Hebrew verbs (hyphens indicate affix-stem boundaries):

(i) The default stress pattern is primary stress on the final syllable. Stress always falls on the final syllable of the stem in non-suffixed forms (e.g., *katáv*, *hixtív*).

(ii) Morphologically complex forms may involve complications of the generalization in (i). Prefixes may be consonant-final (e.g., *hìt-katév*), thereby inducing secondary stress, and vowel-final (e.g., *hi-xtív*). Suffixes may be vowel-initial (e.g., *katv-á*), thereby inducing vowel deletion, or consonant-initial (e.g., *katáv-tem*). This strictly phonological distinction in the typology of affixation has strong effects on stress assignment in Hebrew.

(iii) Stemming from the previous generalizations we observe that penultimate primary stress occurs in forms with a consonant-initial suffix (e.g., *katáv-tem*).[1]

[1] For now, I ignore other cases of penultimate stress such as *mèdabéret* 'speak, fem.sg.pres.' I claim that these forms are similar to the *segolate* class of nouns in Hebrew, which also exhibit unexpected penultimate stress (Bat-El 1989, Graf 1999). The analysis I present does not apply to such forms, though they can be accounted for by positing an epenthetic final vowel, inserted to break up an underlying cluster. This vowel cannot be stressed because it has no input correspondent, along the lines of a

(iv) Secondary stress is observed in forms of three syllables with final primary stress (e.g., *hìt-katév*) and in forms with four syllables with penultimate primary stress (e.g., *hìt-katáv-tem*).

3.3 Analysis of stress

3.3.1 Primary stress on the final syllable

We may analyze the first observation as a requirement that primary stress is assigned to the rightmost syllable. This demand for final stress is expressed by the constraint RIGHTMOST:

(3) RIGHTMOST (Prince 1983, 1990, Prince & Smolensky 1993; proposed in rule form for Modern Hebrew by Bat-El 1989:162)

≡ ALIGN-R (σ́; PRWD)[2]

("Stress falls at the right edge of the prosodic word.")

For monomorphemic bisyllabic forms, such as *katáv* 'he wrote', the effect of this constraint is to assign primary stress on the final syllable:

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constraint like HEADDEP (Alderete 1995). Another case which I do not analyze here are the inflected past tense forms of the hifʕil binyan. These forms preserve the primary stress of the stem *í*, and could be analyzed by a constraint on prosodic faithfulness to high vowels.

[2] Violations of RIGHTMOST are computed based on the number of syllables from the end of the word where stress occurs.

(4) katáv

katáv	RIGHTMOST
a. kátav	σ!
☞ b. katáv	

The force of this constraint outweighs any considerations regarding possible moraic structure in the language. Thus we never find that Modern Hebrew prefers to stress a CVC syllable over a CV syllable. Another important fact to keep in mind is that the language has no long vowels. It therefore composes a classically quantity-insensitive system. The following data lists two-syllable words of varying syllable structures, showing the persistence of final primary stress.

(5) Stress in two-syllable words: consistent final stress

(i) .CV.CV. words

	Hebrew word	*Gloss*
a.	gilá	‘discover, 3.masc.sg.past’
b.	meví	‘bring, 3.masc.sg.pres.’
c.	roʔé	‘see, masc. sg.pres.’
d.	baná	‘build, fem.sg.pres.’

(ii) .CV.CVC. words

	Hebrew word	*Gloss*
a.	holéx	‘go, masc. sg. pres.’
b.	ʔaxál	‘eat, 3.masc.sg.past’
c.	gadál	‘grow, 3.masc.sg.past’
d.	mevín	‘understand, masc.sg.pres.’

(iii) .CVC.CVC. words

	Hebrew word	*Gloss*
a.	tilfén	'phone, 3.masc.sg.past'
b.	fiksés	'send a fax, 3.masc.sg.past'
c.	hitxíl	'begin, 3.masc.sg.past'
d.	nixnás	'enter, 3.masc.sg.'

(iv) .CVC.CV. words

	Hebrew word	*Gloss*
a.	marʃé	'permit, masc.sg.pres.'
b.	herʔá	'show, 3.masc.sg.past'
c.	kantá	'buy, 3.fem.sg.past.'
d.	laxʃú	'whisper, 3.pl. past.'

3.3.2 Rhythmic secondary stress

To determine the proper characterization for the default metrical structure in the language, however, it is necessary to examine longer forms, which contain secondary stress. This will provide evidence for a particular metrical structure from which we will be able to proceed in developing our analysis. In words with three syllables, excluding cases of suffixed verbs, the emergent pattern is that main stress is assigned to the final syllable, with secondary stress on the first syllable (Bolozky 1982).

(6) Rhythmic stress in Modern Hebrew

	Form	*Gloss*
a.	mèdabrót	'speak, fem.pl.pres.'
b.	nìxnesú	'enter, 3.pl.past'
c.	mìtraxt͡sím	'wash, masc.pl.pres.'
d.	hìtraxét͡s	'wash, 3.masc.sg.past'
e.	hùxtevú	'to be dictated, 3.pl.past'

The pattern seen in trisyllabic forms is as follows, with secondary stress on the first syllable, and primary stress in final position:

(7) Stress pattern in trisyllabic words

σ̀σσ́

At this point, I would like to explicitly lay out some assumptions regarding metrical structure. I assume that Modern Hebrew foots every syllable. This assumption is supported by the observation that secondary stress occurs in words that are three syllables or longer when primary stress is final, and in words that are four syllables or longer when primary stress is penultimate. If there were no secondary stress, we would have no evidence for feet other than the foot responsible for main stress. Thus, unsurprisingly, stress plays a direct role in the determination of foot construction since each stress implies one foot.

In addition, I am assuming that the Prosodic Hierarchy, as discussed in the previous chapter, holds for Modern Hebrew. The Prosodic Hierarchy assigns constituent structure to various prosodic categories: the prosodic word (PrWd), the foot (Ft), the syllable (σ) and the mora (μ). Various conditions hold on the Prosodic Hierarchy, which were already mentioned in the previous chapter. The first of these is the Strict Layer Hypothesis:

(8) The Strict Layer Hypothesis (adapted from Selkirk 1984a)

A category of level *x* in the hierarchy immediately dominates a (sequence of) categories of level *x-1*.

What this means is that a PrWd cannot immediately dominate anything other than a foot; that a foot cannot immediately dominate anything other than a syllable, etc. Ito & Mester (1992) have challenged this notion, showing how Weak Layering provides an explanatorily superior account of Japanese prosody. In particular, they demonstrate that allowing Weak Layering not only provides a more general theory, but also explains the prosodic restrictions imposed on Japanese truncations and hypocoristics. Essentially this shows that although Strict Layering may be correct it is not an inviolable principal.

Moving on, another feature of the Prosodic Hierarchy is the principle of Headedness.

(9) Headedness (adapted from Selkirk 1980ab, Ito & Mester 1992)

Every nonterminal prosodic category of level *x* must have a head; that is, it must immediately dominate at least one category of level *x-1*.

Headedness requires, for instance, that a prosodic word (minimally) dominate a foot, and that a foot (minimally) dominate a syllable. However, Headedness differs from

Strict Layering in that it does not require that *every* token of a prosodic category dominated by a higher category belong to the category one level below in the hierarchy. Rather, Headedness is more general, mandating that *at least one* daughter of a prosodic category *x* belong to category *x-1*.

Turning now to the Modern Hebrew pattern observed in trisyllabic forms, there are two possible footings. Either the first syllable forms a degenerate foot, with secondary stress, and the final two syllables form an iambic foot, with primary stress; or else the first two syllables form a trochaic foot, and the final syllable forms a degenerate foot.

(10) Possible footings for trisyllabic words ('[' and ']' indicate left and right foot boundaries respectively.)

a. [σ̀][σσ́]

b. [σ̀σ][σ́]

According to general theoretical considerations regarding metrical structure, the first option is not available as a possible metrical parse. This is due not only to the presence of the degenerate foot in the structure, but also to the location of this degenerate foot. Assuming that this type of form must contain two feet, however such a form is footed, there will always be a degenerate foot in the structure. Degenerate feet, though, are not freely permitted. According to Hayes (1995:87), degenerate feet are restricted in two ways:

(11) Degenerate Feet Prohibition (from Hayes 1995:87)

a. Strong prohibition: degenerate feet are absolutely disallowed.

b. Weak prohibition: degenerate feet are allowed only in strong position.

Since a trisyllabic form in Hebrew must contain one degenerate foot, given the weak prohibition on degenerate feet we may admit only the structure [σ̀σ][σ́], with a degenerate foot in final position bearing primary stress. This satisfies the weak prohibition on degenerate feet.

Modern Hebrew does not constitute the sole case in the world's languages where a degenerate foot receives main stress. A similar situation is found in the Ecuadoran language Auca. The original analysis of stress in Auca is provided in Pike (1964), and has been recast in parametrical theory by Hayes (1995:182-188). In Auca, metrical structure is complicated by the fact that stems and suffixes each comprise a domain for stress, which is assigned from left to right in stems, and right to left in suffixes. These two stress trains, as they have been called, sometimes clash, producing interesting results. These do not concern us here; what we are interested in is that in odd-numbered stems we find the same pattern as we have observed in Modern Hebrew. (In the following Auca data, I do not indicate vowel nasalization. In addition, adjacent vowels in the stem are taken to be heterosyllabic, following Pike (1964:430) and Hayes (1995:184). Suffixes are demarcated with a hyphen.)

(12) Auca stress in odd-numbered stems (from Hayes 1995:183)

	Auca word	*Gloss*
a.	mòikó	'blanket'
b.	kìwenó-ŋa	'where he lives'
c.	àpæné-kadàpa	'he speaks'
d.	yìwæmó-ŋàba	'he carves, he writes'
e.	tìkawòdonó-kàba	'he lights

I have followed Hayes (1995) in marking the strongest stress as the rightmost stress within the stem. The analysis of trisyllabic stems is that they manifest the same kind of footing we proposed for Modern Hebrew trisyllables.

(13) Auca foot structure in trisyllabic stems

[σ̀σ][σ́]

As explicitly pointed out by Hayes, the degenerate foot at the right edge is permitted to surface because although Auca invokes the Prohibition on Degenerate Feet, it only invokes the Weak Prohibition, which allows degenerate feet precisely when they occur in strong, or main-stressed, position. What is surprising about forms like those above is the stress clash observed in cases like (d) and (e). Recall that stress is assigned both at the stem level and again for suffixes, producing two distinct stress trains in Auca. The argument here, according to Hayes, is that in the second level, stress assignment for the suffixes crosses the morpheme boundary to produce stress on the final syllable of the stem. This results in an output foot structure with a degenerate foot in receiving primary stress.

(14) Degenerate foot in strong position, following level 2 stress assignment

[yìwæ][mó]-[ŋàba]

Hayes (1995:133-140) discusses a further case that resembles Modern Hebrew. This is the case of Cahuilla, a language which like Modern Hebrew is a top-down system as far as metrical structure. That is, in procedural terms, word level stress is assigned first, followed by the construction of feet. Degenerate feet are permitted in Cahuilla, but only in strong position, as in Modern Hebrew. An example is the form *súkàʔtì* 'the deer, objective case', which places main stress on a degenerate foot.

These examples show that Modern Hebrew is not alone in placing primary stress on degenerate feet. In fact, doing so obeys Hayes' Weak Prohibition on Degenerate Feet, so such data are expected. How this prohibition is implemented in OT remains a question, though. It is possible to postulate a constraint that restates the Weak Prohibition directly, though this seems stipulative. In the analysis of Modern Hebrew metrical structure that follows, this result is achieved through the gradiently violable constraint ALLFTRIGHT, which demands that every foot be aligned to the right edge of a prosodic word. This constraint has the effect of right-to-left directionality. However, nothing guarantees that cross-linguistically this constraint should play such an important role. Some sort of universal ranking would be required to assure that degenerate feet always bear main stress; one way to accomplish this would be to require a correlation between the EDGEMOST constraint at issue (RIGHTMOST for Modern Hebrew, LEFTMOST for a language like Cahuilla) and the directionality constraint responsible for the footing. For instance, in Modern Hebrew, where RIGHTMOST is responsible for placing main stress on the rightmost foot, this would imply the ranking ALL-FT-R » ALL-FT-L in order to guarantee that the degenerate foot is in a strong position, i.e., receives the main stress. This could be formalized through the following ranking principle:

(15) Degenerate feet allowed in strong position only:

$\text{EDGE}_i\text{MOST} \gg \text{EDGE}_j\text{MOST} \rightarrow \text{ALLFTEDGE}_i \gg \text{ALLFTEDGE}_j$

where $\text{EDGE}_i, \text{EDGE}_j \in$ {Left, Right} and $i \neq j$.

This principle states that if a language places stress at a particular edge, it will also manifest feet aligned to that edge. Exceptions to this generalization abound (e.e., Cairene Arabic, Seminole/Creek), and it remains to be seen if the principle could be effectively modified to account for such cases (see Hayes 1995:71-76 for a relevant discussion of foot inventories). Clearly other constraints could intervene in the ranking, thus obscuring its effects, but this principle could be a first step toward explaining the Weak Prohibition on degenerate feet. Although this implicational statement describes the situation seen in Modern Hebrew and Cahuilla, it remains speculative. The relation between word level stress assignment and subsequent footing remains an important issue for an OT analysis of stress in such languages. The analysis of metrical structure in Modern Hebrew presented below assumes a need for feet, and a need to parse syllables into feet, based on theoretical considerations. It should be mentioned, though, that the default pattern of final main stress, with secondary stress on alternating syllables to the left, could also be achieved through constraints that do not mention feet at all; for instance, the constraints RIGHTMOST, *CLASH, and *LAPSE will produce similar results. For the sake of completeness, however, the following analysis proceeds on the assumption that Modern Hebrew does group syllables into feet, and that main stress may fall on a degenerate foot, following Hayes's Weak Prohibition. The issue of an OT implementation of the Weak Prohibition remains a question for future research.

Further support for the existence of degenerate feet in Modern Hebrew is the fact that such feet may appear as words, showing that whatever minimal word requirement is in effect in Modern Hebrew it is only active for derived forms, as will be discussed at length below. For now, it suffices to show relevant data that involve monosyllabic words. These words are divided up into CV and CVC words, although since Hebrew is quantity-insensitive this distinction should not make a difference. There does appear to be a statistically significant generalization however. Using Ussishkin (1999a) as a guide, out of a total of 42,868 words, Modern Hebrew contains only 35 CV words, while there are 1080 CVC words. Examples of each are given below.

(16) *Some monosyllabic words*

(a) CV words

Monosyllabic word	*Gloss*
bó	'in him'
gé	'proud'
zé	'this'
ló	'no'
lí	'to me'
má	'what'
mí	'who'
rá	'bad'
pé	'mouth'

(b) CVC words

Monosyllabic word	*Gloss*
bád	'cloth'
gúr	'cub'
xám	'hot'
láx	'humid'
lév	'heart'
més	'tax'
míts͡	'juice'
rák	'only'
páz	'gold'

Clearly, Modern Hebrew allows degenerate feet to serve as whole words. The skewing toward a preference for CVC over CV words remains unexplained, though. According to the analysis presented here Modern Hebrew makes no weight distinction, so these two types of syllables should be equally represented. This is not a problem I address in detail here, however. One suggestion is that since earlier forms of Hebrew were quantity-sensitive, CVC words counted as heavy and therefore were allowed, while CV words were not, given their monomoraic status.

At this point, I turn to the analysis of Modern Hebrew metrical structure, beginning with the appropriate constraints responsible for the default metrical structure, where we observe final stress, and alternating secondary stress on words of three or more syllables.

3.3.3 The constraints

Moving on to construct our analysis, we need to account for the following generalizations on metrical structure: a degenerate foot is constructed in final position, and as many feet as possible are built from the available material. This is analogous to a top-down parsing of feet from right to left. Work by Crowhurst & Hewitt (1995) has demonstrated that capturing such generalizations on directionality and iterativity of footing is accomplished by the interaction of three constraints:

(17) ALL-FT-R/L (Prince & Smolensky 1991, 1993, McCarthy & Prince 1993b)

The right (or left) edge of every foot is aligned with the right (or left) edge of the prosodic word.

(18) FTBRANCH

A foot must branch.[3]

(19) PARSE-σ

Every syllable is parsed by a foot.

In Modern Hebrew, trisyllabic forms are parsed as [σ̀σ][σ́] through the following ranking:

(20) Ranking for default metrical structure

PARSE-σ
2
ALL-FT-R FTBRANCH

This is illustrated in the following tableau:

(21) Trisyllabic words

/σσσ/	PARSE-σ	ALL-FT-R	FTBRANCH
a. [σ̀][σσ́]		σσ!	*
b. σ[σσ́]	*!		
☞ c. [σ̀σ][σ́]		σ	*

An important question here concerns the status and ranking of the constraint RIGHTMOST, which is not indicated in the previous tableau. To determine its relative ranking in the hierarchy established so far, we must consider a longer form. We will

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[3] This constraint is used in lieu of FTBIN, and penalizes degenerate feet. Since Modern Hebrew has no evidence for moras, this constraint requires a foot to branch at the syllable level.

consider a form with four syllables, *mevùgarím* 'adults'. A noun is chosen to exemplify this section of the analysis because quadrisyllabic verbs exhibit an exceptional stress pattern (whose analysis is discussed below, in the section on penultimate stress). In the case at hand, secondary stress is on the second syllable, while primary stress still falls on the final syllable. Such forms make clear the rhythmic nature of secondary stress in Modern Hebrew, and provides evidence for an additional constraint:

(22) *LAPSE (following Kager 1993)

Adjacent stressless syllables are prohibited.

The following tableau illustrates the analysis:

(23) Quadrisyllabic forms

/mevugar-im/	PARSE-σ	RIGHTMOST	*LAPSE
a. [mèvu][garím]			*!
b. mevu[garím]	σ!σ		**
c. [mèvu][gárim]		*!	
☞ d. [mevù][garím]			

RIGHTMOST is clearly high-ranking, as is *LAPSE, though for now we have no evidence regarding the relative ranking of these three constraints. This is essentially a word-based stress system, with right-edge main stress and alternating secondary stress to the left of the main stress.

3.3.4 Assessment

Let us now assess the analysis as established so far. One striking aspect of the account is that no appeal to foot prominence is made. That is, we have said nothing about the form of the metrical feet in Modern Hebrew stress: whether they are iambic or trochaic has not been directly stipulated via any constraint. Modern Hebrew is a quantity-insensitive language (Bat-El 1989, 1994a, Graf 1999): there are no long vowels, and the default stress is final regardless of whether syllables end in a consonant or a vowel. With respect to these facts, our analysis is positive for several reasons. First, we have seen evidence that both iambic and trochaic feet exist in Modern Hebrew:

(24) Foot typology in Modern Hebrew (relevant feet are bolded)

	Trochees	*Iambs*
a.	**[mèda]**[brím]	**[dibér]**
b.	**[mèda]**[brót]	**[dibrá]**
c.	**[mèvu]**[gár]	**[mevù][garím]**
d.	**[hùxte]**[vú]	**[katáv]**
e.	**[hìtka]**[táv]tem	**[katáv]**ti

In particular, note that no constraint is necessary to stipulate syllabic (quantity-insensitive) iambs, as seen in the analysis of quadrisyllabic forms above. This consequence is in harmony with important theoretical considerations banning such feet, because they are cross-linguistically rare or unattested. Although Modern Hebrew appears to make use of such feet in its metrical structure, their appearance is emergent, in the following sense: they are generated via a constraint ranking that does not include any demand specifically calling for their shape. There is, therefore, no need to specify them in the grammar, which would elevate them to a universal foot type; rather, they are a foot type generated through the interaction of conflicting constraints on surface forms.

In addition, the fact that this analysis does not specify any foot type at all is in line with larger current theoretical considerations having to do with prosodic structure. As discussed previously, much recent work in prosodic morphology has successfully eliminated templatic effects as derived through templatic constraints, instead deriving their effects from constraints that the theory requires independently. The result seen in this analysis of Modern Hebrew stress could be viewed in the same light, contributing to a general theory in which no specific foot structure is specified when the results may be achieved through simpler prosodic constraints that are needed in any case. Specifically, no "Foot Type" constraints are called upon in this analysis, which could be seen as an advantage since the analysis is simpler without such constraints. The analysis is composed of constraints that are already motivated in the theory, and accomplishes its goal of explaining the stress pattern in Modern Hebrew verbs, without resort to constraints on foot headedness. Given the additional fact that both foot types are attested in Modern Hebrew, it makes sense not to include such constraints in the analysis. It is, in a way, unsurprising that such constraints play no role, given both the quantity-insensitivity and the word-level alternating nature of the stress pattern in Modern Hebrew.

3.3.5 Penultimate stress and stem-word alignment

So far, all the cases of Modern Hebrew stress we have analyzed involve primary stress in final position. Final primary stress does not occur unexceptionally in Modern Hebrew; in fact, penultimate stress is observed in many cases. Examples include some nouns, as well as verbs that fall into particular affixational classes.

(25) Penultimate stress

	Form	*Gloss*
a.	katávten	‘write, 2.pl.fem.pres.
b.	hìtkatávtem	‘correspond, 2.pl.masc.past’
c.	gadálti	‘grow, 1.sg.past’
d.	dibárta	‘speak, 2.sg.masc.past’

The principal claim here is that these deviations from the default stress pattern (final primary stress) are the result of a demand on prosody to reflect morphological constituency and structure; in particular, a desire to reflect the morphological entity *stem*. For the case of verbs, both prefixes and suffixes are relevant for stress assignment. We can break down these affixes into different affixational categories, depending on their segmental make-up (where C = consonant and V = vowel):

(26) Prefixal/suffixal typology (relevant affixes are in italics)

Prefixes		*Suffixes*	
(i) C-final	(ii) V-final	(iii) C-initial	(iv) V-initial
*hì**t***-raxéts͡	***ni***-xtáv	dibár-***ti***	dibr-***á***

The crucial observation is that primary stress tends to fall on the rightmost syllable of the stem. This is always the case when the stem abuts a consonant; that is, in cases (i) and (iii) above. In the cases where the stem contacts a vowel ((ii) and (iv) above) there is a correlation between vowel deletion and the location of stress: stress falls on the rightmost syllable of the word in these cases.

The analysis begins by examining cases of verbs with C-initial suffixes, as in (iii) above. The ranking so far predicts the wrong result, because the constraint hierarchy will decide on a form that has final stress. This is indicated in the following tableau, where the actual output is signaled by a forward-pointing hand, while the candidate chosen by the ranking is signaled by a backward-pointing hand. In the following tableaux, the edges of the prosodic word (PrWd) are marked with parentheses in the cases where such marking is crucial. Otherwise, the PrWd to encompasses the whole form.

(27) *dibárti* 'I-spoke'

	dibar-ti	Parse-σ	Rightmost	All-Ft-R
	a. di[bárti]	*!	*	
☞	b. [dibár]ti	*!	*	σ
	c. [dì][bartí]			σσ!
☜	d. [dìbar][tí]			σ

When a consonant-initial suffix or a consonant-final prefix is attached to a verb, there is no syllabification across the stem-affix boundary; that is, the stem boundary coincides with the prosodic boundary at the level of the syllable, and in the case of consonant-initial suffixes as high as the foot. In such cases, main stress is assigned to the rightmost syllable of the *stem*. The placement of stress within the morphological category *stem* will allow us to account in a uniform manner for the difference in the distribution of stress on the surface in forms such as *hit-raxéts͡* vs. *dibár-ti*.

The correlation of prosodic headedness with the stem is formulated in the grammar as a constraint demanding alignment of the stem with some prosodic category. This alignment constraint must be higher-ranking than the default metrical constraint hierarchy, so that it can override the demand of aligning feet to the right edge in cases such as *dibárti*, which induce penultimate stress, rather than the default of final stress. We must also avoid parsing the suffix as a degenerate foot, in contrast to the metrical structure of trisyllabic forms with no suffix, since this would lead to its being stressed as well.

(28) ALIGN-WD (adapted from Cohn & McCarthy 1994:33 and Selkirk 1995a)

The right edge of every verbal stem coincides with the right edge of some prosodic word.

The constraint ALIGN-WD, following a suggestion of Cohn & McCarthy (1994), causes the verbal suffixes to be analyzed as extra-prosodic. This way, stress remains final within the prosodic word, though it is penultimate on the surface, because C-initial suffixes are not part of the prosodic word. However, affixes do not need to be explicitly specified as extra-prosodic; this fact will fall out of the constraint hierarchy. In other words, *purely prosodic principles* determine extra-prosodic status.

The force of this constraint generates some of the effects of top-down footing, since it compels the right edge of the stem to be as close to the right edge of the word as possible. The next tableau demonstrates the generation of penultimate stress with ALIGN-WD high-ranking.

(29) Penultimate Stress

dibar-ti	ALIGN-WD	PARSE-σ	ALL-FT-R
a. di[bárti]	*!	*	
b. ([dì][bartí])	*!		σσ
c. ([dìbar][tí])	*!		σ
☞ d. ([dibár])ti		*	σ

This ranking is summarized in the following diagram:

(30) Ranking summary

ALIGN-WD
|
PARSE-σ
|
ALL-FT-R

A potential problem is a candidate in which the suffix *-ti* builds its own PrWd, such as *(([*dibar*])$_{PdWd}$([*tí*])$_{PrWd}$)$_{PrWd}$. This form merits some discussion. First of all, such a candidate involves a recursive PrWd, which dominates two subordinate PrWd's. This could be ruled out using the Headedness principle of prosodic phonology, since the uppermost PrWd in this case has no prosodic head (i.e. no head foot). Recursive structures such as this violate the constraint NONRECURSIVITY as proposed by Truckenbrodt (1995), which could be high-ranking in Hebrew. Additionally, in the suffix *–ti* constitutes its own prosodic word, it would violate the constraint PRWD ⊃ ROOT (McCarthy & Prince 1993:86; cf. Selkirk 1984a, Kaisse 1985, Nespor

& Vogel 1986). This constraint demands that every prosodic word contain a root (or stem). Another way in which this form can be ruled out is to appeal to the word minimality requirement in Hebrew. Modern Hebrew does allow monosyllabic words, but not when they are derived from other words. Here, the suffix *–ti*, when it is prosodified as its own PrWd, violates the minimality requirement, which requires a bisyllabic minimum. This requirement will be further motivated and elaborated below and in the following chapter.

The optimal output of this form, *dibárti*, does not attach *–ti* at the level of the prosodic word; instead, such consonant-initial suffixes are attached at the next higher level, that of the clitic group (Nespor & Vogel 1986) or the phonological phrase (Selkirk 1984a).

Aside from cases of extraprosodified suffixes, it is also important to examine trisyllabic words that contain secondary stress. Such forms are exemplified by verbs in the hitpaʕel binyan, such as *hìtraxéts͡* 'he washed'. The following tableau illustrates the analysis:

(31) Trisyllabic verb

hitraxets͡	ALIGN-WD	PARSE-σ	ALL-FT-R
a. (hit[raxéts͡])		*!	
b. ([hìt][raxéts͡])			σσ!
☞ c. ([hìtra][xéts͡])			σ

ALIGN-WD is satisfied in such forms, since there is no suffix at the right edge to compete with the stem for the PrWd boundary.

Next, consider cases involving a verbal stem either preceded by a vowel-final prefix (e.g., *hi-*), or followed by a vowel-initial suffix (e.g., *-a*). In such cases, final stress is attested. These forms involve syllabification across the stem-affix boundary (e.g., *.hi-g.díl.*, *.dib.r-á.*). For the case of vowel-initial suffixes, in optimality-theoretic terms, this observation indicates that ALIGN-WD is dominated by the structural markedness constraint ONSET:

(32) ONSET (Ito 1989)

$*[_{\sigma}V$

ALIGN-WD becomes irrelevant for these cases, since there is no way to satisfy it under the assumption that every syllable must have an onset. The following tableau illustrates the analysis:

(33) Verb+vowel-initial suffix (*diber-a* 'she spoke')

diber-a	ONSET	ALIGN-WD	PARSE-σ	ALL-FT-R	MAX-OO
a. ([dibér])a	*!		*	σ	
b. ([diber][á])	*!	*		σ	
c. ([dì][berá])		*		σ!σ	
d. di[berá]		*	*!		
e. ([dìbe][rá])		*		σ!	
☞ f. ([dibrá])		*			*

Given undominated ONSET, the vowel-initial suffix must syllabify as part of the same syllable whose onset contains stem material (in this case, the stem-final consonant *r*). Given this demand, ALIGN-WD will never be satisfied in cases involving V-initial suffixes and the selection of the optimal candidate is passed down to lower-ranking constraints. This indicates that ALL-FT-R must dominate a faithfulness constraint demanding that each vowel of the base have a correspondent in its related form. This dominated constraint is MAX-OO. So far the ranking schema is as follows:

(34) Modified ranking schema

ONSET RIGHTMOST *LAPSE
|
ALIGN-WD
|
PARSE-σ
3
ALL-FT-R FTBRANCH
|
MAX-OO

Turning now to cases of vowel-final prefixes, such as *ni-xtáv*, the analysis proceeds along similar lines. These forms are derived by prefixing *ni-* to the verbal stem, in this case *katáv*. As in the case of vowel-initial suffixes (*dibrá*), these forms induce vowel deletion. The analysis is essentially the same for *nixtáv* as for *dibrá*.

(35) Verb+vowel-final prefix (*ni-katáv* → *nixtáv* 'she spoke')[4]

ni-katáv	ALIGN-WD	PARSE-σ	ALL-FT-R	MAX-OO
a. ([niká])tav	*!	*	σ	
b. ([nìka][táv])			σ!	
c. ([nì][katáv])			σ!σ	
d. ni[katáv]		*!		
☞ e. ([nixtáv])				*

Looking more closely at the cases of *dibrá* and *nixtáv*, the decision in favor of the candidate demonstrating vowel deletion (*diber-a* → *dibrá*; *ni-katav* → *nixtáv*) is an example of templatic, or fixed prosodic, effects: a disyllabic form, perfectly aligned with the edges of both foot and prosodic word, is created at the cost of deleting stem material.

This vowel deletion has been offered previous treatment (e.g., Bat-El 1989) but not within an OT framework. Rather than treat vowel deletion as the effect of a syncope rule, I propose here to treat the phenomenon as a result of fixed prosody. In fact, this case provides our first example of the force of fixed prosodic effects in Hebrew, which will be fully examined and motivated in the next chapter. Here I sketch the beginning of the account.

In the case discussed above (*dibrá* from *dibér-a*), the motivation behind vowel deletion, under a fixed prosody approach, is to make the result of affixing the inflectional suffix fit into a bisyllabic 'window.' Although this is achieved in the previous set of tableaux using the constraint ALL-FT-R, the intent here is to show that

[4] The process of spirantization, which derives *x* from *k* in *nixtáv*, is not addressed here. Historically, this process has become less and less transparent, and most dialects of Modern Hebrew contain principled variation in spirantization. For a recent account based on Output-Output correspondence, including an analysis of the variation, see Adam (1996).

a different constraint is actually responsible for these effects. That is, there is an active constraint in Modern Hebrew which demands that to the extent possible, all verbs should be no longer than two syllables. The nature of this constraint will be fully elucidated in the following chapter; for now, it suffices to note that this is a constraint on *maximal word size*, called σ-ALIGN. This constraint represents a particular type of Hierarchical Alignment constraint, as discussed in the previous chapter. This constraint is high-ranking in Hebrew; in particular, it must be ranked above MAX-OO in order to force vowel deletion when the input contains more material than will fit into two syllables. The following tableau includes many of the same candidates as in the previous tableau for this form (though much of the prosodic structure is omitted, for the sake of clarity), and shows that any form longer than two syllables is automatically ruled out:

(36) Verb+vowel-initial suffix (*dibér-a* → *dibrá* 'speak, 3.sg.fem.past')

diber-a	σ-ALIGN	MAX-OO
a. ([dì][berá])	*!	
b. (di[berá])	*!	
c. ([dìbe][rá])	*!	
☞ d. ([dibrá])		e

In the following chapter, we will further examine the interaction between demands on prosodic and morphological structure. This will include a comprehensive analysis of fixed prosody in the Modern Hebrew verbal system. Recall that a principle goal of this dissertation is to eliminate templatic constraints from the theory, in an effort to reduce the theoretical machinery necessary to capture templatic effects. The constraint σ-ALIGN represents an effort to implement well-motivated non-templatic constraints to explain word size restrictions. This is the goal of the fixed prosodic analysis of the Modern Hebrew verbal system that is undertaken in the next chapter.

3.4 Appendix: The Modern Hebrew binyanim

This appendix provides examples of verbs in each binyan. Stress, both primary and secondary, is indicated in all the examples. Prefixes and suffixes are separated by hyphens from the edges of the stem.

(1) paʕal: katav 'to write'

PAST	Singular	Plural	FUTURE	Singular	Plural
1.	katáv-ti	katáv-nu	1.	ʔe-xtóv	ni-xtóv
2.masc.	katáv-ta	katáv-tem	2.masc.	ti-xtóv	tì-xtev-ú
2.fem.	katáv-t	katáv-ten	2.fem.	tì-xtev-í	tì-xtev-ú
3.masc.	katáv	katv-ú	3.masc.	yi-xtóv	yì-xtev-ú
3.fem.	katv-á	katv-ú	3.fem.	ti-xtóv	yì-xtev-ú

PRESENT	Singular	Plural
masc.	kotév	kotv-ím
fem.	kotév-et	kotv-ót

(2) nifʕal: nixtav 'to be written'

PAST	Singular	Plural	FUTURE	Singular	Plural
1.	ni-xtáv-ti	ni-xtáv-nu	1.	ʔè-katév	nì-katév
2.masc.	ni-xtáv-ta	ni-xtáv-tem	2.masc.	tì-katév	tì-katv-ú
2.fem.	ni-xtáv-t	ni-xtáv-ten	2.fem.	tì-katv-í	tì-katv-ú
3.masc.	ni-xtáv	nì-xtev-ú	3.masc.	yì-katév	yì-katv-ú
3.fem.	nì-xtev-á	nì-xtev-ú	3.fem.	tì-katév	yì-katv-ú

PRESENT	Singular	Plural
masc.	ni-xtáv	nì-xtav-ím
fem.	nì-xtev-á	nì-xtav-ót

(3) piʕel: gidel ‘to raise’

PAST	Singular	Plural	FUTURE	Singular	Plural
1.	gidál-ti	gidál-nu	1.	ʔà-gadél	nè-gadél
2.masc.	gidál-ta	gidál-tem	2.masc.	tè-gadél	tè-gadl-ú
2.fem.	gidál-t	gidál-ten	2.fem.	tè-gadl-í	tè-gadl-ú
3.masc.	gidél	gidl-ú	3.masc.	yè-gadél	yè-gadl-ú
3.fem.	gidl-á	gidl-ú	3.fem.	tè-gadél	yè-gadl-ú

PRESENT	Singular	Plural
masc.	mè-gadél	mè-gadl-ím
fem.	mè-gadél-et	mè-gadl-ót

(4) puʕal: gudal ‘to be raised’

PAST	Singular	Plural	FUTURE	Singular	Plural
1.	gudál-ti	gudál-nu	1.	ʔà-gudál	nè-gudál
2.masc.	gudál-ta	gudál-tem	2.masc.	tè-gudál	tè-gudl-ú
2.fem.	gudál-t	gudál-ten	2.fem.	tè-gudl-í	tè-gudl-ú
3.masc.	gudál	gudl-ú	3.masc.	yè-gudál	yè-gudl-ú
3.fem.	gudl-á	gudl-ú	3.fem.	tè-gudál	yè-gudl-ú

PRESENT	Singular	Plural
masc.	mè-gudál	mè-gudl-ím
fem.	mè-gudél-et	mè-gudl-ót

(5) hifʕil: hixtiv ‘to dictate’

PAST	Singular	Plural	FUTURE	Singular	Plural
1.	hi-xtáv-ti	hi-xtáv-nu	1.	ʔa-xtív	na-xtív
2.masc.	hi-xtáv-ta	hi-xtáv-tem	2.masc.	ta-xtív	ta-xtív-u
2.fem.	hi-xtáv-t	hi-xtáv-ten	2.fem.	ta-xtív-i	ta-xtív-u
3.masc.	hi-xtív	hi-xtív-u	3.masc.	ya-xtív	ya-xtív-u
3.fem.	hi-xtív-a	hi-xtív-u	3.fem.	ta-xtív	ya-xtív-u

PRESENT	Singular	Plural
masc.	ma-xtív	mà-xtiv-ím
fem.	mà-xtiv-á	mà-xtiv-ót

(6) hufʕal: huxtav 'to be dictated'

PAST	Singular	Plural	FUTURE	Singular	Plural
1.	hu-xtáv-ti	hu-xtáv-nu	1.	ʔu-xtáv	nu-xtáv
2.masc.	hu-xtáv-ta	hu-xtáv-tem	2.masc.	tu-xtáv	tù-xtev-ú
2.fem.	hu-xtáv-t	hu-xtáv-ten	2.fem.	tù-xtev-í	tù-xtev-ú
3.masc.	hu-xtáv	hù-xtev-ú	3.masc.	yu-xtáv	yù-xtev-ú
3.fem.	hù-xtev-á	hù-xtev-ú	3.fem.	tu-xtáv	yù-xtev-ú

PRESENT	Singular	Plural
masc.	mu-xtáv	mù-xtav-ím
fem.	mù-xtav-á	mù-xtav-ót

(7) hitpaʕel: hitkatev 'to correspond'

PAST	Singular	Plural	FUTURE	Singular	Plural
1.	hìt-katáv-ti	hìt-katáv-nu	1.	ʔìt-katév	nìt-katév
2.masc.	hìt-katáv-ta	hìt-katáv-tem	2.masc.	tìt-katév	tìt-katv-ú
2.fem.	hìt-katáv-t	hìt-katáv-ten	2.fem.	tìt-katv-í	tìt-katv-ú
3.masc.	hìt-katév	hìt-katv-ú	3.masc.	yìt-katév	yìt-katv-ú
3.fem.	hìt-katv-á	hìt-katv-ú	3.fem.	tìt-katév	yìt-katv-ú

PRESENT	Singular	Plural
masc.	mìt-katév	mìt-katv-ím
fem.	mìt-katév-et	mìt-katv-ót

Chapter 4:
Fixed prosody in Modern Hebrew

4.0 Introduction

This chapter serves as both an introduction to the concept of fixed prosody as well as a detailed analysis of the concept using the language Modern Hebrew as a case study. This chapter is organized as follows. In the first section, I briefly review the morphemic-tier segregation model of Semitic morphology as proposed by McCarthy (1979) and the later prosodic morphology model of McCarthy & Prince (1986). The remainder of the chapter is devoted to a fixed prosodic account of templatic morphology in the Modern Hebrew verbal system. I begin by discussing the structure of the verbal system and motivating a critical distinction between verbs in the paʕal binyan versus all other binyanim. The analysis rests on the fact that this particular binyan is taken to be the input for the formation of verbs in other binyanim. Subsequently, the fixed prosodic analysis is given in detail. This involves a description of the minimality requirements and maximality conditions evident in the verbal system, and a formal explanation for these effects, which is achieved through the type of constraints discussed at length in the previous chapter.

This account differs from previous approaches to templatic effects in Semitic in two important ways. First, it makes no appeal to template-specific constraints. Nor does it rely on the consonantal root as input to any morphological or phonological process in Modern Hebrew.

4.1 Empirical background and focus

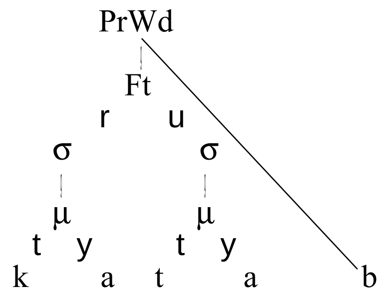
Since the ground-breaking work on Semitic morphology and phonology of McCarthy (1979, 1981), languages of the Semitic branch of the Afro-Asiatic language family have served as a classic example of templatic morphology. In his original work on these languages, McCarthy (1979, 1981) extended the representations provided by Autosegmental Phonology (Goldsmith 1976) to describe the patterning of morphemes in languages like Arabic. Three types of morpheme compose a word under this view: the vocalic melody, the consonantal root, and the CV template. To briefly illustrate an oft-used example, the representation of the word *katab* 'he wrote' appears as follows:

(1) Morphemic tier representation

(a)	the consonantal root	k		t		b
		¦		¦		¦
(b)	the prosodic template	C	V	C	V	C
			u		r	
(c)	the vocalic melody			a		

Further developments in template theory arose in the work of McCarthy & Prince (1986), known as Prosodic Morphology. The basic principle underlying this approach is that templates are defined in terms of authentic prosodic units. Therefore, rather than defining the Arabic verbal template for *katab* as CVCVC, it is defined as a trochaic foot, which is independently known to occur in the language. This prosodic structure is illustrated below:

(2)



The superiority of this approach over the earlier approach is that templates are no longer viewed as extra-theoretical structures that the language happens to make use of; rather, their existence is driven by the fact that their prosodic make-up is independently necessary. In this view, templatic effects are linked to prosodic and metrical structure whose existence is independently borne out.

Within the framework of OT, the overwhelming majority of work concerning templatic effects centers on reduplicative phenomena. Much less work, however, has been done in the domain of languages in which the majority of the words, as opposed to simply those in the reduplicative domain, exhibit templatic effects. It is the templatic effects or what I term here *fixed prosody* in these languages which I turn to in this section. The primary empirical focus of this study continues to be the verbal system of Modern Hebrew, which is characterized by templatic effects typical of nonconcatenative morphology. In the following section I present a description of these effects in Modern Hebrew.

4.2 The binyanim

The Modern Hebrew verbal system contains seven classes or *binyanim*. The basic proposal here is that one binyan serves as the base of affixation for the others,[1] and that prosodic constraints govern this relation. I claim that the basic binyan is the *paʕal* binyan. If the paʕal form indeed serves as the base of affixation in an output-output correspondence relation (Benua 1995, 1997) for deriving the other binyanim, what can we say about the lexical status of the paʕal form itself? Interestingly, the paʕal form has been claimed to be the unmarked, basic pattern by Horvath (1981:231), who maintains that the other binyanim can be semantically and/or syntactically characterized, while the paʕal form cannot be, as seen in the following table (adapted from Horvath 1981:231).

[1] An important paper that makes a similar (pre-OT) proposal is McCarthy's (1993) work on Arabic and Akkadian. That account, however, still relies on the consonantal root as a morpheme used to derive Binyan I (=paʕal), and therefore crucially differs from the account presented here. Other work arguing for the importance of prosodic considerations in Modern Hebrew include Bat-El (1994a), Inkelas (1990), Sharvit (1994) and Ussishkin (1999bc).

(3) The verbal system of Modern Hebrew

Binyan[2]	*Function*	*Examples*	*Gloss*
paʕal	• unmarked, basic pattern	gadal paxad katav badak ʔaxal	'he grew' 'he feared' 'he wrote' 'he checked' 'he ate'
nifʕal	• passive of paʕal • ingressive (change of state) from paʕal • Intransitive form of a transitive hifʕil form	nirdam nifrad nivdak nixtav	'he fell asleep' 'he separated (intrans.)' 'he was checked' 'it was written'
piʕel	• A typically transitive basic pattern • Intensified form of paʕal	gidel ʔikel diber kibel	'he raised 'he consumed' 'he spoke' 'he received'
puʕal	• passive of piʕel	gudal dubar	'he was raised' 'it was spoken'
hitpaʕel	• middle voice reflex of transitives in piʕel • reflexive • reciprocal • repetitive action	hitkabel hitraxe͡ts hitnaʃek hitnadned hitkatev	'he was received' 'he washed (himself) 'he kissed (recip.) 'it oscillated' 'he corresponded'
hifʕil	• causative of paʕal • transitive reflex of nifʕal	higdil hifrid hixtiv hifxid	'he enlarged' 'he separated (trans.)' 'he dictated' 'he frightened (trans.)'
hufʕal	• passive of hifʕil	hugdal hufxad huxtav	'he was enlarged' 'he was frightened' 'it was dictated'

Under this classification, we have two patterns which are candidates for lexical entries (or bases of affixation): the paʕal and the piʕel binyanim, both of which may be "basic patterns", according to Horvath's classification. Interestingly, in favor of the paʕal being lexically listed, it is important to note that it is the only

[2] The system of binyan names stems from the practice of associating (in traditional parlance) the consonantal root *p, ʕ, l* (to which the meaning 'to act' is attributed) with the appropriate vocalic melody and template.

binyan containing monosyllabic forms, although the majority of forms in this binyan are bisyllabic. Monosyllabic forms are observed in data such as the following:

(4) Some monosyllabic paʕal verbs

Monosyllabic paʕal	*Gloss*
kám	'he got up'
rát͡s	'he ran'
sám	'he put'
bá	'he came'
ʔát͡s	'he hurried
záz	'he moved'
lán	'he lodged'
dán	'he judged'
gár	'he lived'
xás	'he pitied'

I take such forms as evidence that verbs in the paʕal binyan are lexically specified, and therefore subject to Input-Output faithfulness constraints.[3] However, since paʕal forms serve as the base of affixation in forming other binyanim, these other binyanim are subject not to IO-faithfulness, but rather to Output-Output-faithfulness (Benua 1995, 1997). The emergent generalization, to be fleshed out in greater detail below, is that such affixation exhibits typical Emergence of the Unmarked (TETU) effects.

[3] Junko Ito (p.c.) has pointed out that the exceptionless occurrence of the vowel *a* in these forms weakens the argument for lexically specifying these forms. However, although the *a* here appears to be some sort of default, it is clearly not the phonological default. Modern Hebrew utilizes the vowel *e* as its epenthetic vowel. These facts suggest that *a* may in fact be a different sort of default segment: a morphological default. This accords with earlier conclusions reached by Bat-El (1994c).

4.3 Fixed prosodic effects: The analysis

In this section I provide an analysis of the Hebrew verbal system. The analysis involves two central theoretical claims: (i) that there are no specifically templatic constraints at work and (ii) that there is no need to refer to the consonantal root. I now turn to the fixed prosody, a term I introduce to describe the templatic effects so prevalent in the verbal system of Hebrew and “nonconcatenative” languages in general.

4.3.1 Bisyllabicity as a fixed prosodic effect

The data illustrating the Hebrew verbal paradigm, as well as the data on stress in the previous chapter, show that in general, verbs in Modern Hebrew are bisyllabic. In fact, this is true for every binyan except monosyllabic paʕal forms and the trisyllabic hitpaʕel binyan. This bisyllabicity is the focus of this chapter, and an account is developed in this section.

The account is driven by several assumptions regarding Modern Hebrew prosodic morphology. The first of these is that there is no consonantal root. Rather than being derived from a consonantal root, words are derived from other words. This approach has been shown to be the only possible analysis of denominal verb formation in the language (cf. Bat-El 1994a, Ussishkin 1999b, 1999c; cf. the following chapter), where referring only to the consonantal root as opposed to an actual output obscures crucial information which turns out to be required for determining the pattern particular verbs will conform to. The analysis of denominal verb formation, and the analysis of relations between binyanim to be presented here, rely on the concept of melodic overwriting (Steriade 1988, McCarthy & Prince 1990), whereby an affixal melody, rather than simply concatenating with a base of affixation, actually overwrites a portion of the phonological material in the base. This approach, I claim, is especially appropriate to an analysis of Semitic morphology, where in related forms the vowels may be the only material that differs. Note that this does not imply the existence of the consonantal root *qua* morpheme; under this view the consonants happen to be consistent from one related form to another only because they are the residue remaining after melodic overwriting. This is illustrated in the following verbal paradigm, which contains related verbs in different binyanim.

(5) Paradigm for *gadal*

Binyan	*Hebrew verb*	*Gloss*
paʕal	gadal	‘he grew’ (intransitive)
piʕel	gidel	‘he raised’
puʕal	gudal	‘he was raised’
hifʕil	higdil	‘he enlarged’
hufʕal	hugdal	‘he was enlarged’

An important question relating to the above discussion concerning templatic effects is how to enforce the bisyllabic limit on verbal stems in Hebrew. This is accomplished through the interaction of prosodic constraints with faithfulness constraints, as will be analyzed in depth below. Before presenting the analysis of Hebrew fixed prosody, I will assess the crucial properties of Hebrew prosodic structure and develop a system of constraints that explains the maximal and minimal size requirements imposed on Hebrew words.

We will begin with the paʕal binyan, in which monosyllabic and bisyllabic forms are permitted but never forms that are greater than two syllables. In fact, this generalization holds across the majority of verbal forms in Hebrew, as we have already observed. The existence of monosyllabic forms in this binyan, however, is anomalous, since monosyllabic forms exist in no other binyan. The explanation for this fact is that these forms are actually lexically listed. As such, they are subject to faithfulness constraints on the input-output mapping (FAITH-IO), which outrank constraints responsible for minimal word size effects, so that monosyllabic forms listed in the lexicon surface faithfully.

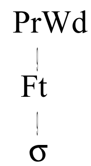
(6) Ranking responsible for preservation of monosyllabic paʕal forms

FAITH-IO
|
'Minimality'

A problem with this view is that if FAITH-IO is so high-ranking, then paʕal forms of *any* underlying length should surface faithfully, under the assumption that Richness of the Base (ROTB; Prince & Smolensky 1993) holds, whereby any form may serve as a potential input. That is, a five syllable paʕal form, for instance, should surface completely faithfully. Let us examine this situation in more detail. The following prosodic structures are permitted in paʕal stems:

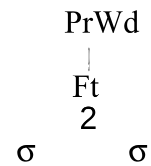
(7) Licit paʕal structures

(a) Monosyllabic forms



e.g., *kám* ‘he got up’

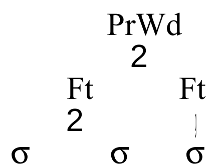
(b) Bisyllabic forms



e.g., *gadál* ‘he grew, intrans.’

But in the paʕal, stems like the following are disallowed:

(8) Illicit paʕal structure: three syllables or more, or two or more feet



e.g., **gadalam*

Given these observations, there must be some constraint that outranks even FAITH-IO: some markedness constraint that restricts verbal stems to a maximum of two syllables. Following a lead set by Ito (1990) and Ito & Mester (1992), I propose constraints on word size, implemented through two types of conditions: a maximality condition and minimality condition, detailed in the previous chapter. To begin, I discuss the constraint on word maxima. This is an alignment constraint, referring strictly to prosodic categories. This constraint is an extension of Ito, Kitagawa & Mester’s (1996) Hierarchical Alignment, as mentioned in the previous chapter, and whose definition is repeated here:

(9) Hierarchical Alignment (Ito, Kitagawa, & Mester 1996:242)

$\forall$PCat1 $\exists$PCat2 [PCat2 $\supset$ PCat1 & ALIGN (PCat1, PCat2)],

where PCat stands for a prosodic category.

(≡Every prosodic constituent is aligned with some prosodic constituent containing it.)

I propose to extend the notion of Hierarchical Alignment such that it applies at non-adjacent levels of prosodic structure. Originally, Hierarchical Alignment as proposed by Ito, Kitagawa, & Mester (1996) refers to the alignment between the categories foot (Ft) and prosodic word (PrWd):

(10) FOOTALIGNMENT (FT-ALIGN)

$\forall$Ft $\exists$PrWd [PrWd $\supset$ Ft & ALIGN (Ft, PrWd)],

(≡Every foot must be aligned to the edge of some prosodic word containing it.)

Expanding on Hierarchical Alignment, I posit the following constraint, demanding Hierarchical Alignment between the categories syllable and PrWd.

(11) SYLLABLEALIGNMENT (σ-ALIGN)

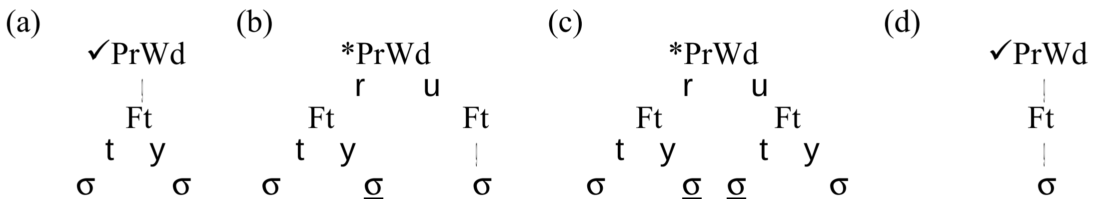
$\forall\sigma$ $\exists$PrWd [PrWd $\supset$ σ & ALIGN (σ, PrWd)]

(≡Every syllable must be aligned to the edge of some prosodic word containing it.)

Given alignment theory, we expect the existence of such constraints on non-adjacent levels of prosodic structure. A similar formulation of alignment between non-adjacent levels of prosodic structure can account for directional syllabification, as proposed by Mester & Padgett (1994).

The effect of the constraint σ-ALIGN is to limit words to two syllables in size. This is because the constraint demands that within a prosodic word, every syllable has at least one edge that coincides with an edge of the prosodic word. To illustrate, the following diagrams exemplify structures that satisfy and violate σ-ALIGN.

(12) σ-ALIGN (offending syllables are underlined)



As shown here, (a) and (d) both satisfy σ-ALIGN, since every syllable has an edge that is aligned to the same edge of a dominating prosodic word. (b) and (c) violate σ-ALIGN, given that they contain syllables lacking any edge that is aligned to a prosodic word-edge. This constraint must outrank FAITH-IO, explaining the fact that in Modern Hebrew no paʕal forms exist that exhibit supramaximal size (i.e. no paʕal forms are greater than two syllables in length).

(13) Ranking responsible for lack of paʕal forms greater than two syllables

σ-ALIGN
|
FAITH-IO

The following tableau illustrates this ranking, showing that an input paʕal form of more than two syllables will surface as bisyllabic.

(14) >2 syllables reduced to 2 syllables

/gadalam/	σ-ALIGN	FAITH-IO
a. gadalam	*!	
☞ b. gadal		**

Recall, however, that paʕal forms may be subminimal: that is, they may be monosyllabic. They violate a minimality constraint, discussed as well in the previous chapter, which states that prosodic categories must branch.

(15) PR(OSODIC)BRANCH(ING)

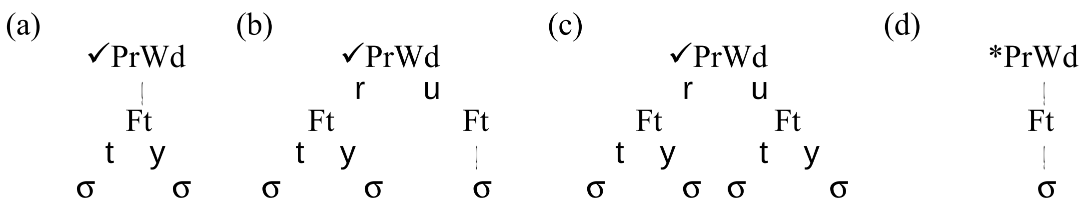
A prosodic category *i* must branch at level *i* or *i-1*,

where "branch" is defined as follows:

A prosodic category branches if and only if it contains more than one daughter.

The effect of PRBRANCH is that of a minimality condition. Thus, PRWDBRANCH states that a prosodic word must minimally consist of a single bisyllabic foot, or of two feet. Crucially, a prosodic word consisting solely of a monosyllabic foot is ruled out by PRWDBRANCH.

(16) PRWDBRANCH



As seen here, (a), (b), and (c) all branch at either the level of the PrWd or the Ft; that is, they all contain either two feet or two syllables. (d), however, does not branch at any of the relevant levels of prosodic structure, and is therefore marked as violating the constraint PRWDBRANCH. Any branching below the level of the syllable is irrelevant. This is captured explicitly by the constraint PRWDBRANCH, which is only allowed to evaluate branching at the level of PrWd or Ft. In addition, Modern Hebrew does not provide any evidence for moraic structure, so prosodic branching below the syllable is not expected to play any role.

In Modern Hebrew, there do exist paʕal forms that do not involve any branching structure, unlike any other binyan. FAITH-IO is responsible for this, as formalized by the following ranking:

(17) Paʕal-relevant ranking

FAITH-IO
|
PRWDBRANCH

The branching requirement states that a prosodic category must branch, which enforces (at least) bisyllabicity. However, given that FAITH-IO is higher-ranking than this requirement, monosyllabic lexical forms (i.e., monosyllabic paʕal forms) are exempt from the branching requirement. This is illustrated in the following tableau.

(18) Monosyllabic paʕal forms surface faithfully

	/kam/	FAITH-IO	PRWDBRANCH
	a. kamam	*!	
☞	b. kam		*

Note that both of these forms satisfy σ-ALIGN, so it is irrelevant here. The ranking FAITH-IO » PRWDBRANCH explains a fact widely observed in languages that impose a minimality condition; namely, the fact that it is possible for the condition to apply only to *derived* words. For instance, Ito (1990) and Ito & Mester (1992) demonstrate that minimality, or branching, is a requirement imposed on “p(honologically)-derived words.” For the case of Modern Hebrew, as seen here, the underived forms, which are all paʕal forms, are not subject to the minimality constraint active in the language. However, derived words are subject to minimality, showing that there must be some other faithfulness relation at stake in the case of derived words. That is, although FAITH-IO must dominate PRWDBRANCH, derived words are subject to PRWDBRANCH. This is easily achieved in a system of ranked constraints, since derived words are not subject to FAITH-IO constraints but are rather subject to FAITH-OO constraints. These are constraints on output-output correspondence (Benua 1995, 1997), and mediate relations between words that are derived from other words. Under the assumption that non-paʕal forms are derived from paʕal outputs, these forms will have to obey FAITH-OO constraints. However, these constraints must be ranked *below* PRWDBRANCH:

(19) Ranking for derived forms

PRWDBRANCH
|
FAITH-OO

Given this ranking, any form derived from an output must be minimally bisyllabic. As for restrictions on its size, as established above, σ-ALIGN must outrank FAITH-IO. By transitivity, since FAITH-IO dominates PRWDBRANCH, and since PRWDBRANCH dominates FAITH-OO, we expect never to find forms that are longer than two syllables. However, the hitpaʕel binyan is always at least three syllables long, clearly violating σ-ALIGN. Therefore, some faithfulness constraint must dominate σ-ALIGN.

The faithfulness constraint at issue must be different from FAITH-IO, since σ-ALIGN clearly dominates FAITH-IO. In fact, this is our first positive evidence that there exist at least two faithfulness dimensions. To understand why this must be the case, reconsider the case of the paʕal forms. These forms are lexical, so high-ranking FAITH-IO protects them from alternation when they are monosyllabic. When they contain more than two syllables, however, they cannot surface faithfully. However, forms with more than two syllables do occur in the hitpaʕel binyan. We can rule out trisyllabic forms in all binyanim but the hitpaʕel by ranking a different constraint above σ-ALIGN. The substantive nature of this constraint is an important topic, which is addressed in the following section.

4.3.2 Melodic overwriting

The issue of melodic overwriting is intimately connected to the fixed prosodic effects discussed in the previous section. Melodic overwriting refers to stem modification whereby segmental insertions or substitutions in the stem take place under affixation (Steriade 1988:74). In Modern Hebrew, under the approach argued for here, the paʕal binyan serves as the base of affixation for the formation of verbs in the other binyanim. This is where the nonconcatenative nature of Hebrew is most clearly visible: from a base paʕal form a new verb is derived. The only difference between the two forms is frequently the vowels; for instance, compare *gadal* 'he grew' with *gidel* 'he raised.' From this pair of related words, it is clear that somehow the affixal vowels *i e* take precedence over the vowels of the base form, because they are the vowels that actually surface in the morphologically complex form *gidel*.

To begin the analysis, I review several important assumptions. First of all, in this analysis, the base of affixation is taken to be an output form. This output form is the paʕal. Thus the verb *gidel* 'he raised' has *gadal* 'he grew' as its base of affixation. The affix /*i e*/ is then combined with this form. Given that *gadal* is itself an output, output-output faithfulness must be taken into consideration. In particular, the following constraint is used:

(20) MAX-OO

Every segment of the base has a correspondent in its related output.

If we incorporate this constraint and competing candidates into a single tableau, we find that the actual output, *gidel*, is not correctly predicted; rather, *gadal is:

(21) *gidel* from *gadal*

	gadal-i e	σ-ALIGN	OO-MAX
☜	a. gadal	✓	
	b. gadel	✓	a
	c. gidal	✓	a
☞	d. gidel	✓	aa

There are three potential solutions to this problem that will be considered here. The approach adopted here involves a constraint requiring faithfulness to affixal material that outranks general faithfulness. Two alternatives will be considered and then rejected. The first of these is theory of Head Dominance (Revithiadou 1999), whereby morphological heads require greater faithfulness than non-head material. In addition, an account based on the constraint REALIZE-MORPHEME, which requires every morpheme to have some phonological exponent, will also be examined. Below, I examine all three of these approaches in detail. As will be made clear, the approach involving affix-specific faithfulness results in the best analysis.

4.3.2.1 Affix Faithfulness

The proposal adopted here involves a faithfulness relation along the affixal dimension. This is just one of several recognized dimensions of diversified faithfulness that also includes faithfulness to stem material. We have already seen a slightly different set of faithfulness constraints: input-output faithfulness and output-output faithfulness. In this section, the analysis of melodic overwriting in Modern Hebrew is presented. Specifically, the constraint FAITH-AFFIX, which requires that material belonging to an affix be realized faithfully. FAITH, of course, is a cover term for (at least) the three constraints defined below:

(22) MAX-AFFIX

Every input segment of an affix has a correspondent in the output.

(23) DEP-AFFIX

Every output segment of an affix has a correspondent in the input.

(24) IDENT-AFFIX

Correspondent affixal segments have identical featural specifications.

Most critical for our purposes here is the constraint MAX-AFFIX, which prevents deletion of input-specified affixal material. Importantly, this constraint must outrank the general FAITH constraint, thus forcing realization of affixal material at the cost of other material when a size restriction is enforced.

(25) High-ranking affix faithfulness[4]

FAITH-AFFIX » FAITH

It is clear that this ranking contradicts McCarthy & Prince's (1995) metaranking on stem faithfulness over affix faithfulness. This metaranking has been proposed in order to explain asymmetries in segmental inventories in stems on the one hand, and affixes on the other; in addition, it is also invoked to explain the relative markedness of structures found in stems, in contrast to the relative unmarkedness of structures found in affixes. The Hebrew data under consideration here, though, constitute a serious empirical challenge to this metaranking, thus motivating the high-ranking status of FAITH-AFFIX as proposed here. Let us examine in detail how this high-ranking constraint works. First, the case of *gidel* 'he raised' as derived from *gadal* 'he grew' is presented. To begin, I illustrate the effect of σ-ALIGN, which enforces the fixed prosodic maximum of two syllables.

(26) *gidel* from *gadal*: derivation of piʕel forms

gadal-i e	σ-ALIGN	FAITH
a. gadalile	*!	
☞ b. gidel		aa

[4] This ranking clearly contradicts McCarthy & Prince's (1995) fixed ranking between FAITH-ROOT and FAITH-AFFIX, which states that root faithfulness universally dominates affix faithfulness. This issue is addressed in more detail below. Clearly the effects of McCarthy & Prince's fixed ranking need to be derived. These effects include asymmetries in segmental inventories of roots versus segmental inventories of affixes (cross-linguistically, roots exhibit a greater number of segments than affixes), in addition to the issue of positional faithfulness, whereby roots are more privileged or prominent than affixes and therefore allow more contrast.

The core of the analysis concerns which vowels are actually realized in the complex form. This is determined by high-ranking affix faithfulness:

(27) *gidel* from *gadal*: derivation of piʕel forms

	gadal-i e	FAITH-AFFIX	FAITH
	a. gadal	i!e	ie
	b. gadel	i!	ia
	c. gidal	e!	ea
☞	d. gidel		aa

High-ranking FAITH-AFFIX requires that *both* affixal vowels surface, even at the cost of deleting material from the base form *gadal*. This approach straightforwardly accounts for the derivation of all binyanim from the paʕal.

(28) *higdil* 'he enlarged' from *gadal* 'he grew'

	gadal-hi i[5]	FAITH-AFFIX	σ-ALIGN	FAITH
	a. higadal	i!	*	i
	b. higadil		*!	a
	c. higadal	i!	*	ia
☞	d. higdil			aa

This case involves the hifʕil binyan, in which a prefix is attached to the base form. This prefix is of the shape CV-, and the rest of the affix is vocalic. Interestingly, such cases force a .CVC.CVC. output in order to satisfy σ-ALIGN. In other words, the *g*

[5] This affix might be subject to some criticism. First of all, it violates Keer's (1999) conception of the Obligatory Contour Principle (OCP) because it contains an input with two identical adjacent elements that do not necessarily fuse into one. However, Keer's account is questionable on the grounds that it seems to impose a constraint on inputs, a move which is not possible in OT. Another way in which Keer's approach can be viewed is as a limitation on the power of faithfulness constraints, which leads him to eliminate certain faithfulness constraints.

and *d* are adjacent to each other in this case, as opposed to *gadal* or *gidel*. A similar situation arises in the nifʕal binyan:

(29) *nignav* ‘it was stolen’ from *ganav* ‘he stole’: derivation of nifʕal forms

	ga$_1$na$_2$v-ni a$_3$	FAITH-AFFIX	σ-ALIGN	FAITH
	a. niga$_1$na$_2$v	a$_3$!	*	a$_3$
	b. niga$_1$na$_3$v		*!	a$_2$
	c. niga$_2$na$_3$v		*!	a$_1$
	c. niga$_2$na$_3$v		*!	
	d. nigna$_1$v	a$_3$!		a$_3$
☞	e. nigna$_3$v			a$_1$a$_2$

A different situation obtains in the hitpaʕel binyan:

(30) *hitraxet͡s* ‘he washed himself’ from *raxac* ‘he washed’: derivation of hitpaʕel forms

	raxat͡s-hit a e	FAITH-AFFIX	σ-ALIGN	FAITH
	a. hitraxát͡s	e!	*	e
	b. raxet͡s	h!it		hit
☞	c. hitraxet͡s		*	aa

Here, the optimal form consists of three syllables, rather than two. The main consequence is that we have established the ranking between FAITH-AFFIX and σ-ALIGN. Crucially, there is no reduction to a bisyllabic form in this binyan. Doing so would violate FAITH-AFFIX, which outranks σ-ALIGN.

Two of the binyanim, the puʕal and hufʕal binyanim, are not derived from the paʕal. Evidence for this claim abounds, as explained by Horvath (1981) and Bat-El

(1989). These two binyanim exhibit a set of properties that sets them apart from the other binyanim, while still being neatly accounted for under the proposals advanced here. These exceptional properties are as follows. Unlike the other five binyanim, the puʕal and the hufʕal binyanim lack certain forms. These binyanim contain neither an imperative nor an infinitive form. In addition, the meanings of these two binyanim are, without exception, transparent. The puʕal form of any verb is always passive, and always corresponds to an active verb in the piʕel binyan. Likewise, all hufʕal forms are passives of a corresponding hifʕil.

Because of this productivity and regularity of meaning, these two binyanim can be analyzed as the result of an inflectional morphological process, in contrast to the derivation of the other binyanim, whose meanings are not always transparent. In addition, there exist gaps in the system with respect to the other binyanim, all hallmarks of derivational morphology. In any case, the process whereby puʕal and hufʕal forms are produced is similar to that of the other binyanim, except that they are derived from piʕel and hifʕil forms, as opposed to paʕal forms. This is illustrated in the next tableaux for one verb of each the two binyan.

(31) *gudal* ‘he was raised’ from *gidel* ‘he raised’

gidel-u a	FAITH-AFFIX	FAITH
a. [gidel]	u!a	ua
b. [gudel]	a!	ia
☞ c. [gudal]		ie

(32) hugdal ‘to be enlarged’ from higdil ‘to enlarge’

	higdil-u a	FAITH-AFFIX	σ-ALIGN	FAITH
	a. [hìgu][dál]		*!	i
	b. [hìga][díl]	u!		
☞	c. [hugdál]			ii

Again, just as in the case of the other verbs, these two verbal classes illustrate fixed prosodic effects: the input to the process contains more material than can be accommodated in the two-syllable maximum, and FAITH-AFFIX determines what is overwritten.

This section has demonstrated the implementation of the fixed prosodic constraints, alongside an explanation for which material ends up surfacing when outputs are restricted to a particular prosodic shape that cannot accommodate the entirety of the material present in the input. In the next sections, I consider how two alternative theories fare with respect to the data. The first of these is the theory of Head Dominance. As is shown, this theory faces serious empirical problems.

4.3.2.2 Head Dominance

The theory of Head Dominance, as proposed by Revithiadou (1999), involves a prosody-morphology interface and was originally introduced to account for asymmetries in lexical accent realization. Head Dominance (HD) involves the following very general constraint schema:

(33) Head Dominance (HD; adapted from Revithiadou 1999:5)

FAITH-HEAD » FAITH

Under this approach, morphological heads require greater faithfulness than general faithfulness. In systems involving lexical accent, this ranking schema is extremely useful in its ability to predict which inherent accent surfaces when an input contains multiple lexical accents. Thus, in Greek, the default stress pattern in nouns is antepenultimate stress (Revithiadou 1999).

(34) Antepenultimate default stress in Greek nouns

a.	ánθropos	‘man’
b.	klívanos	‘kiln’
c.	θálasa	‘sea’
d.	ɣóndola	‘gondola’

In addition, Greek contains a number of nouns which deviate from this default pattern. Such cases are analyzed by Revithiadou as involving lexically specified accent, which surfaces faithfully, thus violating the default metrical structure.

(35) Inherently accented nouns

a.	romándz	‘romance’
b.	papaɣálos	‘parrot’
c.	servitóros	‘waiter’
d.	stafíða	‘stadium’

Now, in Greek, some derivational suffixes have an underlying accent. The interesting situation, for our purposes, are cases in which an inherently accented stem is combined with an inherently accented suffix. Crucially, only one accent is permitted in an output. Thus, the two inherent accents compete for which one actually surfaces. The perhaps surprising result of such a concatenation is that the inherent accent of the derivational suffix surfaces, at the cost of deleting the inherent accent of the stem. Thus, when the inherently accented *romándz* is affixed with the inherently accented derivational suffix *-áð* (followed by affixation of the inherently accented inflectional suffix *–ón*), a conflict arises. Since any lexically specified accent is subject to faithfulness constraints mandating preservation of input accents, but since only one accent may surface, a choice must be made. Either the inherent accent of the stem is realized, or the inherent accent of the derivational suffix is realized. What actually occurs is preservation of the underlying accent of the derivational suffix. The following tableau illustrates this, with only crucial constraints demonstrated (adapted from Revithiadou 1999:188):

(36) romandzáðon

	romándz-áð-ón	FAITH-HEAD	FAITH
	a. romándzaðon	*	*
☞	b. romandzáðon		*

Because the accented derivational suffix *-áð* constitutes a morphological head, it is subject to high-ranking FAITH-HEAD, and thus it is more important to preserve its underlying accent than that of the stem *romándz*.

This theory is crucially interesting for the reason that it draws a strict line between what counts as a morphological head and what does not. According to Revithiadou (1999), the notion of head extends not only to roots or stems but also to affixes. However, not all affixes may count as heads. The important distinction here, due to work of much previous work (e.g., di Sciullo & Williams 1987, Scalise 1986, and Zwicky 1985) is that between derivational and inflectional affixes. Derivational affixes are taken to be heads of the complex morphological structures they are a part of, while inflectional suffixes are not granted head status. Based on this distinction, the theory makes a strong prediction regarding the expected disparity in behavior between these different types of affixes. Specifically, in a situation where an inherently accented stem combines with an inherently accented inflectional suffixes, the accent on the stem should 'win', and thus be realized at the cost of deleting the underlying accent of the inflectional affix. Indeed, this is what is observed, as seen in the following tableau, where the inherently accented root *stafíð-* is combined with the inherently accent inflectional suffix *–ón*.

(37) stafíðon

stafíð-ón	FAITH-HEAD	FAITH
a. stafiðón	*	*
☞ b. stafíðon		*

In such a case, candidate (a) loses because the head in this case is not the affix but the root itself. Thus, deletion of the inherent accent of the root equals deletion of an inherent accent on a head and is penalized by the constraint FAITH-HEAD. Both candidates violate the standard FAITH constraint equally, because each candidate involves deletion of one underlying accent. This violation must be tolerated however, and candidate (b) emerges the winner.

Stepping back from the Greek data, it is reasonable at this point to consider how the HD approach may be extended to the Semitic cases at hand. Analogous to the restriction in Greek that each output is limited in the number of accents it may bear (a single accent), Hebrew has a similar kind of restriction: namely, its words are limited in their output size to two syllables. Thus, we are dealing with a situation much like that in Greek in that the output may parse only a subset of the material present in the input, and we require a principled explanation for why particular material is parsed at the expense of other material.

Is the analogy strong enough to solve our problem? That is, is it the case that in Hebrew, a principled set of morphological heads compose the material that is parsed at the expense of non-head material? Looking solely at the cases of the Hebrew binyanim and the relations between words there, it is clear that these involve derivational morphology, as discussed by other researchers (Horvath 1981, Bat-El 1989).

Investigating, for instance, the derivation of a form such as *gidel* 'he raised' from the intransitive paʕal form *gadal* 'he grew', it is fairly obvious how the HD ranking configuration will determine which vowels must surface in *gidel*: the affixal vowels must surface, because they constitute a morphological head as a derivational affix. The following tableau illustrates this result, with the accompanying schematic representation capturing the compositionality of such a form ("intensive' simply indicates the semantic characterization of the affix). The violations of faithfulness constraints are indicated in the relevant cells by the actual segments which are unfaithfully parsed.

(38) *gidel* from *gadal*: derivation of piʕel forms

	gadal-i e	FAITH-HEAD	σ-ALIGN	FAITH
	a. gadalile		*!	
	b. gadal	i!e		
	c. gadel	i!		a
	d. gidal	e!		a
☞	e. gidel			aa

(39) *Compositionality of* gidel

gidel$_V$^{intensive}
r u
gadal$_V$ *i e*$^{Head\text{-}intensive}$

As seen in the tableau, σ-ALIGN prevents forms that are longer than two syllables. FAITH-HEAD ensures realization of head material over non-head material when the output is limited is size. The strategy of HD may be extended in this way to all other binyanim, as illustrated in the following tableaux.

(40) *higdil* ‘he enlarged’ from *gadal* ‘he grew’: derivation of hifʕil forms

	gadal-hi i	FAITH-HEAD	σ-ALIGN	FAITH
	a. higadal	i!	*	
	b. higadil		*!	a
	c. higidal		*!	a
☞	d. higdil			aa

(41) *nignav* ‘it was stolen’ from ganav ‘he stole’: derivation of nifʕal forms

	ga_1na_2v-ni a_3	FAITH-HEAD	σ-ALIGN	FAITH
	a. $niga_1na_2v$	a_3!	*	
	b. $niga_1na_3v$		*!	a_2
	c. $niga_2na_3v$		*!	a_1
	d. $nigna_1v$	a_3!		
☞	e. $nigna_3v$			a_1a_2

(42) *hitraxe*t͡s 'he washed himself' from *raxac* 'he washed': derivation of hitpaʕel forms

	raxat͡s-hit a e	FAITH-HEAD	σ-ALIGN	FAITH	*LAPSE
	a. hitraxat͡s	e!	*		
	b. raxet͡s	h!it			
	c. hitraxet͡s		*	aa	*!
☞	d. hitraxet͡s		*	aa	

4.3.2.3 Problems with Head Dominance

Although the HD approach seems to work well for these cases, there are some serious problems that it encounters when taken further. In this section, I develop these criticisms, and argue that they constitute strong evidence against adopting this approach to account for the melodic overwriting that takes place in Hebrew.

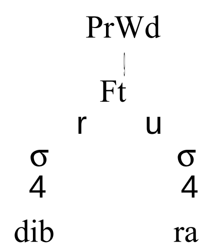
Recall that under Revithiadou's (1999) original approach involving HD, a clear distinction between derivational and inflection morphology is maintained. Thus, inflectional affixes do not constitute morphological heads, and they should therefore not be protected by high-ranking HEADFAITH. This is an empirical problem for Hebrew, because fixed prosodic effects in Hebrew are in force even in the presence of inflectional morphology. Thus, recall from our earlier discussion of Modern Hebrew stress that verbs suffixed with vowel-initial suffixes undergo vowel deletion:

(43) Vowel deletion in Hebrew verbs with vowel-initial suffixes

a.	diber	'he spoke'
b.	dibarti	'I spoke'
c.	dibarnu	'we spoke'
d.	dibra	'she spoke'
e.	dibru	'they spoke'

This is clearly an inflectional paradigm, as opposed to a derivational one, and thus we should not expect the affixes involved to be heads. However, note that when the syllable structure of the language permits it, words in this paradigm conform to the language's fixed prosody. This is evident in the cases involving the suffixes *–a* and *–u*, which cause deletion of the stem-final vowel. Now, if these affixes were derivational, then HD would explain this behavior, since fixed prosody would have to be enforced at the expense of non-head material. However, HD clearly does not apply in the case of inflectional suffixes, so the reason for the vowel deletion remains unexplained under an HD approach. On the other hand, the FAITH-AFFIX approach will account for the above data since it targets all morphology, as opposed to only targeting derivational morphology. Recall from the previous chapter that the forms with consonant-initial suffixes (*dibarti*, *dibartem*) do not induce vowel deletion because they are prosodified outside the prosodic word due to the high-ranking constraint ALIGN-WD. The vowel-initial suffixes, however, cannot be prosodified in this manner because doing so would violate higher-ranking ONSET. These suffixes are therefore prosodified within the prosodic word, as illustrated for *dibra* as follows:

(44) *dibra*



The entire prosodic word is subject to σ-ALIGN, and thus deletion of non-affixal material is required. Given that this is triggered by an inflectional suffix, the HD approach cannot explain why fixed prosodic effects are observed here.

Another problem also becomes evident in the HD approach. With FAITH-HEAD in a high-ranking position, we expect anything that constitutes a head to surface faithfully, as many syllables long as vowels contained in its underlying specification, without being subject to the markedness constraints on minimality or maximality. Thus we predict that morphologically simple forms may be potentially infinite in length.

Consider a monomorphemic form such as hypothetical **gadalanumutiki*. Modern Hebrew has no monomorphemic forms that are this long, but if such a word is monomorphemic, then it must by default constitute a morphological head. It is thus subject to high-ranking FAITH-HEAD under the ranking we have proposed, effectively protecting it from modification that would result in satisfying σ-ALIGN, the constraint on maximality.

In actuality, FAITH-HEAD seems relevant only in cases when we are dealing with polymorphemic forms. In other words, monomorphemes do not behave like the hypothetical example, and do incur size restrictions. This observation leads to the judgment that a more specific constraint must at issue here. Only when a form involves more than one morpheme is FAITH-HEAD invoked.

To deal with this, we must limit FAITH-HEAD such that it applies solely to polymorphemic cases; that is, to restrict its power such that it cannot apply to free morphemes occurring with no overt affixes. To do this, we could invoke a specific version of FAITH-HEAD that evaluates a subset of the properties evaluated by FAITH-HEAD. This constraint, called FAITH-HEAD$_{B(OUN)D}$, is viewed as a specific version of FAITH-HEAD, much in the way FAITH-HEAD is a specific version of general faithfulness constraints.

(45) FAITH-HEAD$_{BD}$

"Be faithful to bound heads."

We are now in a position where the problem of infinitely long monomorphemes is totally avoided. Because they are not bound heads, the specific head faithfulness constraint will not apply to them, and they will be subject to the familiar size restrictions. However, this solution is clearly missing something. We need to seriously consider exactly what this newly invoked constraint targets. It targets "bound heads", but as we have seen in Hebrew, this label must also include inflectional affixes if we want to avoid the first problem that arises in connection with this approach. Thus, we have a constraint that essentially targets bound morphemes, and not heads.

Because of these serious problems, the HD approach will not be pursued further. In this section, we have seen that although this approach works well for derivational relations in Modern Hebrew, it leaves unexplained the fact that inflectional morphology must also be subject to fixed prosodic effects. In addition, once we attempt to rework the FAITH-HEAD constraint to account for the size restrictions imposed on free morphemes, it appears more and more that what we must target are not morphological heads, but rather, something much more general: bound morphology, or affixes.

4.3.2.4 Realize Morpheme

Another potential alternative to explore makes use of the constraint known as REALIZE MORPHEME (Samek-Lodovici 1993, Gnanadesikan 1996, Rose 1996, 1997, 1998, Walker 1997, 1998, Kurisu 2000ab, to appear ab, in preparation). Here the inadequacies of an approach based on this constraint are detailed.

REALIZE MORPHEME has been employed in various analyses to assure that morphological material in the input corresponds to phonological material in the output. Here I adopt the formulation provided by Walker (1998:244):

(46) REALIZE MORPHEME (RM)

A morpheme must have some phonological exponent in the output.

It turns out that because of the more general nature of this device, the force of this constraint is too weak in the face of the empirical evidence. Crucial to our purposes here is the fact that according to the definition of RM, some *minimal* realization of a morpheme will satisfy the constraint just as well as a *maximal* realization of that morpheme. Previous analyses which have used RM typically involve cases where the input and output differ minimally; that is, cases such as morphological gemination (Samek-Lodovici 1993), morphological reduplication (Rose 1996, 1997, 1998), and (non-templatic) nonconcatenative morphology (Kurisu 2000ab, to appear ab, in preparation).

However, for the Semitic cases at hand, a RM analysis will not achieve the right results. This is exactly because of its overly permissive nature: *any* part of an input-specified morpheme that surfaces in the output is sufficient to satisfy RM. However, this predicts that in Hebrew, a bivocalic affix specified in the input could surface with only one vowel. Even if RM is high-ranking, the wrong candidate(s) will be chosen as optimal. The following tableau illustrates the situation, assuming that the same prosodic constraints in effect above are in effect here:

(47) Failed attempt to derive *gidel* from *gadal* using REALIZE MORPHEME

	gadal-i e	RM	FAITH
	a. [gadal]	*!	ie
☞?	b. [gadel]	✓	ai
☞?	c. [gidal]	✓	ae
☞?	d. [gidel]	✓	aa

In this case, it is not clear which candidate is optimal, and there are no constraints that could distinguish between the several potentially optimal candidates in this case without appealing to a mechanism like FAITH-AFFIX to ensure that all of the affixal material is realized. In other words, RM does not provide a way to force both affixal vowels to surface. If one surfaces, this alone is enough to satisfy RM.

The upshot of our examination of the two alternative approaches, Head Dominance and Realize Morpheme, is that the analysis requires an appeal to a different type of faithfulness. Specifically, we need to appeal to faithfulness to affixal material *tout court*, without discriminating between heads and non-heads, and without allowing only portions of lexically specified affixal to surface. In the next section, I turn to a discussion of potential problems that FAITH-AFFIX faces, and provide responses to these problems.

4.3.2.5 Some objections to high-ranking FAITH-AFFIX, and responses

Based on observations about faithfulness and markedness in different morphological domains, McCarthy & Prince (1995:364) propose a universally fixed ranking between two different types of faithfulness constraints, known as the SAFM, originally introduced in McCarthy & Prince (1994a; cf. also McCarthy & Prince 1995, Urbanczyk 1996):

(48) Stem-Affix Faithfulness Metaconstraint (SAFM)[6]

FAITH-STEM » FAITH-AFFIX

Clearly the SAFM is contradicted by the approach advocated here, which ranks FAITH-AFFIX above general FAITH. This raises the more general question of the status of the SAFM. This metaconstraint has been called into question in previous work, and

[6] I have termed this the *Stem*-Affix Faithfulness Metaconstraint rather than use McCarthy & Prince's original *Root*-Affix Faithfulness Metaconstraint in order to avoid confusion between roots in general and consonantal roots.

in order to understand why, it is important to understand the motivation for its conception in the first place.

McCarthy & Prince (1995) develop a model of reductive correspondence called the “Full Model”, involving three dimensions of faithfulness, which may be schematically represented as follows:

(49) Full model of reduplicative correspondence (McCarthy & Prince 1995:252)

Input: /Affix$_{Red}$ - Stem/

Input-reduplicant faithfulness ⤢ ⇕ *Input-base faithfulness*

Output: Reduplicant ⇔ Base

Base-reduplicant identity

The relation above that concerns us here is the input-reduplicant faithfulness dimension. This correspondence involves a relation between the underlying form of the stem and the reduplicant. Admitting the existence of this correspondence relationship, McCarthy & Prince argue, leads to two potential but pathological ranking typologies. These are as follows:

(50) Pathological rankings

(a) B-R Identity, I-R Faithfulness » C » I-B Faithfulness

(b) I-R Faithfulness » C » B-R Identity, I-B Faithfulness where "C" stands for some phonological markedness constraint. What is problematic about the case in (a) is that because I-R Faithfulness and B-R Identity are so high-ranking, the markedness constraint C never has any effect in reduplicated words, even though in the language as a whole, C is obeyed. The (b) case is problematic because it leads to emergence of the marked; that is, C is not obeyed in cases of reduplication, even though it is obeyed in the language as a whole. Thus marked structures are permitted only in reduplicated forms under this ranking. Both of these situations seem bizarre, and indeed this behavior is unattested.

Because of these problematic rankings, McCarthy & Prince propose the SAFM. The metaconstraint has the crucially desired effect: "…no I-R faithfulness constraint can ever dominate its I-B cognate, and the pathological interactions observed [above] can never occur." Interestingly, McCarthy & Prince make use of the SAFM to explain a more general, widely observed phenomenon: the fact that cross-linguistically, there is overwhelming evidence that affixes are less marked than roots. The SAFM, they claim, accounts for this fact, because marked structures that are potentially present in the underlying specifications of affixes are neutralized under the following ranking schema:

(51) Affixes are less marked than roots

FAITH-ROOT » C » FAITH-AFFIX

Under this ranking, C is observed only when an affix is at stake; any underlying material in a root surfaces faithfully. This implementation of the SAFM can therefore explain, for instance, why in Arabic pharyngeals occur in roots but not in affixes:

(52) Arabic roots contain pharyngeals, but affixes do not (McCarthy & Prince 1995:365)

IDENT-ROOT(PLACE) » *PHARYNGEAL » IDENT-AFFIX(PLACE)

However, this approach has been subject to some criticism. In particular, Spaelti (1997:71) argues against the formalization of this asymmetry via the SAFM, and dispenses with the metaconstraint altogether. As Spaelti discusses, if the effects of the SAFM are real, we should try to derive them, rather than achieve them through a stipulative metaconstraint. In addition, Spaelti argues against the Full Model of reduplicative correspondence as presented above, proposing instead a more economical model, one which does not involve any I-R faithfulness dimension. Once this faithfulness dimension disappears, so does the original motivation for the SAFM, since we no longer need to worry about I-R faithfulness appearing in troublesome high-ranking positions in a constraint hierarchy.

Another point worth raising is that the SAFM conflates two conceptually distinct types of markedness, and makes the same prediction with respect to both of these. As mentioned earlier, the SAFM can be invoked to explain why stems may contain material that is relatively marked, while affixes rarely do; such is the case of the Arabic example just discussed. This is a case of featural markedness, and can be used to explain the asymmetry in the segmental inventory of stems versus that of affixes. This type of markedness can be contrasted with structural markedness. For instance, to explain the fact that Sanskrit roots contain onset clusters, but affixes do not, McCarthy & Prince (1995:365) invoke the same SAFM, with a structural markedness constraint sandwiched between the two faithfulness constraints:

(53) Sanskrit roots contain complex onsets, but affixes do not (McCarthy & Prince 1995:365)

MAX-ROOT » *COMPLEX » MAX-AFFIX

Rather than determining the segmental inventories of roots versus affixes, this ranking determines structural asymmetries between the two. The SAFM conflates these two types of markedness, though it is not clear that this should be the case. In particular, instances of the SAFM involving the constraint MAX may be questionable, providing possible support for the reversal of this ranking as instantiated in Modern Hebrew through high-ranking FAITH-AFFIX, whose main purpose is to compel affixal segments to surface, even at the cost of preventing stem segments from surfacing.

Because in Hebrew the burden of expression of affixal material falls to vowels, the number of possible affixal segments is limited to the inventory of vowels in Hebrew. For now, assuming that the majority of derivational morphology in Hebrew is expressed by vowels, we can explain why FAITH-AFFIX must come to occupy such a high position in the constraint hierarchy. Modern Hebrew contains five vowels: *i*, *e*, *u*, *o*, and *a*. There is not much room for sloppiness in this system. Since the number of vowels is so small, the number of potential affixal material that may be constructed from vowels is small, in contrast to the number that would be possible if both vowels and consonants were used. Assuming the fixed prosodic nature of Modern Hebrew as a primitive, then we are dealing with a system in which combinations of two vowels may be used to express derivational meanings. This yields 25 possibilities for Modern Hebrew, with its five-vowel system.

Given the nature of the vowel inventory, the language cannot afford confusion or deviation from underlying affixal material that is limited to vowels. The most simple expression of the fixed prosodic limit in Hebrew is a .CV(C).CVC. shape. Now, if this is the maximal prosodic size allowed to surface in the language, then the options for what can be changed under affixation are quite limited. For instance, the first C could be replaced by an affixal C. Or the first CV could be replaced by an affixal CV. What happens in Hebrew is that both V's are replaced by affixal V's, or, in some cases, a CV-prefix is added, where the V of the prefix replaces the first vowel of the base. This works out to produce the right number of stem and affixal contrasts in the language, as it turns out. So for instance, if the first CVC composed the stem, and the last VC were used as the affix, then the system would generate too few stems and too many affixes, compared to what is actually observed. The opposite is true if CVC-C composes the stem, and just one V is used for affixal expression. In this case, there are too many stems (more than actually exist in the language) and not enough affixes. The best solution, given the relative inventories of consonants versus vowels in Modern Hebrew, is for the affixal material to compose the V-V portion of .CV.CVC. Since contractiveness among the vowels is easily lost by any deviation, the high-ranking nature of faithfulness to affixes is explained.

These points can be illustrated with some actual numbers. Given the 25 possible V-V combinations in Hebrew, and assuming 22 possible contrasting consonants (this number takes into account neutralization of certain sounds that were historically distinct), we can calculate the expected number of contrasting stems of the shape .CV.CVC. This calculation takes into broad consideration Obligatory Contour Principle (OCP) effects with respect to place of articulation in the first and second consonants, though it turns out that the number of potential stems excluded by this consideration is small. In any case, given a fixed prosody of .CV.CVC., if the two vowel positions of this shape are used to express affixal material, a total of 9,368 possible stems are predicted, which is very close to the actual number of 10,000 (Morgenbrod & Serifi 1987:VII). This goes a long way in offering support for the argument that the burden of affixal expression in Hebrew falls to vowels.

Interestingly, in a system where we still take .CV.CVC. as the fixed prosodic shape, but where one of the consonantal positions is used to express affixes (recall that there are 22 possible contrastive consonants), a similar prediction is made: 12,150 contrasting stems are predicted. Although this number also approximates the actual number of roots, one consonant is never used alone as an affix. The reason for this, I speculate, could be related to the fact that given the large number of consonants (especially compared to the much smaller number of vowels in Hebrew), the affixal burden that would fall to the single consonant position would result in a system where affixes are not contrastive enough among themselves.

Another possibility would be for the .CVC. portion of .CV.CVC. to be used as stem material, while the .CV. portion could be reserved for affixal expression. In this manner, 130 .CV. affixes are predicted, and only 2,430 .CVC. stems would exist. This is clearly an insufficient number of predicted stems, compared to the actual number.

All of these facts point lend support to the claim that given the inventory of Modern Hebrew it makes sense for affixal material to be expressed by vowels. Of course, this is not the only way affixal material is expressed; as we have seen there exist CV-V affixes as well, which also induce melodic overwriting of the base vowels. Given this fact, several questions remain regarding why certain segmental combinations are not attested as affixes. For instance, there is no CVC affix; the one affix in Hebrew that we have given an explicit account of here that contains CVC contains two additional vowels: the *hit-a e* affix of the hitpaʕel binyan. If there were a CVC affix, the analysis of fixed prosody so far would predict that this CVC would overwrite more of the stem than just the first vowel, given high-ranking FAITH-AFFIX. For instance, given a base paʕal form like *raxac* 'he washed', a hypothetical affix *hit-*, when attached to this stem, would yield *hitxac*, where the affixal material overwrites the consonantal material base, which cannot be accommodated by the phonotactics of Hebrew. The nonexistence of such affixes could be explained by the fact that this behavior would result in mass neutralization of all stems ending in *–axac* under affixation of the hypothetical *hit-* prefix, since the first base consonant would be eliminated under affixation. A formal explanation for the lack of such affixes might in fact involve a separate constraint, one we have not seen so far in this account, which would require faithfulness to consonantal material:

(54) MAX-C (McCarthy & Prince 1995)

A consonant in the input has a correspondent in the output.

Note that this constraint is purely phonological, and therefore does not recognize any special morphological status granted to consonants. Its purpose is to prevent consonants from being overwritten, and could be responsible for helping determine the segmental make-up of affixes in Hebrew, in tandem with the fixed prosodic shape dictated by the markedness constraints that regulate maximal word size.

4.4 Assessing the fixed prosody account

This section focuses on the implementation of the constraint hierarchy that generates the fixed prosodic effects in Modern Hebrew. The preceding discussion concentrated on establishing the constraints responsible for the forms surpassing the maximal word size of two syllables in Modern Hebrew, as is the case in the hitpaʕel binyan. The relevant ranking is shown here.

(55) Ranking responsible for trisyllabic hitpaʕel forms

FAITH-AFFIX
|
σ-ALIGN

Since the material *hit- a e* is affixal, optimal candidates may never be unfaithful to this material. It surfaces faithfully, thereby violating σ-ALIGN since these forms are always trisyllabic.

This case shows that we must distinguish between FAITH-AFFIX and FAITH-IO. This is manifested in the constraint ranking we have proposed, because σ-ALIGN is ranked in between FAITH-AFFIX and FAITH-IO. This is a useful result, providing further evidence for the following three dimensions of faithfulness in Modern Hebrew which are ranked separately from one another:

(56) *Dimensions of faithfulness*

a. FAITH-AFFIX

b. FAITH-IO

c. FAITH-OO

The ranking proposed for Hebrew is therefore as follows:

(57) *Ranking*

FAITH-AFFIX
|
σ-ALIGN
|
FAITH-IO
|
PRWDBRANCH
|
FAITH-OO

This situation, resulting from the effects of fixed prosody, gives rise to a very interesting ranking schema, and one which is very reminiscent of a TETU ranking (McCarthy & Prince 1994a). TETU describes cases in which certain phonological constraints are dominated by general faithfulness constraints, and so are inactive, except within specific morphological domains where faithfulness is subordinate to the phonological constraints. This is a novel instance of TETU, however, in that it is observed not in some special, morphologically-restricted domain, such as reduplication, but rather in a very large domain of a language; that is, the entire verbal system. Consider the following fragment from the ranking for the Modern Hebrew verbal system. As seen here, this is a clear case of TETU:

(58) *Ranking fragment illustrating TETU*

FAITH-IO			FAITH-IO
|			|
PRWDBRANCH	}	TETU:	Phono-Constraint
|			|
FAITH-OO			FAITH-OO

Another consequence of this approach is the elimination of the consonantal root as a morpheme. In the analysis advocated here, the consonantal root is simply the residue remaining after melodic overwriting has occurred. However, as seen in the tableaux above, the consonantal root is never referred to. This is because it has no morphemic status in this analysis. This is an expected consequence of the combination of melodic overwriting with high-ranking constraints on prosodic shape. In addition, this accords with conclusions reached by Bat-El (1994) and Ussishkin (1999c) with respect to the formation of denominal verbs in Hebrew.

4.5 Morphologically complex forms with no paʕal base

An interesting problem remains to be addressed. Modern Hebrew contains verbs in binyanim other than the paʕal binyan which have no correspondent in the paʕal. That is, it is not possible to decompose such forms into an affix plus a paʕal base. Some examples are listed below.

(59) Verbs with no paʕal correspondent

Binyan	*Examples*	*Gloss*	*No related paʕal form*[7]
nifʕal	nirdam nifrad	'he fell asleep' 'he separated (intrans.)'	*radam *parad
piʕel	diber kibel	'he spoke' 'he received'	*davar *kaval
hitpaʕel	hitkabel hitnaʃek	'he was received' 'he kissed (recip.)	*kaval *naʃak
hifʕil	hifrid	'he separated (trans.)'	*parad

Although such forms have no paʕal base from which they are derived, they are still analyzed as morphologically complex. They can be compared to English examples such as *perceive* and *uncouth* . Such forms are analyzable as a combination of bound morphemes only, in contrast to words like *preview* and *unlike*, which each contain one free morpheme. The above examples from Hebrew can also be viewed as a combination of bound morphemes: a paʕal form that happens to be bound, and an affix. Such forms are much more prevalent in Hebrew than in English, and an explanation for this difference remains problematic. However, this is not problematic only for the analysis argued for here; it is problematic as well even for an account based on the consonantal root. Even that approach must contend with the fact of such gaps, and why some consonantal roots are not realizable in certain binyanim.

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[7] The forms in this column do not exist as paʕal verbs with meanings related to those of the morphologically complex forms listed to the left. However, some of these words do exist, with independent, unrelated meanings. For instance, *davar* exists as a noun meaning 'thing.' Similarly, a verb *kaval* does exist, but has the meaning 'he complained' (which cannot be transparently related to *kibel* 'he received'). Note the spirantization allophony relating the segments *b* and *v* in *kibel* and *kaval*, and similarly relating *p* and *f* in *parad* and *nifrad*.

4.6 Summary of analysis

Under the analysis argued for in this chapter, the binyanim of Modern Hebrew may be schematized as follows:

(60) Binyanim and their inputs

Binyan	*Input*
paʕal	paʕal
nifʕal	ni- a
piʕel	i e
puʕal	u a
hitpaʕel	hit- a e
hifʕil	hi- i
hufʕal	hu- a

As discussed above, for all binyanim but the basic paʕal, the affixes representing the phonological expression of the binyanim are considered to be bound heads, and are therefore subject to high-ranking FAITH-AFFIX.

Finally, the following constraint ranking instantiates fixed prosodic effects in Modern Hebrew, illustrating the interaction between the various faithfulness constraints and the prosodic markedness constraints:

(61) *Ranking for Fixed Prosody in Modern Hebrew*

FAITH-AFFIX
|
σ-ALIGN
|
FAITH-IO
|
PRWDBRANCH
|
FAITH-OO

❶ = FAITH-AFFIX ≫ σ-ALIGN; ❷ = σ-ALIGN ≫ FAITH-IO; ❸ = FAITH-IO ≫ PRWDBRANCH; ❹ = PRWDBRANCH ≫ FAITH-OO

Key

❶ > 2 syllables are allowed in morphologically-complex forms only

❷ paʕal forms are never > 2 syllables

❸ paʕal forms may be < 2 syllables

❹ derived forms must be ≥ 2 syllables

In this section, I have investigated the verbal system of Modern Hebrew in an approach to root-and-pattern morphology without making any analytical commitment to either the consonantal root or template-specific constraints. Based on general theoretical considerations of Optimality Theory and prosodic morphology, I have shown that Modern Hebrew can be seen as a case in which TETU effects are observed in the language as a whole and are not restricted to a particular morphological domain. Previous work has clearly established the ubiquity of TETU effects in the area of reduplicative morphology, but this is the first account of fixed prosodic effects outside of reduplicative morphology analyzed as an instance of TETU.

I have also argued that within OT, melodic overwriting can be achieved through a phonology-morphology interface such as Head Dominance, where morphological heads are subject to special faithfulness constraints. Another consequence of this approach is the elimination of the consonantal root as a morpheme. In the analysis advocated here, the apparent consonantal root is simply the residue remaining after melodic overwriting. This is an expected result of the combination of melodic overwriting with fixed prosody, and accords with conclusions reached in Bat-El (1994) and Ussishkin (1999c) with respect to derivational processes such as the formation of denominal verbs in Modern Hebrew. To the extent that this approach is viable in such systems, the Semitic languages begin to appear less exotic with respect to their morphology, further undermining the special status of 'nonconcatenative' templatic systems in general.

Chapter 5: Further fixed prosodic effects in Modern Hebrew

5.0 Introduction

In this chapter, the goal is to explore consequences of fixed prosody with respect to other processes in Modern Hebrew. As I showed in the previous chapter, fixed prosody, which governs the prosodic shape of outputs, may interact with morphology to produce the effect of melodic overwriting. In the case of the Modern Hebrew verbal system, fixed prosody forces the loss of phonological material in the input; for instance, the vowels of a stem form are overwritten to accommodate the vowels of an affixal morpheme. This can be described as an effect of maximal stem size, whereby fixed prosody dictates that in circumstances where there is more material than can fit into a particular prosodic shape, some of this material is not realized. This was formalized in the previous chapter by the constraint σ-ALIGN, a version of Ito, Kitagawa, & Mester's (1996) Hierarchical Alignment.:

(1) σ-ALIGN

Every syllable is aligned to some edge of a prosodic word

Another way in which fixed prosody influences output forms is to augment potential forms to match a particular prosodic shape. In these cases, there is not enough material to produce a well-formed output, so material is added. In Modern Hebrew, and throughout Semitic in general, this takes place through *reduplication*. Some examples of forms containing reduplication are given below, taken from Ussishkin (1999b). These forms are all denominal verbs, with their respective bases given on the right. Such verbs form an important portion of the empirical material examined in this chapter.

(2) Consonant doubling in Modern Hebrew denominal verbs

	Verb	*Gloss*	*Base of verb*	*Gloss*
a.	t͡sidéd	'he sided'	t͡sád	'side'
b.	simém	'he drugged, to poisoned'	sám	'drug'
c.	dimém	'he bled'	dám	'blood'
d.	xidéd	'he sharpened'	xád	'sharp'
e.	minén	'he apportioned'	maná	'portion'
f.	flirtét	'he flirted'	flírt	'flirt'
g.	fiksés	'he sent a fax'	fáks	'facsimile'

These forms are called 'consonant doubling' forms because in each case, the two final consonants are identical. I contrast consonant doubling forms with the forms in the next set of data, dubbed 'total reduplication' forms because each consonant appears twice in these forms:

(3) Total reduplication in Modern Hebrew denominal verbs

	Form	*Gloss*	*Base*	*Gloss*
a.	hidhéd	'he echoed'	héd	'echo'
b.	nimném	'he dozed'	nám	'sleep'
c.	difdéf	'he turned pages'	dáf	'page'
d.	kivkév	'he drew a dotted line'	káv	'line'
e.	pixpéx	'he flowed, gushed'	páx	'jar, vessel'

Interestingly, Semitic languages tend to reduplicate in order to meet fixed prosodic requirements. This is not the sole alternative, however. In some languages minimal word size is met not through reduplication, but rather through the insertion of phonological material that does not correspond to material in the base or input. In these cases, epenthesis of unmarked phonological material occurs, thus resulting in a more uniform set of data in which the phonological material in question is predictable not on the basis of faithfulness to base material (as in reduplication) but rather on the basis of markedness considerations.

To provide a concrete example of such a system, consider the treatment of Axininca Campa of McCarthy & Prince (1993a). In this language, there is a minimal word requirement such that no output less than two moras long may surface. Thus, a stem such as /*na*/ 'carry' is never realized faithfully as *[*na*]. Instead, the form is augmented to conform to a bimoraic minimum to produce *nata*, with epenthetic *t* and *a*. Neither of these segments is reduplicative,[1] in contrast to the Semitic data above in which the copied segments are entirely predictable on the basis of the stems from which these forms are derived.

A question that immediately arises with respect to these data concerns the difference between the two sets. In other words, we need to ask whether there is motivation for the division between consonant doubling forms and total reduplication forms. I claim that there is a difference, with a strong morphosemantic basis, and that this difference has important consequences for the derivation of such forms. The

[1] This claim is verified by the existence of stems whose vowel is not *a*, such as $t^h o$, which surfaces as [$t^h ota$].

distinction at hand, I claim, is the contrast between *phonological* and *morphological* reduplication. In this chapter, I will focus on these two types of copying and their interaction with fixed prosody.

The chapter is organized as follows. In the next section, I provide arguments in favor of the distinction between the two kinds of reduplication. The following section provides an analysis of consonant doubling, showing that this process is motivated by the issue of minimal stem size. An analysis of differing patterns follows, in which I show that when possible as much material from the base of affixation is faithfully realized in related forms. The last section discusses cases of total reduplication.

5.1 Two kinds of reduplication

Consider once again the differences between the two sets of data above. Phonologically, the difference can be described as follows. The consonant doubling forms typically have a structure like the following, where subscript numerals indicate identity.

(4) $C_1VC_2VC_2$

In contrast, the total reduplication forms all exhibit copies of both consonants:

(5) $C_1VC_2C_1VC_2$

Within work on Modern Hebrew, researchers have attributed the difference between these two types of forms to various factors. Most work on denominal verb formation in Hebrew considers the choice of 'template' (i.e. either consonant doubling or total reduplication) to be lexically determined. Such work includes Bat-El (1989, 1994a) and Sharvit (1994). However, I will show in this chapter that in fact a morphological distinction between these two prosodic shapes is motivated. It turns out that all cases of total reduplication involve durative or repetitive meaning. Given this consistency of semantic content throughout the paradigm of total reduplication, I claim that such forms involve an actual morpheme that induces reduplication (i.e. RED), and therefore a base-reduplicant correspondence relation. However, cases of consonant doubling, are cases of copying triggered by solely prosodic considerations and thus do not involve any RED morpheme at all. This view has been advocated by other researchers as well for both related and unrelated languages; see Rose (1997) for Ethio-Semitic and Kawu (2000) for Temiar.[2]

From a theoretical perspective, it is important to understand the formal differences between these approaches. Consider the cases of total reduplication. In such cases, a RED morpheme in the input induces a Base-Reduplicant (BR) correspondence relation:

[2] Gafos (1998), however, assumes a reduplicative correspondence relation for Semitic and Temiar. At the same time, the implementation of this correspondence relation in Gafos's account does not involve a RED morpheme with morphological content, so his account seems to be similar to what is proposed here.

(6) Reduplicative correspondence

/i_1 e_2 - n_3 a_4 m_5 - RED/

[n_3 i_1 m_5 n_3 e_2 m_5]

RED forces copying of as much material as will fit within the allowed fixed prosody; in this case, as we have established for Modern Hebrew, this fixed prosody is a bisyllabic stem. Given the phonology of the language, this allows both consonants to be copied, but not the vowel *a* of the base; doing so would violate the fixed prosody, as would copying the affixal vowels. Compare total reduplication cases to those with consonant doubling. In the cases of total reduplication, *all* consonantal material is reduplicated, because it will all fit within the allowable maximal stem. The cases of consonant doubling do not involve any reduplicative morpheme RED because if they did they would then undergo total reduplication. In other words, there is no principled motivation for positing RED in cases of consonant doubling.

To illustrate the correspondence relations at work in such cases, consider the following example:

(7) Consonant doubling correspondence

/i_1 e_2 - d_3 a_4 m_5/

[d_3 i_1 m_5 e_2 m_5]

In these cases, the stem-final consonant (e.g., *m* in *dam*) appears twice in the related denominal verb form (e.g., *dimem*). This occurs, I claim, as an example of fixed prosody: the verb must be bisyllabic, and if the input /dam-i e/ surfaced faithfully, this fixed prosody would be violated:

(8) Faithful parse of /dam-i e/

*.di.a.em.

This trisyllabic output violates fixed stem bisyllabicity, achieved through prosodic constraints ranked as discussed in the previous chapter. It also violates ONSET, a constraint that is undominated in Hebrew. In order to avoid these violations, there are several possible solutions, which will be explored and discussed in detail in the following section. The essential point raised here is the distinction between the two kinds of copying attested in Semitic.

5.2 Modern Hebrew denominal verbs

Modern Hebrew possesses a derivational paradigm whereby verbs are derived from nouns, and occasionally adjectives. These verbs are referred to as denominal verbs, and the process that forms them is referred to as Denominal Verb Formation (DVF). I refer to the respective noun to which each denominal verb is related as its *base*. We may divide these denominal verbs into two classes: on the one hand, those whose bases contain three or more consonants, and on the other hand, those whose bases contain two consonants. In this chapter, I will devote the majority of the discussion to cases of biliteral verbs, or those whose bases have two consonants. The analysis that is developed below shows that denominal verbs must be derived from their related bases (which are themselves output forms), and not from consonantal roots. To begin, consider representative examples of biliteral denominal verb formation in Hebrew. These verbs surface in a variety of patterns.

5.2.1 Biliteral forms: the four patterns

The following schematic representation illustrates the four possible patterns for biliteral denominal verbs.

(9) Biliteral denominal verb patterns

(a) C_1 i C_2 e C_2

(b) C_1 i j e C_2

(c) C_1 i v e C_2

(d) C_1 i C_2 C_1 e C_2

A biliteral base can surface as a denominal verb (a) with the second consonant appearing twice (consonant doubling), (b, c) with *j* or *v* occupying the second onset position, or (d) with each base consonant appearing twice (total reduplication). In the overwhelming majority of these verbs, the vocalic pattern is *i e*. This pattern is characteristic of the binyan to which all of these verbs belong (the piʕel); I will focus only on this pattern here. Let us now turn to some actual data that illustrate these patterns.

5.2.1.1 Consonant doubling: $C_1iC_2eC_2$

As discussed above, in the first pattern, known as *consonant doubling*, the second consonant of the base appears twice in the denominal verb. All forms exhibiting this pattern contain only low vowels in the base. Both monosyllabic and bisyllabic bases are realized similarly as denominal verbs; such cases of consonant doubling result in the pattern $C_1iC_2eC_2$:

(10) $C_1iC_2eC_2$

Base	*Gloss*	*Related denominal verb*	*Gloss*
t͡sád	‘side’	t͡sidéd	‘he sided’
sám	‘drug’	simém	‘he drugged, to poisoned’
dám	‘blood’	dimém	‘he bled’
xád	‘sharp’	xidéd	‘he sharpened’
maná	‘portion’	minén	‘he apportioned’

5.2.1.2 C_1ijeC_2

In this pattern the resulting verb contains the first and second consonants of the base at its right and left edges respectively, and the medial position is occupied by *j*, resulting in the shape C_1ijeC_2. Again, we see that both monosyllabic and bisyllabic bases behave similarly.

(11) *j*-forms

Base	*Gloss*	*Related denominal verb*	*Gloss*
tík	‘file’	tijék	‘he filed’
búl	‘stamp’	bijél	‘he stamped’
ʔír	‘city’	ʔijér	‘he urbanized’
kís	‘pocket’	kijés	‘he pickpocketed’
buʃá	‘shame’	bijéʃ	‘he put to shame’

In such forms, the vowel of the base is always a high vowel (*i* or *u*).

5.2.1.3 C_1iveC_2

This pattern resembles the previous pattern, except that instead of the glide *j*, we find *v* in medial position. In such forms, the vowel of the base is always a round vowel (*o* or *u*).

(12) *v*-forms

Base	*Gloss*	*Related denominal verb*	*Gloss*
súg	‘kind, type’	sivég	‘he classified, sorted’
ʃúk	‘market’	ʃivék	‘he marketed’
hón	‘capital, wealth’	hivén	‘he capitalized’
tóx	‘inside, midst’	tivéx	‘he mediated, arbitrated’
lúax	‘table’	livéax	‘he tabulated’

As will be made explicit below, the distribution of *j*-forms and *v*-forms emerges from constraint interactions that demonstrate the inadequacy of the consonantal root in denominal verb formation.

5.2.1.4 Total reduplication: $C_1iC_2C_1eC_2$

In the final pattern, each consonant of the base appears twice in the denominal verb, resulting in the shape $C_1iC_2C_1eC_2$. As in the cases above, monosyllabic and bisyllabic bases surface in the same shape when they are made into denominal verbs. In general, these verbs denote a durative or repetitive action. I refer to such cases as *total reduplication*.

(13) $C_1iC_2C_1eC_2$

Base	*Gloss*	*Related denominal verb*	*Gloss*
héd	‘echo’	hidhéd	‘he echoed’
nám	‘sleep’	nimném	‘he dozed’
dáf	‘page’	difdéf	‘he turned pages’
káv	‘line’	kivkév	‘he drew a dotted line’
páx	‘jar, vessel’	pixpéx	‘he flowed, gushed’

5.2.2 Consonant clusters

Let us now compare the data above with denominal verbs formed from bases with consonant clusters, as seen below. Such verbs involve bases with three or more consonants. Such consonant clusters are usually preserved from a base to its related denominal verb, but as shown, consonant clusters in the base may be split up in some cases.

(14) Consonant clusters preserved from base to denominal verb (data from Bat-El 1994a)

(a) Forms with a final cluster in the base

Base	*Gloss*	*Related denominal verb*	*Gloss*
flírt	‘flirt’	flirtét	‘he flirted’
fáks	‘facsimile’	fiksés	‘he sent a fax’

(b) Forms with an initial and a medial cluster in the base

praklít	‘lawyer’	priklét	‘he practiced law’
ʃravráv	‘plumber’	ʃrivrév	‘he plumbered’

(c) Forms with medial clusters in the base

(c)	guʃpánka	‘approval, seal’	giʃpénk	‘he approved, sealed’
	nostálgia	‘nostalgia’	nistélg	‘he was nostalgic’

(d) Forms with triconsonantal clusters in the base

transfér	‘transfer’	trinsfér	‘he transferred’
streptíz	‘striptease’	striptéz	‘he performed a striptease’

(15) Consonant clusters *not* preserved from base to denominal verb

Base	*Gloss*	*Related denominal verb*	*Gloss*
xróp	‘nap’	xaráp	‘he took a nap’
blóf	‘bluff’	biléf	‘he bluffed’

These data illustrate that onset clusters in a monosyllabic base are split when there are no other clusters (cf. *flirt*/*flirtet* above). The forms with consonant cluster preservation show that information about the base form is necessary for the formation of the related denominal verb. In fact, such evidence figures crucially in Bat-El’s (1994a) analysis of DVF; the fact that clusters tend to be preserved illustrates that the consonantal root is not sufficient as the input to DVF, since extraction of the root from such forms obscures consonant adjacency relations. Since the focus of this chapter concerns biliteral denominal verbs, I will not discuss the issue of consonant clusters further. The analysis that follows concentrates on explaining the distribution of patterns of biliteral denominal verbs. As a guide to the analysis that follows, the table below summarizes key characteristics of each pattern:

(16) Summary of biliteral denominal verb patterns

Base form	*RED morpheme?*	*Form of related denominal verb*	*Is related denominal verb bisyllabic?*
C_1[a]C_2	no	$C_1iC_2eC_2$	yes
C_1[i]C_2	no	C_1ijeC_2	yes
C_1[u]C_2	no	C_1ijeC_2 or C_1iveC_2	yes
C_1[o]C_2	no	C_1iveC_2	yes
C_1[a]C_2	yes	$C_1iC_2C_1eC_2$	yes

Since one of the essential theoretical issues in the analysis of biliteral forms is the controversy of the base, or output, versus the root, the next section is devoted to motivating the output-based account, and laying the groundwork for demonstrating the inadequacy of an analysis that relies on the consonantal root.

5.3 Base versus root

5.3.1 New word formation

Much work on Hebrew has focused on the nature of word formation and root consonants (e.g., Bar-Adon 1978, Bat-El 1986, 1989, 1994a, 1996, Berman 1978, Bolozky 1978, McCarthy 1979, 1981, Morgenbrod 1981, Ravid 1990, Tobin 1990, Yannai 1970). A recurring question addressed in such work has to do with the input to word formation processes. One view is that consonants are extracted from an output form (a base) and associated to a particular template (Bat-El 1986, McCarthy 1979, 1981, McCarthy & Prince 1986). An opposing view is that the entire base serves as the input to forming a new word (Bat-El 1994a, Lederman 1982). In support of the latter approach, it has been argued that simply extracting the consonants from a base is not sufficient. Extracting the consonants obscures information about clusters in the base form, since the result is simply a string of consonants. Extraction, therefore, cannot account for the robust preservation of consonant clusters from bases to denominal verbs. As discussed above, these data have in common the property that consonant clusters which appear in the base are preserved in the resulting denominal verb. Such cases are important, in particular because other combinations of the consonants are potentially possible in MH as long as they obey the Sonority Sequencing Principle (SSP; e.g., Clements 1988, 1990, Jespersen 1904, Sievers 1881, Selkirk 1984b, Steriade 1982, Whitney 1865). For example, consider the case of *.pra.klit.* 'lawyer'/*.pri.klet.* 'he practiced law'. The unattested output **.par.klit.* is a possible word in MH; the consonant cluster found in such a form (namely [r.kl]) does not violate the SSP. However, this combination does not surface because the output must preserve the consonant clusters of the base. This phenomenon is termed Cluster Transfer by Bat-El (1994a), who makes the important observation that the base form must be directly involved in determining the shape of its related denominal verb. Her conclusion is that processes operate directly on the base, itself an output form. Bat-El (1994a) abandons the notion of root and appeals instead to stem modification (Steriade 1988), which allows direct reference to an output base form. Under such an analysis, stem modification acts directly upon the base and changes the vowels to reflect the verbal morphology (i.e., *i e*).

5.3.2 The first evidence for output-output correspondence

Bat-El (1994a) and Lederman (1982) both provide the first evidence against the root in Modern Hebrew. Their arguments concern derivational morphology, which is sometimes realized as a prefix or suffix. When morphologically complex nouns serve as the base for a related derived verb, it is frequently the case that the consonant of the derivational affix is part of the derived verb. The following data (from Bat-El 1994a) illustrate this:

(17) Consonantal affixes appear in derived forms

(a)	*Base*	*Gloss*
	hìtkamét͡s	‘he was stingy’
	kat͡sé	‘edge’
	mit͡sá	‘he exhaustd’
	hixzík	‘he held’
	safár	‘he counted’

(b)	*Inflected base*	*Gloss*
	kamt͡s-án	‘stingy person’
	kit͡s-on-í	‘extreme’
	ta-mt͡s-ít	‘summary’
	tà-xzuk-á	‘a maintenance’
	mi-spár	‘number’

(c)	*Derived verb*	*Gloss*
	hìtkamt͡sén	‘he was stingy’
	hikt͡sín	‘he brought to extremity’
	timt͡sét	‘he summarized’
	tixzék	‘he maintained’
	mispér	‘he enumerated’

Nominalizing affixes, such as the suffixes *-an*, *-on*, and the prefixes *ta-*, *mi-* are part of the derived verb in each case. Taking only what would be considered the consonantal root in each case as input to the derived verb would incorrectly result in the loss of such affixal material.

The issue of base versus root will be important throughout the analyses and discussions that follow. I claim that the properties of consonant cluster preservation and preservation of affixal material are not the only properties of bases that need to be realized in denominal verbs. Vowel quality of the base vowel may also be transferred to denominal verbs. Bat-El (1994a:589, fn. 16) suggests that this may be the case, but a complete account is not provided. My analysis, however, takes into consideration a set of data not investigated in previous work on MH denominal verb formation (Bat-El 1994a, Fox 1994, Gafos 1998, Sharvit 1994): data involving denominal verbs with medial *v*, as provided above. These data shed light on the problems associated with the variation attested in biliteral denominal verbs. The result is an account which relies on the entire base, without reference to consonantal roots, and which has strong predictive power.

5.4 The input to denominal verb formation

The crucial issue under consideration here is the input to denominal verb formation. It is clear that some part of the base is present as input to denominal verbs. This is seen clearly in the case of consonant doubling, in which both the second and third consonants of the denominal verb always correspond to the final consonant of the base. A more intriguing question is whether we need more than just information about the consonants of the base in order to form a denominal verb. As argued by Bat-El (1994a), information about consonant clusters must be preserved, but what happens when we consider more than the consonants? In the following sections, I study the effects of the base vowel on the distribution of denominal verb patterns.

5.4.1 Vowel quality and its effect on denominal verb patterns

The principal claim of this section is that the entire base, itself an output, serves as the input to denominal verb formation. This claim is supported by a closer examination of the variation attested in biliteral forms. I repeat the relevant data below. First, recall the forms with consonant doubling:

(18) Consonant doubling

Base	*Gloss*	*Related denominal verb*	*Gloss*
t͡sád	‘side’	t͡sidéd	‘he sided’
sám	‘drug’	simém	‘he drugged, to poisoned’
dám	‘blood’	dimém	‘he bled’
xád	‘sharp’	xidéd	‘he sharpened’
maná	‘portion’	minén	‘he apportioned’

All denominal verbs with consonant doubling have bases with the low vowel *a*. Now consider the denominal verbs whose medial consonant is *j*. All of these verbs have bases whose vowel is high, either *i* or *u*.

(19) *j*-forms

Base	*Gloss*	*Related denominal verb*	*Gloss*
tík	‘file’	tijék	‘he filed’
búl	‘stamp’	bijél	‘he stamped’
ʔír	‘city’	ʔijér	‘he urbanized’
kís	‘pocket’	kijés	‘he pickpocketed’
buʃá	‘shame’	bijéʃ	‘he put to shame’

Finally, recall the denominal verbs in which the medial consonant is *v*. All of these denominal verbs are formed from bases whose vowel is round, either *u* or *o*.

(20) *v*-forms

Base	*Gloss*	*Related denominal verb*	*Gloss*
súg	‘kind, type’	sivég	‘he classified, sorted’
ʃúk	‘market’	ʃivék	‘he marketed’
hón	‘capital, wealth’	hivén	‘he capitalized’
tóx	‘inside, midst’	tivéx	‘he mediated, arbitrated’
lúax	‘table’	livéax	‘he tabulated’

These observations have not been pointed out previously in the literature, as far as I am aware. The above correlations are striking; we observe a pattern which can be described very broadly as follows: the shape of the denominal verbs depends on the vowel of the base. When the vowel is low, consonant doubling is attested. When the base contains a high vowel, the denominal verb has *j* in medial position. And finally, when the vowel of the base is round, the denominal verb has *v* in medial position. Note that this description is not completely precise, because the vowel *u* is both high and round. Thus, there are cases in which a base with *u* surfaces as a denominal verb with *j* (e.g., the pair *bul*/*bijel*), and there are also cases in which a base with *u* surfaces as a denominal verb with *v* (e.g., *sug*/*siveg*). This observation will be fully explored below. At this point, the generalizations which have emerged so far illustrate that it is not enough to refer to only the consonants of the base as relevant to the formation of denominal verbs. Information about the vowel of the base is also present in some denominal verbs: namely, those with *j* and *v* in medial position.

This brings to light an important issue concerning these two sounds and their similarity. *j* is unquestionably a glide (that is, a non-syllabic vocoid; cf. Clements & Keyser 1983, Clements & Hume 1995, Kaye & Lowenstamm 1984, Levin 1985, Pike 1943, Sievers 1881, Among others). The status of *v* is not as clear. I claim that in the cases under investigation, *v* may be a correspondent of the vowel *u* and has a similar relation to *u* as that which exists between *i* and *j*. In other words, *v* may be treated here as a glide, a claim supported by the fact that Modern Hebrew *v* corresponds to *w* in older stages of the language. Observe the alternation between *u* and *w* which exists in the paradigm of the conjunctive prefix *wə-* "and" in Tiberian Hebrew. What is intriguing is that this prefix is not always realized as *wə-*. The data below illustrate the crucial alternation:

(21) *wə* + noun in Tiberian Hebrew (data from Bat-El 1994b)

(a) Before non-labials

Base	*Gloss*	'*wə-*' - *base*	*Gloss*
napʃii	'my soul'	wənapʃii	'and my soul'
tirooʃaam	'their wine'	wətiirooʃaam	'and their wine'
ħooʃek	'dark'	wəħooʃek	'and dark'
ʔemet	'truth'	weʔemet	'and truth'
ʕabaadim	'servants'	waʕabaadim	'and servants'

(b) Before labials

meeʔaa	'a hundred'	umeeʔaa	'and a hundred'
baanaw	'his sons'	ubaanaw	'and his sons'
bigdoo	'his dress'	ubigdoo	'and his dress'

These data show the alternation for the prefix meaning “and” in Tiberian Hebrew, but instead of the *ve-* allomorph seen in Modern Hebrew we see that Tiberian Hebrew uses *wə-*. The *u-* allomorph appears before a labial consonant.[3] These data provide further evidence for the variation between *v* and *u* in Hebrew, and we see that it is clear that Modern Hebrew *v* corresponds to a glide in a previous stage of the language. There exists some further evidence for treating *v* as a sonorant. When *v* is the target of regressive voicing assimilation, it behaves as an obstruent (e.g., *hivtiax* → *hiftiax* ‘he promised’). However, when [v] is a potential trigger, it behaves as a sonorant, in other words, it does not trigger voicing assimilation (e.g., *kvut͡sa* but **gvut͡sa* ‘group’, although there are some speakers who do say *gvut͡sa*).[4] Although it has been argued that even in Tiberian Hebrew the sound in question was pronounced *v* (see Khan 1996), further evidence exists for treating *v* as a glide in Modern Hebrew. There are cases in which *v* alternates with a round vowel, such as the *v* in *lehivaled* ‘to be born’, and the *o* in *nolad* ‘he was born’ and *holid* ‘he fathered’. In any case, it is clear that in Modern Hebrew *v* is one of the closest non-syllabic counterparts to *u*, so the correspondence between these two segments in denominal verb formation is unsurprising.

There are more facts that suggest that the vowel of the base must be part of the input to denominal verb formation. Consider the following data.

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[3] This allomorph occurs as well before initial clusters.

[4] Thanks to Outi Bat-El (p.c.) for pointing this out. See Barkai & Horvath (1978) for more on this issue in Hebrew and other languages

(22) Base *o* preserved in some denominal verbs

Base	*Gloss*	*Related denominal verb*	*Gloss*
kód	'code'	kodéd	'he encoded'
ʔót	'sign'	ʔotét	'he signaled'
xók	'law'	xokék	'he created a law'
róm	'height'	romém	'he raised, lifted'

Although exhibiting an exceptional pattern of verb by realizing the first vowel of the base fully faithfully, these denominal verbs show the strongest influence of a base vowel. As pointed out by Bat-El (1994a:580), this vowel transfer cannot be explained unless the denominal verb has access to the entire base from which it is formed. The novel claim here is that the correlations discussed above concerning the data illustrating *j*-forms and *v*-forms are also the manifestations of vowel transfer, the only difference being that in these cases the vowel of the base is realized as a glide or glide-like element in the related denominal verb.

We have seen compelling evidence for treating the input to denominal verb formation as the entire base, as opposed to only the consonantal root. With the base as input to DVF, I have argued that we can predict the shape of the denominal verb. This is because the vowel provides crucial information that determines which pattern a denominal verb will select.

5.4.2 The verbal affix

In addition to the base, there is one other morpheme present in the input to DVF. This morpheme is the vocalic pattern *i e*, which is characteristic of the verbal class to which the denominal verbs under investigation here belong. As seen above, occasionally the vocalic pattern is *o e*, but this pattern is marginal and depends on the presence of *o* in the base, as well as on other factors, which will be addressed below. I therefore assume that the underlying vocalic pattern *i e* is present in the input to each denominal verb. Note that admitting the vocalic pattern as a morpheme does not automatically entail that consonantal melodies exist as morphemes: the consonants are simply what remain after we overwrite the vocalic pattern.

5.5 Bisyllabicity in denominal verbs as fixed prosody

Turning now to an important characteristic of the outputs of denominal verb formation, we have seen that all denominal verbs in the data above share the property of bisyllabicity. One way to capture this generalization would be to claim that all verbs must conform to a bisyllabic template. However, as analyzed in detail in earlier chapters, such templatic constraints should be eliminated from the theory. This approach is continued here, showing in particular how the so-called bisyllabic template of denominal verbs may be derived from the interaction between other constraints.

5.5.1 Syllable alignment

Bat-El (1996:293) points out that "[t]he imposition of a prosodic template in Hebrew is robust in verbs: verb stems must be disyllabic." This is seen explicitly in Bat-El

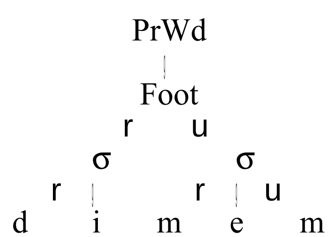
(1994a), as the imposition of a bisyllabic foot-sized template. In my analysis, however, this template is not imposed as a prosodic constraint such as “verb = [σ σ]”, but rather results from the effects of several independently motivated prosodic constraints. Several of these are the same constraints responsible for fixed prosody as illustrated in the previous chapter. The core ranking for emergent fixed prosody in Modern Hebrew denominal verbs is given in the following diagram.

(23) *Ranking for emergent fixed prosody*

FAITH-AFFIX
|
σ-ALIGN
|
MAX-OO

These constraints essentially require every denominal verb to be a single bisyllabic foot. For a denominal verb such as *dimem* ‘he bled’, the four constraints above produce a prosodic structure such as that below:

(24) Prosodic structure of *dimem* ‘to bleed’



We have achieved a bisyllabic foot dominated by a prosodic word without any reference to templates. In fact, this prosodic word is the minimal word for MH, as argued in the previous chapter, and in Bat-El (1994a, 1996), and its effects are seen not only in verbs but in MH blends as well. No templatic constraint, however, is necessary in order to specify the prosodic shape exemplified above.

5.6 Analysis of biliteral forms

In this section, I provide an account of denominal verbs formed from biliteral bases. I will demonstrate that in forming denominal verbs, the entire base must be taken as input, instead of only the root. I first focus on the case of consonant doubling.

5.6.1 Consonant doubling and STRONG-ANCHOR

Recall the data presented above, in which denominal verbs double the final consonant of the base:

(25) Consonant doubling

Base	*Gloss*	*Related denominal verb*	*Gloss*
t͡sád	'side'	t͡sidéd	'he sided'
sám	'drug'	simém	'he drugged, to poisoned'
dám	'blood'	dimém	'he bled'
xád	'sharp'	xidéd	'he sharpened'
maná	'portion'	minén	'he apportioned'

5.6.1.1 Anchoring and STRONG-ANCHOR-LEFT

An important observation about MH and Semitic in general is that initial consonants are extremely rarely doubled.[5] A crucial question that must be addressed is how to prevent the initial consonant from doubling and compel the final consonant to do so instead. My solution to this problem involves a new type of ANCHOR constraint (McCarthy & Prince 1995). McCarthy & Prince define ANCHOR as follows:

(26) {RIGHT, LEFT}-ANCHOR (S_1, S_2) (McCarthy & Prince 1995:371; see also Marantz 1982, McCarthy & Prince 1986:94, Prince & Smolensky 1993, Yip 1988)

Any element at the designated periphery of S_1 [e.g., the input] has a correspondent at the designated periphery of S_2 [e.g., the output].

Let *Edge*(X, {L, R}) = the element standing at the Edge = L(eft), R(ight) of X.

(i) ANCHOR-RIGHT: If x = Edge(S_1, R) and y = Edge(S_2, R), then $x\Re y$.

(ii) ANCHOR-LEFT: If x = Edge(S_1, L) and y = Edge(S_2, L), then $x\Re y$.

where $x\Re y$ stands for “x and y are in a correspondence relation.”

Using ANCHOR-LEFT to illustrate our example, ANCHOR can be formalized as follows:

(27) ANCHOR-L

$$\forall x, y\ [(x = \text{Edge}(S_1, L))\ \&\ (y = \text{Edge}(S_2, L))] \rightarrow [x\Re y]$$

---

[5] Some examples appear below.

In other words, if x is the leftmost element of the input, and y is the leftmost element of the output, then x corresponds to y. This constraint is violated when the leftmost segments of an input and output do not stand in correspondence. The following diagram, in which correspondence relations are represented with subscript numerals, illustrates the effects of ANCHOR-L:

(28) Violation and satisfaction of ANCHOR-L

	ANCHOR-L satisfied:	ANCHOR-L satisfied:	ANCHOR-L violated:
S_1:	$[_L\ \mathbf{b_1}\ a_2\ d_3\ u_4\ p_5\ i_6\ ]_R$	$[_L\ \mathbf{b_1}\ a_2\ d_3\ u_4\ p_5\ i_6\ ]_R$	$[_L\ \mathbf{b_1}\ a_2\ d_3\ u_4\ p_5\ i_6\ ]_R$
S_2:	$[_L\ \mathbf{b_1}\ a_2\ d_3\ u_4\ p_5\ i_6\ ]_R$	$[_L\ \mathbf{b_1}\ a_2\ \mathbf{b_1}\ d_3\ u_4\ p_5\ i_6\ ]_R$	$[_L\ a_2\ \mathbf{b_1}\ d_3\ u_4\ p_5\ i_6\ ]_R$

Subscript 'L' and 'R' designate the left and right edges, respectively. ANCHOR-L is satisfied whenever the leftmost element of S_1 has some correspondent at the left edge of S_2. From a logical standpoint, the formal definition of ANCHOR-L suggests additional types of ANCHOR constraints. Consider what results when we change the position of the elements in the conditional expression given above. For instance, consider the following rearrangement, where the second antecedent of the *if…then* expression changes places with the consequent:

(29) Second antecedent and consequent switched: STRONG-ANCHOR-L

$\forall x, y\ [(x = \mathrm{Edge}(S_1, L))\ \&\ (x \Re y)] \rightarrow [y = \mathrm{Edge}(S_2, L)]$

This expression, a constraint I name S(TRONG)-A(NCHOR)-L(EFT), states that if x is at the left edge of the input, and x and y stand in correspondence, then y is at the left edge of the output.[6] This disallows *internal* correspondents of input-left-edge elements, and in particular, has the effect of disallowing multiple correspondents of a segment that is at the left edge of the input. This is because the constraint entails that for an input-initial element, *every* correspondent of that element must be initial in the output: the correspondent of an edge element must itself be an edge element. Thus, doubling of input-initial elements is prohibited by such a constraint because *edgehood* is preserved under correspondence according this constraint. The diagram below illustrates the effects of S-ANCHOR-L.

(30) Violation and satisfaction of S(TRONG)-ANCHOR-L

	S-ANCHOR-L satisfied:	S-ANCHOR-L violated:	S-ANCHOR-L violated:
S_1:	$[_L\ \mathbf{b_1}\ a_2\ d_3\ u_4\ p_5\ i_6\ ]_R$	$[_L\ \mathbf{b_1}\ a_2\ d_3\ u_4\ p_5\ i_6\ ]_R$	$[_L\ \mathbf{b_1}\ a_2\ d_3\ u_4\ p_5\ i_6\ ]_R$
S_2:	$[_L\ \mathbf{b_1}\ a_2\ d_3\ u_4\ p_5\ i_6\ ]_R$	$[_L\ \mathbf{b_1}\ a_2\ \mathbf{b_1}\ d_3\ u_4\ p_5\ i_6\ ]_R$	$[_L\ a_2\ \mathbf{b_1}\ d_3\ u_4\ p_5\ i_6\ ]_R$

Note that S-ANCHOR-L is satisfied only when there is a unique correspondent of the element at the left edge of S_1 present at the left edge of S_2. I suggest that S-ANCHOR-L is responsible for the fact that base-initial consonants are never doubled (i.e., never have multiple correspondents) in Hebrew. Note the entailment relation between the two types of ANCHOR constraints: satisfaction of S-ANCHOR entails satisfaction of ANCHOR.

[6] The effects of the Strong Anchoring constraints closely mirror the effects of "Edge-in association" in Arabic as argued for by Yip (1988), who suggests similar analyses for Tigrinya, Tigre, Cupeño, and Yokuts. Hoberman (1988) argues for an "Edge-in" analysis of Syriac, and Buckley (1990) takes an "Edge-in" approach in his analysis of Tigrinya broken plural forms.

5.6.1.2 Generalized Edge-Anchoring

Given S-ANCHOR-L, how may we account for the fact the final consonants *are* doubled, as exemplified by consonant doubling in denominal verbs? That is, we do find multiple correspondents of non-initial base consonants. Following recent work by Nelson (1998) this analysis makes no use of any independent right-edge ANCHOR constraint. That is, the typology of anchoring includes the following constraints:

(31) Anchoring typology (Nelson 1998)

(i) ANCHOR-L(EFT) (as above:)

$\forall x, y\, [(x = \text{Edge}(S_1, L))\ \&\ (y = \text{Edge}(S_2, L))] \rightarrow [x\Re y]$

(ii) ANCHOR-E(EDGE)

$\forall x, y\, [(x = \text{Edge}(S_1, L))\ \&\ (y = \text{Edge}(S_2, L))] \rightarrow [x\Re y]$ *and*

$\forall x, y\, [(x = \text{Edge}(S_1, R))\ \&\ (y = \text{Edge}(S_2, R))] \rightarrow [x\Re y]$

According to this typology, there exists a constraint on the anchoring of left edges, as well as a constraint on the anchoring of *both edges at once*, but there is no constraint on the anchoring of the right edge alone. We can extend this generalization to the sub-family of Strong-Anchoring constraints. Clearly, in the Modern Hebrew cases of consonant doubling, STRONG-ANCHOR-LEFT is in force as an inviolable constraint, but the existence of consonant doubling of right-edge consonants may be taken as further evidence that there is no STRONG-ANCHOR-RIGHT constraint in effect. STRONG-ANCHOR-EDGE, a constraint requiring Strong Anchoring at both edges, is low-ranking with respect to STRONG-ANCHOR-LEFT. This results in the copying of right-edge consonants, since such copying violates a lower-ranking constraint.

Throughout the data, we find that every denominal verb ends in a consonant. Such final consonantism has been noted by many researchers (Gafos 1998, McCarthy 1993ab, McCarthy & Prince 1990a, Rose 1997, among others), and the solution to this phenomenon given in McCarthy & Prince (1993a) (and extended to Hebrew by Gafos 1998) is the constraint FINAL-C, which requires that a PrWd end in a consonant:

(32) FINAL-C (e.g., McCarthy 1993a:176)

$*V]_{PrWd}$

A prosodic word does not end in a vowel.

Such a templatic constraint is unnecessary in my approach. However, certain data necessitate a revision of part of the constraint ANCHOR-EDGE, a revision which turns out to mimic the effects of FINAL-C. Certain bases in denominal verb formation end in a vowel: words like *mana* 'portion', *bima* 'stage', *mila* 'word', and *buʃa* 'shame'. Out of the entire data set presented in the appendix to this chapter, these are the only four forms that end in a vowel (one other form, *xuga* 'circle, sphere', is also attested as *xug*, without the final *a*). Given the way ANCHOR-EDGE is currently defined, it will select the right edge of these base nouns (in other words, a vowel) and demand that this vowel have a correspondent at the right edge of the denominal verb. Obviously, this never happens; it is always the rightmost consonant of these forms that end up requiring a correspondent at the right edge of the denominal verb (i.e., *minen* 'he apportioned', *bijem* 'he staged', *milmel* 'he muttered', *bijeʃ* 'he put to shame'). Because of this, a refinement of ANCHOR-EDGE and is needed; specifically, a refinement of the definition of alignment at the right edge. This refinement could be stated as follows:

(33) RIGHT-EDGE ANCHORING

Let C_R = the rightmost consonant of a string:

$\forall x, y, [(x = (S_1, C_R)) \& [y = Edge(S_2, R)] \rightarrow (x \Re y)$

For S-ANCHOR-EDGE a similar revision is also necessary in the definition of alignment at the right edge. In this way the rightmost consonant of the base, which in the overwhelming majority of cases is also the final segment, will always have a correspondent at the right edge of the denominal verb. Vowel-final bases are thus compelled to have related denominal verbs ending in a consonant. The effects of these constraints will be illustrated in the following section.

5.6.2 Analysis

Recall that the entire base (as opposed to the consonantal root) is part of the input when a related denominal verb is formed. This claim was argued for and supported above, where it was shown that in many cases, the vowel of the base influences the shape of the denominal verb. However, although where possible this vowel must be realized in a denominal verb, the vowels of the affix, *i e* are generally always faithfully realized. This distinction is captured by the ranking motivated in the previous chapter, FAITH-AFFIX » MAX-OO. In addition, several other constraints play a role in the analysis:

(34) MAX-OO

Every element of the base has a correspondent in the output.

("No deletion")

(35) INTEGRITY (McCarthy & Prince 1995:372)

No element of the base has multiple correspondents in the output.

("No copying/doubling")

(36) DEP-OO

Every element of the output has a correspondent in the base.

("No epenthesis")

(37) (a) S-ANCHOR-L (cf. above)

(b) S-ANCHOR-E (cf. above)

Finally, besides the correspondence-theoretic constraints above, the analysis makes use of the well-formedness constraint ONSET:

(38) ONSET (Ito 1989, Prince & Smolensky 1993)

$*[_\sigma V$

I will first illustrate the analysis for consonant doubling. Consider, for example, the denominal verb *dimem* 'he bled', which is related to the base *dam* 'blood'. The following tableau shows the interactions between several constraints.

(39) *dimem* 'he bled' from *dam* 'blood'

	dam-i e	FAITH-AFFIX	MAX-OO	INTEGRITY
	a. damem	*!		*
	b. dimam	*!		*
☞	c. dimem		*	*

This tableau illustrates the ranking FAITH-AFFIX » MAX-OO, as established in the previous chapter. It is worth pointing out that satisfaction of both of these constraints is impossible, because of fixed prosodic considerations. The size restrictor constraint σ-ALIGN limits words to two syllables, so anything longer than this maximal length is ruled out.[7]

(40) *dimem* 'he bled' from *dam* 'blood'

	dam-i e	FAITH-AFFIX	σ-ALIGN	MAX-OO
	a. damime		*!	
☞	b. dimem			*

Having narrowed the field of potentially competing candidates the following tableau shows two competing INTEGRITY-violating candidates. The choice of optimal candidate in this case is decided by the ANCHOR constraints:

[7] Recall that the ranking FAITH-AFFIX » σ-ALIGN was motivated in the previous chapter.

(41) When doubling is compelled, only final consonants may double

	dam-i e	S-ANCHOR-L	S-ANCHOR-E	INTEGRITY
	a. didem	*!	*	*
☞	b. dimem		*	*

Candidate (a) is ruled out due to its violation of S-ANCHOR-L. By the ranking discussed earlier, candidate (b) emerges as optimal. In this candidate, the final consonant has doubled, while the initial consonant of the base has only one correspondent in the denominal verb. Note that ANCHOR-E is also needed, in order to rule out a vowel-final candidate.

(42) ANCHOR-E » INTEGRITY

	dam-i e	ANCHOR-E	INTEGRITY
	a. dime	*!	
☞	b. dimem		*

Finally, two more potential competitors are ruled out as follows:

(43) Epenthesis and hiatus are disallowed

	dam-i e	ONSET	DEP-OO	INTEGRITY
	a. dijem		*!	
	b. diem	*!		
☞	c. dimem			*

Both the constraints ONSET and DEP-OO are inviolable and thus epenthesis is not permitted. Again, INTEGRITY is ranked low enough to permit doubling, which is what occurs in the optimal candidate.

It is clear that the constraint INTEGRITY must be violable, for in all of the forms involving consonant doubling, there are multiple correspondents of one of the two consonants. Which of these consonants doubles is determined by the ranking S-ANCHOR-L » S-ANCHOR-E. In order to ensure a bisyllabic output as optimal, the constraints on fixed prosody must be high-ranking. The optimal candidate therefore must not parse one of the input vowels: the fact that it is the stem vowel which deletes in every case is due to the ranking FAITH-AFFIX » MAX-OO.

The account provided so far is appealing on several grounds. First of all, it is consistent in many ways with the account provided by Rose (1997) for similar data in Ethio-Semitic languages, a group of languages closely related to Modern Hebrew. Rose achieves the phenomenon of final consonant doubling (as opposed to the non-existence of initial-consonant doubling) by associating root consonants with moras in the input, and by requiring precedence relations among these associations to be maintained. In addition to requiring less richly specified input representations, the account provided here goes further than Rose's account in that the stipulative constraint FINAL-C does not need to be invoked. Instead, its effects are derived via the interaction between other constraints that are independently motivated; namely, S-ANCHOR-E and INTEGRITY. This result is positive, since it follows the spirit of deriving all templatic requirements (in this case, the requirement that a word must end in a consonant) from other constraints that are non-templatic in nature.

We can also compare the account given here to that of Gafos (1998). Gafos explains the effects of rightward 'spreading' in Hebrew using a constraint that aligns an affix with the right edge of the prosodic output (in addition to the constraint

FINAL-C). As pointed out by Rose (1997), however, there is no affix that could be responsible for consonant doubling, because of the strictly phonological nature of the 'reduplication.' In other words, there is no reduplicative morpheme (RED) involved in the formation of MH denominal verbs involving consonant doubling. S-ANCHOR-E states nothing about reduplicative morphemes, only that there is a correspondence relation between the right edges of denominal verbs and their bases. A different OT account, provided by Sharvit (1994), also relies on the presence of a reduplicative morpheme. Such an account is problematic for the same reasons.

In the following section, I turn to the cases of denominal verbs whose medial consonant is *j* or *v*. We will see that in such cases as well there is no reduplicative morpheme, and that the shape of such denominal verbs is accounted for through the interactions between ranked constraints. Here, the interaction between denominal verb formation and fixed prosody is more straightforward than in the cases of consonant doubling, since the entire base may fit into the fixed prosodic shape, as will be shown.

5.7 Denominal verbs with medial *j* or *v*

Recall the denominal verbs in which the medial consonant is either *j* or *v*. The data are repeated below for convenience.

(44) *j*-forms

Base	*Gloss*	*Related denominal verb*	*Gloss*
tík	'file'	tijék	'he filed'
búl	'stamp'	bijél	'he stamped'
ʔír	'city'	ʔijér	'he urbanized'
kís	'pocket'	kijés	'he pickpocketed'
buʃá	'shame'	bijéʃ	'he put to shame'

(45) *v*-forms

Base	*Gloss*	*Related denominal verb*	*Gloss*
súg	'kind, type'	sivég	'he classified, sorted'
ʃúk	'market'	ʃivék	'he marketed'
hón	'capital, wealth'	hivén	'he capitalized'
tóx	'inside, midst'	tivéx	'he mediated, arbitrated'
lúax	'table'	livéax	'he tabulated'

There are several observations concerning the data that must be explained. First of all, it is the case that every base form with *i* as its vowel has a related denominal verb whose medial consonant is *j*. Second, medial *j* and *v* are used when the base vowel is *u*. Finally, base forms with *o* have related denominal verbs whose medial consonant is *v*. The evidence is quite compelling: the entire base form is involved in determining the shape of the denominal verb. This is due, I claim, to relatively high-ranking correspondence-theoretic constraints which demand that every segment of the base have a correspondent in the related denominal verb. Recall the cases of consonant doubling, as analyzed above, in which the base vowel has no correspondent in the related denominal verb. This is due to the interaction between fixed prosody (which forces only two syllables in each denominal verb), FAITH-AFFIX, and MAX-OO. In those cases the base vowel has no correspondent because there was no way to realize it in the denominal verb without violating σ-ALIGN. However, in the cases where the base vowel is *i*, *u*, or *o*, it is possible for this stem vowel to be realized in the denominal verb. This realization is one that satisfies both FAITH-AFFIX and MAX-OO in addition to fixed prosodic considerations; namely, as a glide.[8]

5.7.1 Denominal verbs with *j*

Let us illustrate how such forms may fit entirely within the shape resulting from fixed prosody. Consider the base *tik* 'file.' Its related denominal verb, *tijek* 'he filed', contains correspondents for every segment of the base. The first and last consonants of the base, *t* and *k*, are realized as *t* and *k* respectively in the denominal verb. More interestingly, the vowel *j* of the base is realized as *j* in the denominal verb. This is because the vowel *i* of the base may be realized in such a way that allows satisfaction of fixed prosody, namely as the glide *j*. Consider the following tableau.

[8] Outi Bat-El (p.c.) points out the possibility that glottal stop could be the non-syllabic counterpart of the low vowel *a* in Hebrew. However, there are no denominal verbs derived from bases with *a* that have a medial glottal stop. The glottal stop could not be a non-syllabic counterpart of *a* because it is not a vocoid. Therefore, were it to appear as a correspondent of *a*, it would violate a high-ranking IDENT constraint. Both glottal stop and the glide *j* may function as epenthetic segments in Hebrew (*ʔuniversitaot* → *ʔuniversitaʔot* 'universities'; *tavnitot* → *tavnijot* 'patterns'), but this distribution seems to be phonetically determined. An explicit account of why consonant doubling takes place in denominal verbs whose bases contain *a* is presented below.

(46) Glide *j* as correspondent of high vowel in base: no doubling

tijek 'he filed' from *tik* 'file'

tik-i e	ONSET	σ-ALIGN	MAX-OO	INTEGRITY
a. .ti.i.ek.	*!	*		
b. .ti.kek.			*!	*
☞ c. .ti.jek.				

This tableau involves constraints we saw earlier in our analysis of consonant doubling cases; the same ranking is involved here. Candidate (a) is a faithful parse, but violates ONSET, in addition to the fixed prosodic constraint σ-ALIGN. Candidate (b) violates MAX-OO, since the *i* of the base *tik* has no correspondent. The *i* of **tikek* could correspond to both the *i* of the base and the *i* of the stem, but this would violate the constraint UNIFORMITY (McCarthy & Prince 1995:371), which prohibits coalescence. UNIFORMITY must be relatively high-ranking, therefore, and such a potential candidate is ruled out. Candidate (b) also violates INTEGRITY. Candidate (c), the optimal candidate, satisfies every constraint discussed so far, including FAITH-AFFIX. The base vowel *i* has a correspondent in the denominal verb, namely *j*.

The cases involving denominal verbs whose bases contain *i* are thus relatively easily explained. We have now discussed denominal verbs whose base vowels are *a* and *i*, and I will now turn to an account of verbs whose base vowel is *u* or *o*. We will not analyze forms whose bases contain the mid vowel *e*. Such forms are quite rare, and although the account presented here can shed some light on these cases it does not provide a conclusive explanation of their behavior.[9] Indeed, the account given

[9] Thanks to Outi Bat-El (p.c.) for providing data on verbs which derive from a base noun whose vowel is *e*.

here makes correct predictions for some of these verbs but not all. Given that *e* is both [coronal] and [-low], it is clear how the account so far predicts that bases with *e* will have related denominal verbs with the glide *j*. Such examples exist, such as *gijér* 'he made a convert' from *ger* 'stranger', and *ʃijém* 'he named' from *ʃem* 'name'. However, some bases with *e* have related denominal verbs with a doubled consonant, such as *kinén* 'he nested' from *ken* 'nest' and *tilél* 'he made mounds' from *tel* 'mound'. This disparate distribution of patterns is not neatly accounted for here, and obviously merits further research.

Perhaps the most interesting and curious case involves denominal verbs whose base vowel is *u*. As shown in the data above, some bases with *u* surface with *j* in their related denominal verb, while others surface with *v* in their related denominal verb. Let us first examine those cases in which a base with *u* has a related denominal verb whose medial consonant is *j*. Take, for example, the base *bul* 'stamp', the related denominal verb of which is *bijél* 'he stamped.' Given the analysis given above for *tijek*, it is logical to assume that there is a correspondence relation between the *u* in *bul* and the *i* in *bijél*. However, establishing this relation implies a more complicated scenario than presented for *tijék* above. In *tijék*, *j* shares the feature [high] with its correspondent *i* of the base *tik*. In fact, all segmental features of *i* and *j* can be analyzed as identical (e.g., Clements & Keyser 1983, Clements & Hume 1995, Hume 1992, Kaye & Lowenstamm 1984, Levin 1985, Pike 1943, Sievers 1881). In *bijél*, on the other hand, the *j* shares the feature [high] with its correspondent (*u* in *bul*), but the feature [labial] is not shared. These facts can be explained with two correspondence-theoretic constraints in addition to a partial markedness hierarchy. The correspondence constraints are from the IDENT family of constraints (McCarthy & Prince 1995:370; cf. also Ito & Mester 1997a, McCarthy & Prince 1994b:7, Pater 1995, Urbanczyk 1995).

(47) IDENT-PL(ACE)

Correspondents have identical specification for place features.

This constraint forces identical feature specifications for place features between corresponding elements. For *i* and *u*, I assume the following featural specifications:[10]

(48) Featural specifications of high vocoids

(a) [i/j]
r u
high coronal

(b) [u]
r u
high labial

For *v*, I assume the following featural specification:

(49) Relevant featural specification of *v*

[v]
|
labial

Recall that *v* is the nonsyllabic counterpart of *u* in Modern Hebrew, which lacks the glide *w*. Given these specifications, we have a clearer way of assessing

[10] Only relevant features are shown here. Arguments in favor of treating front vowels as coronal may be found in Clements 1976, Hume 1992, among others. Arguments for treating palatals as coronal appear in Clements 1991, Mester & Ito 1989, and Keating 1988, 1991, 1993.

correspondence between *i* and *j* on the one hand, and *u* and *j* or *v* on the other. One potential difficulty is characterizing the correspondence that exists between *u* and *j* in a case such as *bijél* 'he stamped' from the base *bul* 'stamp.' What needs to be explicitly addressed is the relation between *u* and *j*. Normally, we might assume that if there is an alternation between the vowel *i* and the glide *j*, a similar alternation exists between the vowel *u* and the glide *w*. Modern Hebrew lacks *w*, but if there is correspondence between *u* and *v*, the feature [labial] of *u* is realizable in a nonsyllabic segment. That is, the grammar of Modern Hebrew contains a constraint banning high labial vocoids in non-nuclear positions. This may be abbreviated by the following constraint:

(50) *[w]

The next best option, therefore, is to realize as many of the features in [high] and [labial] as possible. As we have seen, this means realizing either the feature [high], in which case the resulting segment is the glide *j*, or the feature [labial], in which case the resulting segment is *v*.

In case *u* is realized as *j*, the feature [high] is preserved. Since in nonnuclear positions [high] and [labial] are incompatible with each other (this would result in *w*, which is disallowed), only [high] may surface. Following Prince & Smolensky (1993, ch. 9) and Smolensky (1993), I assume that such cases are handled by markedness constraints:[11]

[11] In a sense, the assignment of [coronal] is similar to a default feature assignment. This is not a typical case of default segmentism, because it does not involve segmental epenthesis. It may be analyzed as a type of underspecification, in which

(51) *[lab] » *[cor]

This ranking forces [coronal] to be assigned. The hierarchy states that coronals (such as *j*) are less marked than labials (such as *v*). The combination of this hierarchy with the IDENT-PL constraint above explains why in *bijél* the correspondent of the base vowel *u* is *j* and not *v*. This is due to the ranking in the markedness hierarchy, as illustrated by the following tableau.[12]

(52) Glide *j* as correspondent of *u* in base

bijel 'he stamped' from *bul* 'stamp'

bu_1l-i e	IDENT-PL	*[lab]	*[cor]
a. biv_1el	*	*!	
☞ b. bij_1el	*		*

The crucial correspondence relations are indicated with a subscript numeral. In this case, the base vowel is *u*, which is specified as both [high] and [labial]. However, at a syllable margin only one of these features can be realized, not both, as discussed above (cf. the constraint *[w]). Candidate (a) in the tableau above violates IDENT-PL, because the [high] feature of the base vowel is lost in **bivél*. Candidate (b) also violates IDENT-PL, because the [labial] feature of the base vowel is not present in its

case the default is the result of filling in featural contents of segments that are not completely specified (e.g., Archangeli 1984, 1988, Broselow 1984, Herzallah 1990, Paradis & Prunet 1991, and Pulleyblank 1988). This can be viewed as a type of Emergence of the Unmarked, as pointed out by Kazutaka Kurisu (p.c.).

[12] For the sake of clarity, only crucial violations of the constraints *[lab] and *[cor] are indicated in the following tableaux. Since we are focusing here on the medial consonants of the denominal verbs, this means that only violations incurred by these segments are indicated.

correspondent. Candidate (b) emerges as optimal, because the *j* in *bijél* is less marked than the other option, *v*.

5.7.2 Denominal verbs with *v*

As the data show, however, this is not yet a complete analysis, because not all bases with *u* have related denominal verbs with *j*. A subset of bases with *u* actually do surface with *v* in the related denominal verb; such forms are listed below.

(53) Denominal verbs with *v* whose bases contain *u*

Base	*Gloss*	*Related denominal verb*	*Gloss*
súg	'kind, type'	sivég	'he classified, sorted'
ʃúk	'market'	ʃivék	'he marketed'
zúg	'couple'	zivég	'he paired'
lúax	'table'	livéax	'he tabulated'
dúax	'report'	divéax	'he reported'

Given the analysis presented above for *bijél* 'to stamp', we might expect the above denominal verbs whose bases contain *u* to be different; e.g., **sijég*, **ʃijék*, **zijég*, etc. In other words, our constraint ranking so far would predict *j* to be the medial consonant in every case given the markedness hierarchy between the segments *v* and *j*. However, in these cases *v* is always the medial consonant. There is something special about these data however; they share a striking characteristic concerning their base consonantism. In each case, the first base consonant is coronal, while the final consonant is dorsal. I claim that if the *u* of the base in each of these forms were to be realized as *j* (as we would expect following our analysis above involving simply the markedness hierarchy *[lab] » *[cor]), a higher-ranking constraint would be violated. This constraint reflects a type of Obligatory Contour Principle effect (OCP; cf. Goldsmith 1976, Leben 1973, McCarthy 1986, 1988, Mester 1986, among others). As stated by McCarthy (1988) the OCP appears as follows:

(54) OCP

Adjacent identical elements are prohibited.

A well known example of the OCP comes from Classical Arabic. This example involves the verb *samam* 'he poisoned.' Superficially, such an example appears to violate the OCP:[13]

(55) Violates OCP

```
          a
        r   u
C   V   C   V   C
|       |       |
s       m       m
```

However, McCarthy (1979, 1981) argues that in fact the root is not /*s m m*/, rather, it is /*s m*/, and that the OCP in fact does apply and is not violated by a form such as *samam*. This is accomplished through the use of a left-to-right spreading mechanism (McCarthy 1981:382), and results in a structure that does not violate the OCP:

[13] The representation here reflects McCarthy's (1979) analysis, in which morphemes are represented on separate tiers. In this case, the root is argued to contain the consonants, while the vowels indicate the binyan.

(56) Satisfies OCP

```
              a
            /   \
C   V    C    V  C
|              \  /
s               m
```

Here, the second root consonant *m* is multiply linked to the final two C-slots, resulting in *samam*. This explanation is not only harmonious with respect to the OCP but also explains why identical consonants are only allowed in second and third position in a $C_1VC_2VC_3$ structure, and never in first and second position. The situation becomes slightly more complicated in a language like Modern Hebrew, however, which poses a problem for the analysis seen here. Although Modern Hebrew generally prohibits identical consonants in first and second position, and contains a strikingly large number of words with identical consonants in second and third position (cf. the consonant doubling data above), there are some exceptions. Modern Hebrew contains (at least) four words with identical first and second consonants:

(57) Identical C_1 and C_2 in Modern Hebrew

Hebrew word	*Gloss*
mimén	'he financed'
miméʃ	'he realized'
nanás	'dwarf'
didá	'he limped'

These exceptions must somehow be explained. One suggestion comes from recent psycholinguistic work. Based on experimental evidence adduced by Berent &

Shimron (1997), Everett & Berent (1998) show that such types of words are the least acceptable to native speakers. They compared words involving identity in the first and second consonants, identity in the second and third consonants, and words with no identical consonants. The results of these experiments showed that speakers prefer words with no identical consonants, that words with identical second and third consonants are less acceptable, and that words with identical first and second consonants are the least acceptable.

Given these results, Everett & Berent (1998:14) motivate the high-ranking constraint *INITIAL IDENTITY:

(58) *INITIAL IDENTITY

The first two consonants of the root are nonidentical.

Such a constraint is not a correspondence-theoretic constraint; rather, it is a well-formedness constraint. However, this constraint is defined as a morpheme structure constraint, or a constraint on inputs, which is problematic for OT. This is because markedness constraints in OT target outputs and not inputs. If the forms violating *INITIAL IDENTITY are entered in the lexicon (that is, with initial first and second consonants), their exceptional status becomes somewhat more understandable. These forms violate not only the OCP, but they also violate *INITIAL IDENTITY. As such, Everett & Berent (1998) point out that this identity is not the result of any morphological process, and that this way of explaining the exceptionality of such forms is a matter of markedness. A different approach that seems to capture the same effects would posit some type of positional faithfulness constraint (following

Beckman 1997) prohibiting initial consonants from having correspondents in the same form. The issue of how such forms entered the lexicon of Modern Hebrew remains problematic. This issue certainly merits further exploration, though this will not be undertaken here.

Returning to our discussion of the OCP, further insight with respect to this principle has been provided by many researchers. For example, besides identical segments being prohibited, the OCP has been used to prevent identical adjacent Place (or Articulator) features and to explain root cooccurrence restrictions (e.g., McCarthy 1994, Mester 1986, Padgett 1995a, Yip 1989). Semitic languages exhibit such cooccurrence restrictions; a commonly cited such language is Arabic, and root cooccurrence restrictions in Arabic have been documented by many researchers (e.g., McCarthy 1994 for an OCP constraint relativized to Place features, and Frisch, Broe, & Pierrehumbert 1997, and Frisch 1998, for an account based on a gradient constraint that computes perceived similarity).

Let us now return to our analysis of Modern Hebrew denominal verbs with *j* and *v* in medial position. Recall the cases involving bases with *u* whose related denominal verbs contain *v* in medial position. Were *j* to surface in these denominal verbs, the OCP would be violated with respect to the place feature specifications of the consonants of the denominal verb, because the first and second consonants would both be coronal. With the OCP ranked above the partial markedness hierarchy *[lab] » *[cor], we will be able to force *v* to surface in exactly these cases. It is very important to note that this *v* is a correspondent of a base element. It is not simply inserted in order to satisfy the OCP; after all, we have already seen that DEP-OO is high-ranking. Rather, it is available (as manifestation of the feature [labial]) in the input (the base). The relevant OCP constraint is given below.

(59) OCP-PL(ACE)

Consonants with identical place specification (labial, coronal, dorsal) are disallowed within a stem.

This constraint needs further refining; indeed, this principle requires much further research in light of optimality-theoretic concerns. One suggestion is that the OCP applies only to non-correspondents within a form. This will prevent consonant doubling cases from incurring OCP violations. Another suggestion is that the given rankings will resolve the problem. The analysis that follows shows that the OCP is ranked below Faithfulness constraints, and therefore an OCP violation may not be avoided by resorting to an unfaithful parse. In addition, this OCP constraint may need to be prevented from applying to second and third consonants. With respect to the main theoretical point of this work, I do not mean the OCP here to specifically target consonants as though the consonants form some sort of constituent (a root). It is clear from similar OCP effects in other languages (e.g., Russian; cf. Padgett 1995a) where no evidence for consonantal roots exists that just consonants are targeted by whatever type of constraint is at work. A possible elaboration that allows reference to the consonants of a form without assuming a consonantal root involves a type of analysis proposed in Archangeli & Pulleyblank (1987), where two types of feature-geometric scansion, minimal and maximal, are permitted. Another possibility is the approach of Selkirk (1993), where the notions of root vs. tier adjacency and primary vs. nonprimary place could help. This important issue is related to much current work on locality, such as work by Gafos (1996) and Ní Chiosáin & Padgett (to appear).

The constraint OCP-PL, like all well-formedness constraints in OT, evaluates outputs. The following tableau illustrates the analysis.

(60) *siveg* ‘to classify’ from *sug* ‘type’

sug-i e	IDENT-PL	OCP-PL	*[lab]	*[cor]
a. sijeg	*	*!		*
☞ b. siveg	*		*	

Candidate (a) violates the constraint OCP-PL, because both the first and second consonants are coronal. This is illustrated by the following representation of the first two consonants:

(61) OCP-PL violation

This structure violates OCP-PL. The coronal identity constitutes an OCP violation, which in this case can be avoided, as in candidate (b). Candidate (b) satisfies OCP-PL; the first consonant in this candidate is coronal while the second is labial, so an OCP violation is not incurred, as seen below:

(62) OCP-PL satisfied

```
  [s]           [v]
   |             |
[coronal]    [labial]
```

An issue raised by the analysis of such forms concerns the constraint IDENT-PL. Specifically, the question arises as to why we do not use individual faithfulness constraints; that is, split the more general IDENT-PL constraint into two separate constraints IDENT-HIGH and IDENT-LABIAL. The analysis of forms such as *siveg* provide us with a strong argument against such a formulation. Given the tableau above for *bijel*, we might speculate that IDENT-HIGH must outrank IDENT-LABIAL. However, forms such as *siveg*, in which the optimal candidate realizes the [labial] feature at the cost of not realizing the [high] feature in order to satisfy OCP-PL show us that it is not always optimal to realize the [high] feature. Thus, we would obtain the following situation:

(63) IDENT-HIGH and IDENT-LABIAL as separate constraints

	sug-i e	IDENT-HI	IDENT-LAB	OCP-PL	*[lab]	*[cor]
	a. sijeg		*	*!		*
☞	b. siveg	*			*	

The problem that arises is that the two separate IDENT constraints must be analyzed as crucially unranked with respect to one another. A violation of one counts equally as a violation of the other, and if either outranks the other we obtain the wrong results. This is inconsistent with the basic OT conception of strict domination (Prince & Smolensky 1993), under which each constraint must outrank or be outranked by every other constraint. Prince (1999) also argues against assuming IDENT constraints that refer to specific place features. In addition, Padgett (1995b:403-404) has presented further arguments against mention of specific features in certain constraints for cases of feature class spreading.

We may avoid this problem, however, with our original model, in which instead of two separate IDENT constraints we invoke one general IDENT-PL constraint, which simply assesses violations for mismatch in place features in correspondent segments without evaluating which specific place features are at issue. In other words, with the monolithic IDENT-PL constraint, a violation of IDENT-HIGH counts as much as a violation of IDENT-LABIAL, without explicitly mentioning these (or any other) features. As an alternative to the monolithic IDENT-PL constraint, one might suggest that the situation here provides evidence for allowing the separate IDENT constraints and ranking OCP-PL above both IDENT-HIGH and IDENT-LABIAL, but this suggestion cannot be correct for these cases, as will be shown below.

Another question at this point is why every base whose first consonant is coronal doesn't surface with *v* in the medial consonant position in the related denominal verb. Consider *tijék* 'to file,' which was discussed and analyzed above. The optimal output violates the OCP, as shown in the following tableau, where crucial correspondence relations (if present) are indicated with subscript numerals.

(64) Segmental faithfulness may compel violation of OCP-PL

	ti_1k-i e	DEP-OO	IDENT-PL	OCP-PL	*[lab]	*[cor]
	a. tivek	*!			*	
☞	b. tij_1ek			*		*

It is potentially possible to rescue the output from an OCP-PL violation, as seen in candidate (a). However, such a candidate violates high-ranking DEP-OO, because the segment *v* in **tivék* has no correspondent in the base. This is in striking contrast with forms such as *sivég* above, where the *v* corresponds to the base vowel *u*. Of course, we must also consider a candidate whose phonetic realization is identical to that of candidate (a) in the tableau above but in which there is a correspondence relation between the *v* in the candidate and the base vowel. Our IDENT-PL constraint correctly predicts that such a candidate will not emerge as optimal, thus showing that OCP-PL must be ranked below IDENT-PL:

(65) Featural faithfulness may compel violation of OCP-PL

ti_1k-i e	DEP-OO	IDENT-PL	OCP-PL	*[lab]	*[cor]
a. tiv_1ek		*!		*	
☞ b. tij_1ek			*		*

Due to the correspondence relation between the base vowel and the *v* and *j* of candidates (a) and (b) respectively, we cannot assess a DEP-OO violation in this candidate. However, candidate (a) does violate IDENT-PL; it contains a *v* corresponding to the *i* of the base and is [labial] and not [high], while its correspondent in the input is [high] and not [labial].

Besides the forms that take *v* with *u* as their base vowel, we must also analyze the cases in which the base vowel is *o*. Aside from several cases to be discussed below, bases with *o* as their vowel take *v* in their related denominal verbs. The following data illustrate this.

(66) Bases with *o* that have *v* in their related denominal verbs

Base	*Gloss*	*Related denominal verb*	*Gloss*
hón	'fortune'	hivén	'he capitalized'
tóx	'inside, center, midst'	tivéx	'he mediated, arbitrated'
kód	'code'	kivéd[14]	'he coded, encoded'

The number of such forms is very small. In these forms, the [labial] feature of the base vowel *o* is realized as *v*, MAX-OO. The following tableau illustrates how the optimal form is chosen.

(67) *o* in base

	to_1x-i e	DEP-OO	IDENT-PL	OCP-PL	*[lab]	*[cor]
	a. tij_1ex		*!	*		*
	b. tij_9ex	*!		*		*
☞	c. tiv_1ex				*	

Candidate (a), in which the base vowel *o* corresponds to the *j* of **tijéx*, incurs a fatal violation of the IDENT constraints. This is because the *o* of the base is [labial] and not [high]; the corresponding *j* of this failed candidate, however, is not [labial] and is [high]. Candidate (b), in which *j* is epenthesized and therefore does not correspond to the base vowel *o*, is ruled out because it incurs a fatal violation of high-ranking OO-DEP. Candidate (c), in which the base vowel *o* is realized as *v*, emerges as optimal. This candidate has *v* as its medial consonant. Therefore, the [labial]

[14] This form appears to be very marginal. Although listed in Zilberman (1993), a majority of native speaker informants claim that this form does not exist. Note that it is identical in meaning to *kodéd*.

specification of the base vowel is preserved, and since this segment corresponds to the base vowel *o* there is no DEP-OO violation.

This concludes our analysis of denominal verbs whose medial consonant is *j* or *v*. As I have shown, such forms involve a correspondence relation between the base vowel and this medial consonant. This relation provides strong evidence against the consonantal root as the input to denominal verbs, because it is impossible to predict the form of these denominal verbs with only the root consonants and no information concerning the base vowel. Such forms are contrasted with the cases involving consonant doubling analyzed above, in which no such relation was posited. This is because in cases of consonant doubling the base vowel is consistently *a*. *a* has no possible realization in a form that is restricted to two syllables in which the vocalism of the verbal morphology takes precedence over the stem vocalism. This is expressed through the ranking FAITH-AFFIX » MAX-OO.

To complete the discussion of these denominal verbs, I present a tableau illustrating why the consonant doubling cases behave differently from those with *j* or *v* in medial position. Recall that all denominal verbs with consonant doubling have bases with the vowel *a*. In order for this vowel to have a correspondent, the correspondent will have to be non-syllabic, as in the cases of *i* (which is realized as *j*), *u* (which is realized as *j* or *v*), and *o* (which is realized as *v*). However, the closest non-syllabic counterpart to the vowel *a* is *ʔ*, which, following many previous researchers, is non-sonorant (Ladefoged 1971, Hyman 1975, Schane 1973; cf. Lombardi 1997 for an implementation of this claim in OT with respect to place markedness hierarchies). This correspondence between *a* and *ʔ* is in contrast to that between non-low vowels and their non-syllabic counterparts, all of which are sonorant. Thus, cases of consonant doubling motivate a ranking between IDENT-SON and MAX-OO, as illustrated below:

(68) Consonant doubling instead of full correspondence

	da_1m_2-i e	IDENT-SON	MAX-OO	INTEGRITY
	a. $di\text{ʔ}_1em_2$	*!		
☞	b. dim_2em_2		*	*

In the following section, I turn to some further cases of denominal verb formation. These cases seem exceptional in nature because they involve an affixal segment that appears not to be faithfully parsed, which comes as a surprise given the important role played by the constraint FAITH-AFFIX in the analyses so far. Below, I sketch a possible account of the strange behavior exhibited by denominal verbs whose vocalic pattern is *o e*.

5.7.3 Denominal verbs with the vocalic pattern *o e*

Recall the exceptional cases in which the first vowel of some denominal verbs is *o* instead of *i*.

(69) *o* in denominal verb

Base	*Gloss*	*Related denominal verb*	*Gloss*
kód	‘code’	kodéd	‘he coded, encoded’
ʔót[15]	‘sign’	ʔotét	‘he signaled’
xók	‘law’	xokék	‘he created a law’
róm	‘height’	romém	‘he raised, lifted’

These data have been discussed by Bat-El (1994a) and were mentioned above in support of our argument against roots. These data show that each denominal verb with *o* instead of *i* as its first vowel is related to a base whose vowel is *o*. Only an account which takes the entire base as the input to denominal verb formation will be able to capture this generalization, since reference to only root consonants obscures information about base vowels.

Rather than provide a definitive account of such cases, I would like to sketch a possible analysis here. This suggestion involves an instability within the grammar; that is, within the constraint ranking proposed up to this point. Let us briefly review the analysis of a typical case in which a base vowel *o* is realized as *v* in the related

[15] This base noun is interesting, because it has two meanings, ‘sign’ and ‘alphabetical symbol’. The denominal verb related to the noun ‘sign’ is *ʔotét* ‘he signaled’, while the denominal verb related to the noun ‘alphabetical symbol’ is *ʔijét* ‘he spelled’. *ʔijét* is the sole exception to the analysis of consonant doubling above; its base vowel is *o*, yet it surfaces with no correspondent of the base vowel. One option might be for it to surface as *ʔivét*, in which the base *o* corresponds to the *v*, but this is not the case. My suggestion for why we do not find *ʔivét* is that this form already exists in the language as an independent verb: *ʔivét* (historically *ʕivét*) ‘he distorted, perverted’. The reason *ʔót* ‘alphabetical symbol’ is not able to have a related denominal verb *ʔivét*, therefore, has to do with preserving contrast. Instead of having a related denominal verb which is homophonous with a verb that already exists, a different strategy is taken: the glide *j* is epenthesized. Perhaps this is an effect of Output-Output correspondence (Benua 1995, 1997, Burzio 1998, Kenstowicz 1994, 1995, 1997) or Paradigm Uniformity (e.g., Steriade 1996). Interestingly, the blocking explanation does not explain why the existence of *ʔijér* ‘he illustrated’ does not block the attested form *ʔijér* ‘he urbanized’ from *ʔir* ‘city’.

denominal verb. Such cases involve the realization of a vowel as a nonvocalic element, that is, *v*. One constraint violated by such correspondence has not yet been discussed, namely an IDENT constraint, which evaluates identity between corresponding elements in two strings. In particular, this constraint evaluates moraicity between correspondents.[16]

(70) IDENT-μ (e.g., Katayama 1998:54)

Let x be a segment in S_1 and y be any correspondent of x in S_2. If x is [α-moraic], then y is [α-moraic].

This constraint is violable in the forms we have analyzed so far. This is illustrated below, with only the relevant faithfulness constraints shown.

(71) FAITH-AFFIX » FAITH-OO » IDENT-μ

μ ¦ to$_1$x-i e	FAITH-AFFIX	FAITH-OO	IDENT-μ
a. tij$_9$ex		*!	
b. to$_1$xex	*!		
☞ c. tiv$_1$ex			*

The optimal candidate *tivéx*, in which the *v* corresponds to the moraic base vowel *o*, violates IDENT-μ because *v* is not moraic. Turning now to the cases in which a base vowel *o* is realized as *o* in the related denominal verb, we see that such cases could possibly be analyzed as a reranking of the constraint IDENT-μ. This constraint

[16] Given that Modern Hebrew is quantity-insensitive, moraic structure is difficult to motivate in the language. I assume here that only vowels may be moraic.

becomes undominated, resulting in an absolute need to realize the *o* as *o*. Consider the tableau below for *xokék* 'he created a law'.

(72) IDENT-μ » FAITH-OO » FAITH-AFFIX

μ ¦ xo_1k-i e	IDENT-μ	FAITH-OO	FAITH-AFFIX
a. xij_9ek		*!	
b. xiv_1ek	*!		
☞ c. xo_1kek			*

This reranking is, admittedly, strange. It involves two constraints, IDENT-μ and FAITH-AFFIX, actually switching positions in the hierarchy. A question we need to address is how this reranking can take place within the same grammar. Such a reranking strategy seems overly stipulative, and lacks predictive power because we must state for exactly which cases this reranking takes effect. The type of reranking involved here is not the same as proposed by Ito & Mester (1995a), for example, to account for core-periphery effects in the lexicon.[17] The Hebrew cases at hand do not involve such lexical stratification, and are not instances of loanword phonology. In addition, this rereanking is apparently unavailable for cases of verbs whose related bases have the vowel *a*, *i*, or *u*. This problem needs to be further explored; for now I leave this issue and turn to our remaining cases concerning biliteral denominal verbs.

[17] Ito & Mester (1995a, 1999) base their arguments on cases of loanword phonology in Japanese, building on ideas originally proposed in Ito & Mester (1994). Their analysis is based on earlier work concerning loanwords and lexical stratification of Kiparsky (1968) and Saciuk (1969). For other work on the core-periphery structure of the lexicon, see e.g., Fukazawa (1998), Fukazawa, Kitahara, & Ota (1998), Ito & Mester (1998), Katayama (1998), Paradis & LaCharité (1996), Paradis & Lebel (1994), and Shinohara (1997).

Recall that the analyses of the cases involving denominal verbs with consonant doubling and with medial *j* or *v* make no reference to any reduplicative morpheme (RED). The consonant doubling cases in particular are analyzed as an instance of *phonological* reduplication, but not as an instance of *morphological* reduplication. Such morphological reduplication is the topic of the next section.

5.8 Analysis of total reduplication

Following numerous researchers (e.g., Bar-Adon 1978, Gesenius 1910, Rose 1997), such forms must be analyzed as involving an actual reduplicative morpheme. This is in contrast to the analysis of forms exhibiting consonant doubling and forms with medial *j* or *v*, in which no such morphological reduplication takes place. In Semitic, the morphological/semantic content contributed by the reduplicative morpheme (RED) signifies either repetitive or durative action,[18] as noted in work by Rose (1997) on Ethio-Semitic languages which exhibit similar phenomena. Some of the relevant data from Modern Hebrew are repeated below for convenience.

(73) Total reduplication

Base	*Gloss*	*Related denominal verb*	*Gloss*
héd	‘echo’	hidhéd	‘he echoed’
nám	‘sleep’	nimném	‘he dozed’
dáf	‘page’	difdéf	‘he turned pages’
káv	‘line’	kivkév	‘he drew a dotted line’
páx	‘jar, vessel’	pixpéx	‘he flowed, gushed’

[18] Thanks to Edit Doron for an enlightening discussion of this issue.

Again, I take as input to such denominal verbs the entire base and the verbal morphology, but unlike the previous analyses there is also a reduplicative morpheme (RED) specified in the input. This morpheme contributes the repetitive or durative semantic content associated with these cases, and there is a correspondence relation between RED and its output realization. This relation necessitates the following constraint in our analysis of cases involving total reduplication:

(74) MAX-BR

Every element of the base has a correspondent in the reduplicant.

Base in this definition refers not to the base form of the denominal verb, but rather to the base of reduplication in the output. Recall, though, that since verbs in Hebrew are limited to two syllables by the constraint σ-ALIGN, it is impossible to fully satisfy all of the faithfulness constraints. The input to a denominal verb exhibiting total reduplication includes the base noun, the verbal affix *i e*, and the morpheme RED. Only consonants end up being copied in such forms, because there is no room for vowels other than the affix. MAX-BR must therefore be dominated by FAITH-AFFIX.

(75) FAITH-AFFIX » MAX-BR

k_1 a_2 v_3-i_4 e_5-RED	FAITH-AFFIX	MAX-BR	MAX-OO
a. $k_1a_2v_3k_1a_2v_3$	**		
☞ b. $k_1i_4v_3k_1e_5v_3$		*	*

The MAX-BR violation assessed for candidate (b) results from the assumption that the base and reduplicant form contiguous strings in the output. Thus the base in this candidate could be either *kiv* or *kev*. Since *i* and *e* are clearly distinct (both morphologically and phonologically, in fact), a MAX-BR violation must be tallied for this candidate since neither can be a correspondent of the other. This candidate also violates MAX-OO, as it has no correspondent of the base vowel *a*. Candidate (a) clearly violates higher-ranking FAITH-AFFIX, since it fails to parse either of the two affixal vowels, and is therefore ruled out.[19]

To conclude this section, we have analyzed cases of denominal verbs with consonant doubling, cases in which the medial consonant is *j* or *v*, and cases of total reduplication. In each case, a different strategy is employed to arrive at bisyllabicity in the denominal verb. The following table summarizes each subtype:

(76) Summary of denominal verb patterns

Base form	*RED morpheme?*	*Form of related denominal verb*	*Is related denominal verb bisyllabic?*
C_1[a]C_2	no	$C_1iC_2eC_2$	yes
C_1[i]C_2	no	C_1ijeC_2	yes
C_1[u]C_2	no	C_1ijeC_2 or C_1iveC_2	yes
C_1[o]C_2	no	C_1iveC_2	yes
C_1[a]C_2	yes	$C_1iC_2C_1eC_2$	yes

[19] There exists another type of denominal verb whose pattern is very similar to the total reduplication cases under consideration here. These are verbs whose bases have three consonants, where the related denominal verb doubles the final consonant, much as in the cases of consonant doubling described above. These verbs, Outi Bat-El (p.c.) observes, seem to be associated with repetitive or durative action. Examples include: *xizrér* 'he iterated' from *xazár* 'he returned', and *ʔiʃrér* 'he reconfirmed' from *ʔiʃér* 'he confirmed'. I do not consider these cases here because they are not derived from biliteral bases, and in addition they are derived from other verbs, unlike the cases I am analyzing here, which are derived from nominal and adjectival bases. In addition, Bat-El mentions cases of total reduplication which have an alternative that does not involve total reduplication, such as *lixáx* 'he moistened' from *láx* 'moist' (in addition to *lixáx* there exists *lixléx*) and *mirmér* 'he embittered' from *már* 'bitter' (in addition to *mirmér* there exists *mirér*/*merér*). At this point, I suggest that the reason for the two possibilities in such cases is simply that one option involves a reduplicative morpheme and the other does not.

5.9 Summary

In this chapter I have analyzed a pattern of denominal verb formation in Modern Hebrew. This process takes a noun or adjective and produces a verb. I have explained the common characteristic among these denominal verbs, namely bisyllabicity, as a minimal word effect. Biliteral denominal verbs were shown to exhibit variation in their surface patterns. The first of these patterns, consonant doubling, was explained as involving correspondence relations between the base and the verb, though in such cases the base vowel has no correspondent in the related denominal verb.

These cases contrast with the second and third patterns, involving medial *j* or *v*. Here, we examined a correlation between the base vowel and the surface form of the related denominal verb. Such data provide strong evidence against roots, since with only consonantal roots, we cannot predict the medial consonant of the denominal verb. We saw that bases with the vowel *i* always surface with *j* in their related denominal verbs, while bases with *u* surfaced either with *j* or *v*, which I explained as an OCP effect. The final pattern involving biliteral bases was demonstrated to contain a reduplicative morpheme, thus resulting in denominal verbs with two instances of each base consonant.

We have seen over the course of the analyses provided here that the comprehensive treatment of DVF in MH must not make reference to any consonantal root. Such a proposal is not an entirely novel one (cf. Bat-El 1994a, Lederman 1982), and the analysis here bears out this claim. This analysis makes use of Correspondence

Theory (McCarthy & Prince 1995) in order to capture the relations between bases and their related denominal verbs. Within such an approach, we have shown such a theory to be a superior framework for analyzing all instances of DVF in Modern Hebrew.

5.10 Appendix[20]

5.10.1 $C_1iC_2eC_2$ (Consonant doubling)

(1)

Base	*Gloss*	*Related denominal verb*	*Gloss*	*Source*[21]
dám	‘blood’	**dimém**	‘he bled’	ES:128; Z:44
xám	‘hot’	**ximém**	‘he heated’	BE:586; ES:224; Z:92
xád	‘sharp’	**xidéd**	‘he sharpened’	ES:204; Z:84
t͡sád	‘side’	**t͡sidéd**	‘he sided with’	BE:586; ES:592; Z:225
sám	‘drug’	**simém**	‘he drugged, poisoned’	ES:495; Z:197
kár	‘cold’	**kirér**	‘he chilled, cooled’	ES:651; Z:244
gáf	‘limb, wing’	**gipéf**	‘he embraced, cuddled’	ES:107; Z:37
bád	‘cloth, material’	bidéd	‘he insulated’	ES:53; Z:20
gáv	‘back’	gibév	‘he heaped, piled up’	ES:86; Z:31
dál	‘poor’	dilél	‘he diluted’	BE:586; ES:126; Z:43
már	‘bitter’	**mirér**	‘he embittered’	BE:586; ES:425; Z:167

[20] The data that I provide below imply a fairly deterministic relation between morphologically-related forms based on the phonological evidence I have discussed in the paper. As several reviewers have pointed out, the relation between each base and its related denominal verb below is not always completely semantically transparent. However, I maintain that these forms are indeed related, and that these relations are captured through my account. It is important to mention that while denominal verbs in Modern Hebrew tend to preserve semantic transparency, this process has been taking place in the language over a long period of time and denominal verbs can be found in the Mishnaic and Midrashic literature. Given that many of these forms have existed for so long, it is not unreasonable that some of their meanings might tend to drift, thus obscuring the original semantic connection. This distinction is marked in the data that follow such that more or less transparently related pairs are bolded, while pairs that are not so clearly transparent are given in plain text.

[21] BE = Bat-El 1994a; ES = Even-Shoshan 1993; Z = Zilberman 1993.

rán	‘chant’	**rinén**	‘he sang, gossiped’	ES:679; Z:252
hás	‘silence’	hisés	‘he hesitated’	ES:157; Z:59
káʃ	‘straw’	**kaʃáʃ**	‘he gathered straw’	ES:653; Z:244
mád	‘gauge’	**madád**	‘he gauged, measured’	ES:342; Z:132
pát	‘bread, slice, piece’	**patát**	‘he crumbed, crumbled’	ES:589; Z:224
maná	‘portion’	**minén**	‘he apportioned’	BE:586; ES:390; Z:154

5.10.2 C_1ijeC_2

(2)

Base	*Gloss*	*Related denominal verb*	*Gloss*	*Source*
ʔíʃ	‘man’	**ʔijéʃ**	‘he manned’	ES:23; Z:10
ʔír	‘city’	**ʔijér**	‘he urbanized’	ES:22; Z:10
tík	‘file’	**tijék**	‘he filed’	BE:586; ES:759; Z:278
gís	‘column, corps’	gijés	‘he mobilized, enlisted’	ES:98; Z:34
mín	‘sort, type’	**mijén**	‘he classified, sorted’	ES:371; Z:146
kís	‘pocket’	**kijés**	‘he pickpocketed’	BE:586; ES:293; Z:114
síd	‘whitewash’	**sijéd**	‘he whitewashed’	BE:586; ES:487; Z:194
tív	‘(good) quality’	tijév	‘he improved’	ES:251; Z:100
bimá	‘stage’	**bijém**	‘he staged’	BE:587; ES:63; Z:23
búl	‘stamp’	**bijél**	‘he stamped’	BE:586; ES:63; Z:23
xúg(á)	‘circle, sphere’	xijég	‘he dialed’	BE:587; ES:213; Z:89
xút	‘thread’	**xijét**	‘he sewed, tailored’	ES:214; Z:89
kúr	‘melting pot, furnace’	**kijér**	‘he molded, modeled’	ES:293; Z:114
buʃá	‘shame’	**bijéʃ**	‘he put to shame’	ES:65; Z:24
ʔót	‘alphabetical symbol’	**ʔijét**	‘he spelled’	BE:586; ES:23; Z:10

5.10.3 C_1iveC_2

(3)

Base	*Gloss*	*Related denominal verb*	*Gloss*	*Source*
súg	‘kind, type’	**sivég**	‘he classified, sorted’	ES:481; Z:191
zúg	‘couple, pair’	**zivég**	‘he matched, paired’	ES:188; Z:80
ʃúk	‘market’	**ʃivék**	‘he marketed’	ES:704; Z:260
lúax[22]	‘board, table’	**livéax**	‘he tabulated’	ES:318; Z:122
dúax[23]	‘report, account’	**divéax**	‘he reported’	ES:118; Z:40
kód	‘code’	**kivéd**	‘he coded, encoded’	ES:619; Z:233
hón	‘capital, wealth’	**hivén**	‘he capitalized’	ES:143; Z:51
tóx	‘inside, center’	**tivéx**	‘he mediated, arbitrated’	ES:752; Z:274

[22] The vowel *a* here is epenthetic, though the reason for this is opaque on the surface. The final segment of this form is underlyingly a pharyngeal /ħ/ which is neutralized to [x] in most dialects of Modern Hebrew. (The denominal verb *liveax* ‘he tabulated’ also contains the vowel *a*).

[23] This noun is actually an acronym word, from ***d**in-ve-xeʃbón*. Note the vocalization of *v* to *u* in the resulting acronym word ***dúax***. This is quite interesting, especially in light of the variation between *v* and *u* in Modern Hebrew.

5.10.4 $C_1oC_2eC_2$

(4)

Base	*Gloss*	*Related denominal verb*	*Gloss*	*Source*
róm	‘height’	**romém**	‘he raised, glorified’	ES:669; Z:249
ʔót	‘sign’	**ʔotét**	‘he signaled’	BE:586; ES:14; Z:6
xók	‘law’	**xokék**	‘he created a law’	BE:586; ES:234; Z:87
kód	‘code’	**kodéd**	‘he coded, encoded’	Z:233

5.10.5 $C_1iC_2C_1eC_2$ (Total reduplication)

(5)

Base	*Gloss*	*Related denominal verb*	*Gloss*	*Source*
héd	‘echo’	**hidhéd**	‘he echoed’	ES:140; Z:49
láx	‘moist’	**lixléx**	‘he moistened’	ES:320; Z:123
hén	‘aye, yes’	**hinhén**	‘he said yes, nodded’	ES:155; Z:53
lév	‘heart’	livlév	‘he sprouted’	ES:315; Z:121
nám	‘sleep’	**nimném**	‘he dozed’	ES:459; Z:182
páx	‘jar, vessel’	pixpéx	‘he flowed, gushed’	ES:560; Z:216
káv	‘line’	**kivkév**	‘he hatched, shaded’	BE:587; ES:625; Z:235
dál	‘poor’	**dildél**	‘he impoverished’	BE:587; ES:125; Z:43
dáf	‘page’	**difdéf**	‘he turned pages’	BE:587; ES:130; Z:44
milá	‘word’	**milmél**	‘he muttered’	BE:587; ES:383; Z:150

Chapter 6:
Fixed prosody, near and far

In this chapter, the goal is to broaden the understanding of fixed prosody to languages other than Modern Hebrew. On the one hand, we will be examining a case of fixed prosody in Arabic, a language closely related to Hebrew. On the other hand, we will initiate a line of research into fixed prosody beyond the Semitic language family. The empirical focus of the second section of the chapter is the Austronesian language Mukah Melanau.

As in the previous chapters, the accounts of fixed prosody here are analyzed in an OT-based framework. The accounts make no reference to template-specific constraints; rather, fixed prosodic effects are explained through what are now familiar constraints on prosodic minimality and maximality.

6.1 Fixed prosody in Arabic

Arabic fixed prosody is observed in the verbal system, much like in Hebrew. Arabic also has a system of binyanim, or verbal classes, each of which has a core semantic force. The Arabic verbal system is illustrated here.

(1) Arabic productive verbal classes

Verb class	*Perfective active verb*	*Meaning*
I	faʕal	Underived
IV	ʔafʕal	Causative of I
VII	nfaʕal	Passive of I
VIII	ftaʕal	Passive, middle of I
X	stafʕal	Reflexive of I, IV
II	faʕʕal	Causative of I
V	tafaʕʕal	Reflexive of II
III	faaʕal	Reciprocal of I
VI	tafaaʕal	Reflexive of III

As in Hebrew, Arabic verbal forms for the most part seem to be bisyllabic. However, the more salient characteristic of Arabic seems to be the rigid requirements on foot structure. As will be seen below, feet in Arabic are always bimoraic. There are no degenerate feet, and there are no feet longer than two syllables. These facts are taken as evidence for an analysis that implements constraints parallel to those seen for Hebrew in chapter 4 but at different levels of prosodic structure. Specifically, whereas in Hebrew the branching requirement was imposed at the level of the prosodic word, in Arabic it is imposed at the level of the foot. Whereas in Hebrew the maximal size restriction was achieved through an alignment constraint at the level of the syllable and the prosodic word, in Arabic the size restriction is imposed through an alignment constraint between moras and feet.

6.1.1 A fixed prosodic approach and theoretical consequences

As in Hebrew, in Arabic fixed prosodic effects result from independently motivated constraints on prosodic and metrical structure, rather than on stipulative templatic constraints. The analysis makes use, once again, of output-output correspondence (Benua 1995, 1997, among others). This analysis follows McCarthy (1993), an approach in which the basic verbal class, or faʕal, serves as the base of affixation for the formation of the other verbal classes.[1] The theoretical approach advocated here, however, differs from McCarthy's account in that here we will make use of OT. The faʕal is taken as the base of affixation, and the affix for each binyan is attached. A set of prosodic constraints, already visible in the language, are responsible for the resulting fixed prosodic effects.

6.1.2 The input to each verbal class

Specifically, the affixation for each verbal class is as follows:

[1] Other recent work advocating a word-based analysis for Arabic includes Ratcliffe (1997, 1998), Darden (1992), McOmber (1995), and Benmamoun (1999, to appear).

(2) Arabic verbal affixes

a. IV is derived from I by prefixation of *ʔa*-.

b. VII is derived from I by prefixation of *n*-.

c. VIII is derived from I by infixation of *–t*-.

d. X is derived from I by prefixation of *sta*-.

e. II is derived from I by mora affixation.

f. V is derived from II by prefixing *ta*- to II.

g. III is derived from I by mora affixation.[2]

h. VI is derived from III by prefixing *ta*- to III.

6.1.3 Metrical structure of Arabic

The fixed prosodic account of the Arabic verbal system relies heavily on constraints independently needed to account for the metrical structure of the language. Here, I will analyze Modern Standard Arabic (MSA) as pronounced in the Levantine dialect. The observations that follow have been noted by others, including McCarthy & Prince (1990a) and Hayes (1995). Arabic constructs metrical feet from left to right in the form of moraic trochees (Hayes 1995). Stress is assigned to the rightmost foot. The data motivate the following constraints:

(3) FTBIN

Feet are binary.

[2] Vowel lengthening, rather than gemination, occurs as a result of homophony avoidance, to distinguish III from II. This issue will be addressed below.

(4) PARSE-σ

Every syllable is parsed by a foot

(5) FINAL-C[3]

Word-final consonants are nonmetrical.

(6) FTFORM

Feet are trochaic.

(7) RIGHTMOST (as in Modern Hebrew)

≡ ALIGN-R (σ́; PRWD)

("Stress falls at the right edge of the prosodic word.")

The data reflect the fact that FTFORM is undominated. All feet are trochaic in the language. Another undominated constraint is FINAL-C, which ensures that any word-final consonant is stray (i.e. not parsed by a syllable or mora). Word-final consonants never contribute to syllable weight/length, and are attached at the level of the prosodic word. The constraint PARSE-σ is violable; as we will see, not every syllable belongs to a foot. RIGHTMOST is also a violable constraint.

The constraint FTBIN will not be used in the following analysis. Instead, along the lines of the analysis pursued for Modern Hebrew above with respect to word binarity, foot binarity is divided into two constraints: one imposing a minimality

[3] This constraint differs from the usual constraint denoted by this term (cf. FINAL-C in the previous chapter.) Rather than demanding that a prosodic word end in a consonant, the constraint as intended in this analysis of Arabic simply requires word-final consonants to be extrametrical.

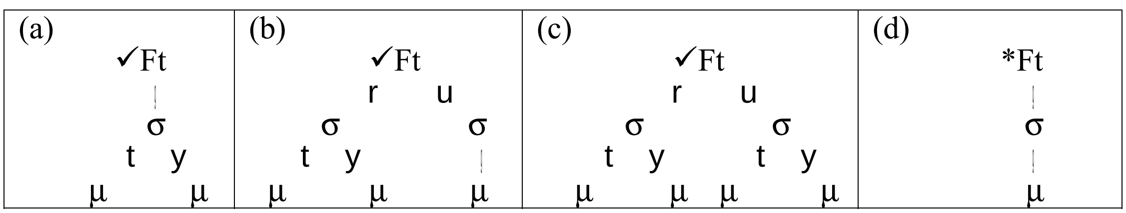
requirement, the other imposing a maximality restriction. The minimality requirement requires a foot to branch, similar to the branching constraint on prosodic words seen in Hebrew:

(8) FTBRANCH

A foot must branch, either at the level of the syllable or the mora.

This constraint rules out degenerate feet, since such feet do not branch at any prosodic level. The following illustration shows how the constraint is evaluated:

(9) FTBRANCH



The maximality condition, on the other hand, rules out feet that contain more than two moras. It is essentially another version of Hierarchical Alignment, this time between moras and feet.

(10) μ-ALIGN

Every mora must be aligned to the edge of some foot.

Like the syllable-based version of this constraint motivated for Hebrew, μ-ALIGN is a size restrictor constraint. It penalizes any foot that contains more than two moras. A strict interpretation of this constraint requires that onset segments be attached to the mora, and not to any higher level of prosodic structure, because otherwise they would prevent left-alignment of moras to higher categories. The following table illustrates μ-ALIGN.

(11) μ-ALIGN (offending moras are underlined)

(a)	(b)	(c)	(d)
✓Ft	*Ft	*Ft	✓Ft
¦	r u	r u	¦
σ	σ σ	σ σ	σ
t y	t y ¦	t y t y	¦
μ μ	μ μ̲ μ	μ μ̲ μ̲ μ	μ

The analysis of Arabic that follows does not necessarily require a distinction between μ-ALIGN and FTBRANCH, but in order to emphasize which of the two is responsible for the effects examined, they are distinguishes in the tableaux that follow.

The analysis, to be provided in detail below, assigns the following prosodic structures to the output of the formation of each verbal class in Arabic.

(12) Prosodic Structure of Arabic Verbs (foot boundaries are indicated by '[' and ']'.)

	Verb class	*Perfective active verb*
a.	I	[fáʕa]l
b.	IV	[ʔáf]ʕal
c.	VII	[nfáʕa]l
d.	VIII	[ftáʕa]l
e.	X	[stáf]ʕal
f.	II	[fáʕ]ʕal
g.	V	ta[fáʕ]ʕal
h.	III	[fáa]ʕal
i.	VI	ta[fáa]ʕal

6.1.4 Fixed prosody results from constraints on metrical structure

The analysis is illustrated in the following tableau for the first verbal class, or faʕal. This form is taken to be lexically listed, and its output realization is segmentally fully faithful. The tableau shows the prosodic structure assigned to the optimal output with these constraints.

(13) I: *faʕal*

/faʕal/	FINAL-C	FTFORM	FTBRANCH	μ-ALIGN	PARSE-σ
a. fa[ʕál]	*!				
b. [faʕá]l		*!			
c. [fá]ʕal			*!		*
d. [fáʕal]				*!	
☞ e. [fáʕa]l					

This tableau shows that the optimal form satisfies all four relevant constraints.

Next consider the derivation of verbal class VII from verbal class I. This requires the following morphology-to-prosody alignment constraint, a constraint type familiar from work of McCarthy & Prince (1993b).

(14) ALIGN-*n*

The affix *n* is aligned to the left edge of the prosodic word.

("*n* is a prefix.")

As seen in the following tableau, this constraint is undominated. In particular, it must dominate a similar alignment constraint demanding that the left edge of the stem be aligned to the left edge of the prosodic word.

(15) ALIGN–L

The left edge of the stem is aligned to the left edge of a prosodic word.

(16) VII: *nfaʕal*

n-faʕal	ALIGN-*n*	FINAL-C	FTFORM	ALIGN-L	PARSE-σ
a. nfa[ʕál]		*!		*	*
b. [nfaʕá]l			*!		
c. [fnáʕa]l	*!				
☞ d. [nfáʕa]l				*	

This justifies the following ranking:

(17) *Ranking*

ALIGN-*n*
|
ALIGN-L

The next form to be analyzed is form VIII. Like form VII, this form involves a consonantal affix. However, this form differs crucially from VII in that the affix is realized not as a prefix but as an infix, resulting in the coincidence of the left edge of the stem with the left edge of the word, and therefore satisfaction of the constraint ALIGN-L. Thus the alignment constraint demanding that *t* be realized at the left edge is outranked by ALIGN-L.

(18) Align-*t*

The affix *t* is aligned to the left edge of the prosodic word.

The following tableau shows the interaction between the constraints.

(19) VIII: *ftaʕal*

t-faʕal	FINAL-C	FTFORM	FTBRANCH	ALIGN-L	PARSE-σ	ALIGN-*t*
a. fta[ʕál]	*!			*	*	*
b. [ftaʕá]l		*!				*
c. [ftá]ʕal			*!		*	*
d. [tfáʕa]l				*!		
☞ e. [ftáʕa]l						*

As stated above, this motivates the ranking of ALIGN-L above ALIGN-*t*.

(20) *Ranking*

ALIGN-L
|
ALIGN-*t*

Next verbal class IV is analyzed. This form is special because it instantiates the first case of fixed prosody in the Arabic verbal system. In the formation of verbal class IV, the prefix *ʔa-* is attached to the *faʕal* (verbal class I). However, rather than surfacing faithfully as three syllables, the output deletes a vowel *a* from the base form, resulting in a bisyllabic output. The analysis makes crucial use of the constraint RIGHTMOST, which is in essence what forces fixed prosody to result. The tableau below illustrates the interactions among the relevant constraints.

(21) IV: *ʔafʕal*

ʔa-faʕal	FTFORM	PARSE-σ	RIGHTMOST	MAX-V
a. [ʔáfa]ʕal		*	σσ!	
b. [ʔafá]ʕal	*!	*	σ	
☞ c. [ʔáf]ʕal		*	σ	*

Thus the following ranking is motivated.

(22) *Ranking*

RIGHTMOST
|
MAX-V

Note that it is impossible to completely satisfy the constraint RIGHTMOST, because it is dominated by other constraints. Conceivably, RIGHTMOST could be satisfied by placing stress on the final syllable, as in *[*ʔafa*][*ʕál*], which also is segmentally faithful to the input. However, such a candidate violates the constraint FINAL-C.

(23) IV: *ʔafʕal*

ʔa-faʕal	FINAL-C	RIGHTMOST
a. [ʔafa][ʕál]	*!	
☞ b. [ʔáf]ʕal		σ

An attempt to circumvent this problem by not parsing the final consonant into the foot while maintaining stress on the final syllable fails, because such a candidate would fatally violate high-ranking FTBRANCH.

(24) IV: *ʔafʕal*

ʔa-faʕal	FTBRANCH	RIGHTMOST
a. [ʔafa][ʕá]l	*!	
☞ b. [ʔáf]ʕal		σ

Finally, consider yet another alternative failed candidate, **ʔa*[*fáʕa*]*l*. This candidate manages to avoid a violation of MAX by building its foot starting with the second syllable. This demonstrates a need for a further constraint requiring the left edge of the foot to be aligned to the left edge of the prosodic word. Note that this constraint is satisfied by all the forms analyzed so far.

(25) ALLFTL

≡ ALIGN-L (FT, PRWD)

The left edge of every foot is aligned to the left edge of some prosodic word.

(26) IV: *ʔafʕal*

ʔa-faʕal	AllFtL	Max-V
a. ʔa[fáʕa]l	σ!	
☞ b. [ʔáf]ʕal		*

A similar situation arises in the case of verbal class X, which involves the prefix *sta-*. Here, once again, the output is a bisyllabic form, resulting from the deletion of a vowel from the base form. The following tableau shows this.

(27) X: *stafʕal*

sta-faʕal	FtForm	Parse-σ	Rightmost	Max-V
a. [stáfa]ʕal		*	σσ!	
b. [stafá]ʕal	*!	*	σ	
☞ c. [stáf]ʕal		*	σ	*

The next set of forms involve more complicated affixational patterns. Consider first the case of verbal class II. This form is differentiated from verbal class I by the gemination of the stem-medial consonant. Following previous analyses (e.g., McCarthy 1993b), I take this as evidence that this form is derived through a morpheme whose underlying specification is a mora. This mora is realized in class II through gemination. However, it must be pointed out that gemination is not the sole manner in which this mora may surface. In fact, in a different verbal class, namely verbal class III, the same phonological material in the affix results not in gemination but rather in vowel lengthening. Somehow, both of these possibilities must be allowed in Arabic, but in a principled fashion whereby gemination is the mark of one verbal class, while vowel lengthening is the mark of another. Focusing on verbal class

II, with gemination, the following two constraints capture the behavior and surface realization of the affixal mora.

(28) IDENT$_V$-μ

Corresponding vowels have the same moraic specification.

(29) IDENT$_C$-μ

Corresponding consonants have the same moraic specification.

In the case of verbal class II, IDENT$_C$-μ is violated because the geminated consonant in the output is not geminated in the input, which in this case is the independently occurring verbal class I. The constraint IDENT$_V$-μ, however, outranks IDENT$_C$-μ because this verbal class is never realized with vowel lengthening, which would violate IDENT$_V$-μ. This is shown in the following tableau, where $μ_{II}$ indicates that a class II verb is derived.

(30) II: *faʕʕal*

$μ_{II}$-faʕal	IDENT$_V$-μ	IDENT$_C$-μ
a. [fáa]ʕal	*!	
☞ b. [fáʕ]ʕal		*

Thus the following ranking is motivated.

(31) *Ranking*

IDENT$_V$-μ
|
IDENT$_C$-μ

Interestingly, verbal class II serves as the base of affixation for one of the verbal classes, which is therefore not directly derived from verbal class I. This is verbal class V, which is formed by prefixing *ta-* to verbal class II. Doing so does not result in the reduction of this trisyllabic input to a bisyllabic form; rather, the material in the input surfaces faithfully. This is because implementing fixed prosody to result in bisyllabic forms, as seen in candidate (c) in the following tableau, for instance, would involve a violation of high-ranking FTBIN, since the foot in this candidate is trimoraic.

(32) V: *tafaʕʕal*

ta-faʕʕal	FTFORM	μ-ALIGN	RIGHTMOST	MAX-V
a. [táfaʕ]ʕal		*!	σσ	
b. [tafáʕ]ʕal	*!	*	σ	
c. [táfʕ]ʕal		*!	σ	*
☞ d. ta[fáʕ]ʕal			σ	

One other potential candidates needs to be ruled out. One is *[*táf*]*ʕal*, a bisyllabic output achieved by deleting the first half of the geminate in the input. This is ruled out because it violates IDENT$_C$-μ.

The next form in the analysis is verbal class III, which is derived in the same way as verbal class II: by affixation of a mora to the output of verbal class I. However, rather than gemination, verbal class III is characterized by a lengthening of the first vowel. Given the ranking motivated earlier between IDENT$_C$-μ and IDENT$_V$-μ, it seems unlikely that vowel lengthening could ever be optimal. Since we are dealing with a distinct morphological class, though, the relative markedness of the long vowel is justified, and is actually the result of an additional constraint. This constraint, AVOIDHOMOPHONY, prevents distinct morphemes from having identical phonological exponents. A similar notion has been developed by Padgett (2000), and stems from familiar concepts in Dispersion Theory (Flemming 1995) regarding the maintenance contrast. In this case, the relevant constraint prevents homophony, or morphological neutralization.

(33) A(VOID)H(OMOPHONY)

Two distinct morphemes must have distinct phonological realizations.

This constraint must dominate IDENT$_V$-μ, since the result of class III affixation is vowel lengthening. Were the result to be gemination, AH would be violated, because class II and class III would be indistinguishable. The force of AH is therefore to prevent homophony. Although the phonological specifications of the class II and class III affixes are identical (i.e. a mora), the phonological specification in each case is affiliated with a different morpheme: class II in one case, and class III in the other.

(34) III: *faaʕal*

μ$_{III}$-faʕal	AH	IDENT$_V$-μ
a. [fáʕ]ʕal	*!	
☞ b. [fáa]ʕal		*

Similarly to the case of class V as discussed above, verbal class VI is derived not from class I but from a different verbal class: in this case, verbal class III. Like class V, this takes place via prefixation of *ta*-.

(35) VI: *tafaaʕal*

ta-faaʕal	FTFORM	μ-ALIGN	RIGHTMOST	MAX-V
a. [táfaa]ʕal		*!	σσ	
b. [tafáa]ʕal	*!	*	σ	
c. [táf]ʕal			σ	*!*
☞ d. ta[fáa]ʕal			σ	

(36) *Ranking*

AH

|

PARSE-σ

|

IDENT-μ

To summarize this section, fixed prosodic effects in the Arabic verbal system have been analyzed here. These effects are the product of interactions between constraints on prosodic well-formedness and faithfulness constraints. The fixed prosodic effects in Arabic are similar in some ways to the fixed prosodic effects observed in Hebrew, but several differences between the two languages deserve mention. In Hebrew, the size restriction is implemented through a high-ranking constraint on alignment between syllable edges and word edges. In Arabic, this constraint is not responsible for the size restrictions seen, because the size restrictions are implemented at the level of the foot rather than the word. Thus in Arabic we have made use of the constraint FTBRANCH, to prevent feet smaller than two moras, in addition to the constraint μ-ALIGN, which limits feet to two moras in size.

In the following section, fixed prosodic effects in the Austronesian language Mukah Melanau are examined. The analysis provides cross-linguistic evidence from outside the Semitic language family for fixed prosody, and solves an intriguing problem that arises in the morphophonology of this language.

6.2 Fixed prosodic effects in Mukah Melanau

Mukah Melanau is a member of the Northwest Borneo group of Austronesian languages, and is spoken on the northern central coast of Sarawak in Malaysia. This language has been described by Blust, whose fieldwork, descriptions, and historical analyses of Mukah Melanau appear in Blust (1988, 1997). The data investigated here are taken from these works, and involve allomorphic alternations in the realization of the active and passive voice markers in Mukah.

6.2.1 The phenomenon: Prefixation vs. ablaut

The data I focus on concern three forms of verbs in Mukah. The basic form is an unaffixed stem, which may be either a verb or a noun. As a verb, it is usually interpreted as imperative (Blust 1997). There are two morphologically complex forms that are considered here as well: the active and passive forms. These forms present an intriguing allomorphy, which is conditioned by the phonological shape of the base of affixation, and can be divided into two principal surface patterns. The first of these patterns is a prefixational allomorphy: when the first vowel of the stem is any vowel other than schwa ([ə]), we find the prefixed allomorph (*mə-* or *nə-* if the stem is consonant-initial; *m-* or *n-* if the stem is vowel-initial):

(37) Affixation to consonant-initial verbal bases with full vowel

	Unaffixed	*Active*	*Passive*	*Gloss*
a.	biləm	məbiləm	nəbiləm	'blacken'
b.	gutiŋ	məgutiŋ	nəgutiŋ	'cut with scissors'

(38) Affixation to vowel-initial bases with full vowel

	Unaffixed	*Active*	*Passive*	*Gloss*
a.	aŋit	maŋit	naŋit	'anger'
b.	ituŋ	mituŋ	nituŋ	'count'
c.	ulin	mulin	nulin	'rudder'

The second allomorph occurs when the first vowel of the stem is schwa [ə]. In these cases, we find ablaut: the passive is signaled by *i*, and the active by *u*, in the first syllable:

(39) Affixation to verbal bases with schwa: u-ablaut (active) vs. i-ablaut (passive):

	Unaffixed	*Active*	*Passive*	*Gloss*
a.	gəga	guga	giga	'chase away'
b.	gəgət	gugət	gigət	'gnaw, moth'
c.	kəkaj	kukaj	kikaj	'rake'
d.	kəkut	kukut	kikut	'excavate'
e.	ləpək	lupək	lipək	'fold'
f.	ləpəw	lupəw	lipəw	'pick'
g.	njənjaʔ	njunjaʔ	njinjaʔ	'chew'
h.	ŋəŋət	ŋuŋət	ŋiŋət	'gnaw'
i.	səbət	subət	sibət	'make'
j.	səkəl	sukəl	sikəl	'strangle'
k.	sələg	suləg	siləg	'burn'
l.	səpəd	supəd	sipəd	'hack, chop'
m.	səput	suput	siput	'blowpipe'
n.	səsaŋ	susaŋ	sisaŋ	'pay'
o.	səsəp	susəp	sisəp	'sip, suck'
p.	təbək	tubək	tibək	'stab'
q.	təbəŋ	tubəŋ	tibəŋ	'to fell (a tree)'
r.	tətək	tutək	titək	'cut'
s.	tətəŋ	tutəŋ	titəŋ	'drink'

The remaining data of interest illustrate what Blust (1997) refers to as compound ablaut: in these cases the active voice not only has the *u* associated with normal ablaut, but in addition the resulting verb form begins with *m*-. Notice that all the stems to which compound ablaut applies begin with a voiced or voiceless labial plosive.

(40) Affixation to labial-initial verbal bases with schwa: *m*- plus u-ablaut (active) vs. i-ablaut (passive)

	Unaffixed	*Active*	*Passive*	*Gloss*
a.	bəbah	mubah	bibah	‘split (stative)’
b.	bəbəd	mubəd	bibəd	‘tie’
c.	bənuʔ	munuʔ	binuʔ	‘kill’
d.	pəpah	mupah	pipah	‘hit, whip’
e.	pəpək	mupək	pipək	‘a whip’

6.2.3 Full vs. featureless vowels

A crucial step toward understanding the alternation between forms that exhibit prefixation of the active or passive morpheme, as opposed to those which exhibit ablaut, is to recognize that the forms undergoing ablaut all contain a schwa in their initial syllable. In any form that contains any other vowel in the initial syllable we find a prefixed allomorph. This correlation, I believe, provides strong support for several constraints that are operative in an optimality-theoretic account of these facts.

Another crucial point is the input to these processes. As far as the verbal stems are concerned, I assume that their input is identical to their unaffixed surface form. The issue of input for the prefixes, however, is complicated by the attested allomorphy. I posit an abstract underlying form for each prefix as follows:

(41) Active and Passive morphemes

Active	*Passive*
/mu-/	/ni-/

These morphemes are underlyingly more abstract in order to explain their attested surface forms. Consider first the forms where the active or passive morpheme is prefixed; that is, in cases where the stem contains a full vowel in the first syllable. In these cases, the vowel of the prefix always surfaces as schwa. Following Blust (1997), this is due to a constraint called Prepenultimate Neutralization, which reduces any vowel in the first syllable of a three syllable word to schwa. Naturally, this constraint requires further phonetic motivation, but its effects are visible throughout the language: in the data at hand, no exceptions to this constraint exist. Although I do not deal at length with this issue here, this neutralization can be related to observations concerning prosodic prominence: stress in Mukah falls on the penultimate syllable, unless that syllable contains schwa, in which case stress is final (Blust 1988). Prepenultimate position is never prosodically prominent, so contrast in vowel quality is not maintained here. This can be formally implemented by requiring a trochaic foot aligned to the right edge of the word. If the penultimate syllable contains schwa, it cannot bear stress, so stress falls on the final syllables in such cases. In addition, unfooted syllables (i.e. any syllables to the left of the foot) do not license vowel place features, accomplished through the constraint PPN, which is an undominated constraint:

(42) PREPENULTIMATE NEUTRALIZATION (PPN)

Unfooted syllables do not license vowel place features.

Thus, when the prefix *mu-* is attached to a two-syllable stem, the vowel of the prefix is reduced to schwa. This results in a violation of input-output faithfulness:

The two constraints interact in such a manner that PPN must outrank FAITH-IO, as illustrated in the following tableau:

(43) *məgutiŋ* 'to cut with scissors, active'

/mu-gutiŋ/	PPN	FAITH-IO
a. mugutiŋ	*!	
☞ b. məgutiŋ		*

This basic constraint interaction explains the cases of prefixational allomorphy in the Mukah active and passive verbal paradigms. From here, we now move on to the more complicated instances of ablaut, where I argue that such cases involve the effects of requirements on prosodic alignment resulting in fixed prosody.

6.2.4 Fixed prosody and its interaction with faithfulness

Ablaut is observed in all cases where the first vowel of the base is *ə*. For instance, consider the passive form *kikut*. The input to this surface form is *ni-kəkut*. Note that such a case results in a bisyllabic output. This illustrates our first case of *fixed prosody*, whereby a derived form must conform to a certain output shape. In this case, the fixed output shape is two syllables, and is enforced through a constraint on maximal word size, familiar from earlier chapters: SYLLABLEALIGNMENT:

(44) SYLLABLEALIGNMENT (σ-ALIGN)

Every syllable must be aligned to some edge of the prosodic word.

σ-ALIGN, as extensively discussed earlier, may be considered an extension of the notion Hierarchical Alignment, as formalized by Ito, Kitagawa, & Mester (1996:242).

σ-ALIGN assesses a violation for every candidate containing more than two syllables, since any syllable not at the edge of the word will not be aligned to a word edge. Crucially, examples of verb stems beginning with a vowel show that the constraint FAITH-IO must be dominated by σ-ALIGN. The following tableau illustrates the interaction between the two constraints.[4]

(45) *kikut* 'to be excavated'

	/n_1i_2-k$ə_3$kut/	σ-ALIGN	FAITH-IO
	a. $n_1ə_2kə_3$kut	*!	
☞	b. ki_2kut		**

I return to such forms shortly; for now, it suffices to state that they clearly show that the constraint on fixed prosody outranks FAITH-IO.

A further constraint is also motivated by these data. First, it must be noted that the prefixal nature of the active and passive affixes may be formalized by a constraint demanding that they appear at the left edge of the prosodic word:

(46) ANCHOR-L ({mu, ni}, PrWd)

The affixes *mu* and *ni* have a correspondent at the left edge of the prosodic word.

This constraint (rather trivially) accounts for the fact that when prefixational allomorphy occurs, it is indeed prefixational. However, when ablauting allomorphy

[4] Crucial correspondence relations in the input and output representations appearing in the following tableaux are indicated with subscripted numerals.

occurs, only one segment of the affix survives, and it is no longer aligned to the left edge of the word. This can be viewed as the influence of a markedness constraint which bans complex syllable margins, and is obeyed throughout the entire language (according to the data in Blust 1988, 1997):

(47) *COMPLEX (Prince & Smolensky 1993)

Syllable margins contain at most one segment.

Thus, in a case of ablaut, a candidate such as **nkikut* or **ŋkikut* is ruled out. In addition, *COMPLEX disallows a candidate such as **knikut*. One more candidate must be considered: **nikut*, which has no complex onset and which preserves both segments of the affix, in addition to satisfying the alignment constraint for the prefix. However, this candidate violates a crucial correspondence constraint that demands a verbal stem to have a correspondent at the left edge:

(48) ANCHOR-L

The left edge of the verbal stem has a correspondent at the left edge of any related form.

The examples of prefixational allomorphy demonstrate that this constraint is outranked by the alignment constraint forcing *mu* and *ni* to occur as prefixes. However, when the only segment of underlying *mu* or *ni* that can survive is a vowel, due to the constraints σ-ALIGN (restricting the output to two syllables) and *COMPLEX (banning complex syllable margins), ANCHOR-L is satisfied. Since ANCHOR-L is outranked by ANCHOR-L *ni*, though, another constraint must be responsible for the preservation of the stem-initial segment. This constraint is MAX-OO$_{PL}$, which assess a violation for any place feature of a stem not present in a complex form.

(49) MAX-OO$_{PL}$

Every place feature in a base has a correspondent in a related output

These interactions are summarized in the next set of tableaux.

(50) *kikut* 'to be excavated': MAX-OO$_{PL}$ » ANCHOR-L *ni* » ANCHOR-L

/n$_1$i$_2$-kə$_3$kut/	MAX-OO$_{PL}$	ANCHOR-L *ni*	ANCHOR-L
a. n$_1$i$_2$kut	*!		*
☞ b. ki$_2$kut		*	

(51) *kikut* 'to be excavated': *COMPLEX » ANCHOR-L *ni* » ANCHOR-L

/n$_1$i$_2$-kə$_3$kut/	*COMPLEX	ANCHOR-L *ni*	ANCHOR-L
a. n$_1$ki$_2$kut	*!		*
b. kn$_1$i$_2$kut	*!	*	
☞ c. ki$_2$kut		*	

(52) *kikut* 'to be excavated': σ-ALIGN » ANCHOR-L *ni* » ANCHOR-L

/n$_1$i$_2$-kə$_3$kut/	σ-ALIGN	ANCHOR-L *ni*	ANCHOR-L
a. n$_1$ə$_2$kə$_3$kut	*!		*
☞ b. ki$_2$kut		*	

The interaction between the two relevant constraints is next illustrated for the derivation of the passive form *nulin* 'rudder'.

(53) *nulin* 'rudder, passive'

	/ni-ulin/	σ-ALIGN	FAITH-IO
	a. nəulin	*!	*
☞	b. nulin		*

Candidate (a), which satisfies PPN (at the cost of violating FAITH-IO by neutralizing the prefixal vowel to *ə*), crucially violates the constraint σ-ALIGN. Candidate (b) satisfies σ-ALIGN, though it also violates lower-ranking FAITH-IO (by deleting the prefixal vowel).[5] One potential argument against this ranking logic could be formulated as follows: since candidate (a) violates FAITH-IO, it could be claimed that this form shows only that a finer distinction must be implemented among the specific FAITH-IO constraints at hand, namely IDENT and MAX. It would then simply be a matter of ranking IDENT above MAX, and this would obviate the need for σ-ALIGN. However, clearer evidence for this constraint and its ranking with respect to MAX is available by looking at forms that exhibit ablaut. For instance, consider the passive form *kikut*. The input to this surface form is *ni-kəkut*. As shown in the tableau for this form, given above, the fixed prosodic constraint clearly outranks FAITH-IO.

Some comments on the constraint MAX-OO_{PL} are in order at this point. It is clear that some constraint must outrank σ-ALIGN in order to prevent ablaut from occurring in all cases. If σ-ALIGN were the most important consideration, then all forms would undergo ablaut in order to satisfy this constraint on maximal word size.

[5] The issue of vowel-initial bases could also be solved by appealing to a hiatus-based account, as pointed out by Jaye Padgett (p.c.). That is, the faithful parse **niulin* involves the hiatal sequence *–iu-*. Since this form violates PPN, it is perhaps better to consider a competitor that satisfies PPN, such as candidate (a) from the previous tableau, **nəulin*. The question at hand is, which of the two adjacent vowels should be deleted? The reason *ə* is deleted rather than *u* is that deleting *u* would involve a violation of OO-MAX-PL.

However, ablaut only occurs when the first vowel of the verbal base is *ə*. Determining the nature of the constraint responsible for this distribution should reflect what is observed empirically. These observations point to an important insight: that the featural (specifically, the place-featural) specifications of stem vowels require high-ranking faithfulness. In particular, my proposal is that such data provide evidence for MAX-OO$_{PL}$, which demands that every place feature in a verbal stem be preserved in a related form. The force of this constraint is to crucially preserve a stem vowel if that vowel is a full vowel; the analysis rests on the critical assumption that the vowel schwa is unspecified for place features. This is why abault is found only in cases where a verbal stem has schwa in the initial syllable: deleting the schwa does not violate the constraint MAX-OO$_{PL}$. However, when the stem-initial vowel is a full vowel, replacing it, in effect, with the vowel of the prefix does violate this constraint. Note that this constraint is crucially of the output-output variety, following work of Benua (1995, 1997): featural specifications of vowels in related *output* forms is at issue. Thus we do not always find the prefixal vowel surfacing faithfully. As observed above, in prefixing allomorphy this vowel is always neutralized, and only emerges faithfully in cases of ablaut. This type of "MAX-F(EATURE)" constraint has precedence in earlier work, e.g., Lombardi 1995, 1998, Causely 1996, Walker 1997; cf. Lamontagne & Rice 1995 on coalescence and feature parsing.

Recall that the motivation behind ablaut is to conform to the fixed prosodic constraint σ-ALIGN. It must be the case, as discussed above, that some constraint dominate σ-ALIGN in order to prevent ablaut from occurring when the stem-initial vowel is not schwa. MAX-OO_{PL} serves this function, as the following tableau illustrates:

(54) *nəgutiŋ* 'to cut with scissors, passive'

/ni_1-gu_2tiŋ/	PPN	MAX-OO_{PL}	σ-ALIGN
a. ni_1gu_2tiŋ	*!		*
b. gi_1tiŋ		*!	
☞ c. $nə_1gu_2$tiŋ			*

Because the ablaut candidate (b) violates MAX-OO_{PL}, it may not surface. However, as discussed earlier, bases with a schwa in the first syllable do undergo ablaut:

(55) *kikut* 'to be excavated'

/n_1i_2-$kə_3$kut/	σ-ALIGN	FAITH-IO
a. $n_1ə_2kə_3$kut	*!	
☞ b. ki_2kut		**

The winning candidate here has no violations of MAX-OO_{PL}. This is because although the first vowel of the stem has no correspondent in the optimal output, the unparsed vowel is schwa, which lacks place features (Jakobson 1938, Anderson 1982, Browman & Goldstein 1992). Therefore MAX-OO_{PL} is vacuously satisfied by such a candidate. MAX-OO_{PL} plays no role in determining the outcome in such a case; as the tableau shows, the competition is therefore passed down to the constraint σ-ALIGN, which favors the bisyllabic output.

We have so far successfully accounted for the main split in the allomorphy exhibited in the active and passive verbal paradigms of Mukah. As we have seen, fixed prosody is emergent; that is, it occurs only in case it does not violate higher-ranking faithfulness constraints. Although the language has a strong desire for words to conform to a maximally bisyllabic size, this is only possible if such a prosodic shape does not involve the deletion of vowel-place features from the verbal stem. In the case where the relevant stem vowel is schwa, there are no vowel-place features to preserve, in which case fixed prosody dictates that a bisyllabic output form is optimal.

6.2.5 Compound ablaut as coalescence

An interesting portion of the data remain to be captured under this analysis, however. This portion involves what is termed by Blust (1997) *compound ablaut*, which involves a further alternation in the active verbal paradigm of some forms. In addition to the expected *u* ablaut in these forms, they also unexpectedly contain an initial *m*. The relevant data are repeated here for convenience.

(56) *Compound Ablaut in Active Verbal Paradigm*

	Unaffixed	*Active*	*Gloss*
a.	bəbah	mubah	‘split (stative)’
b.	bəbəd	mubəd	‘tie’
c.	bənuʔ	munuʔ	‘kill’
d.	pəpah	mupah	‘hit, whip’
e.	pəpək	mupək	‘a whip’

A crucial observation here, due to Blust (1997), is that all of the forms to which compound ablaut applies contain a labial plosive in initial position. Given the account so far, these forms are predicted to surface as normal ablauting forms since their verbal stems contain schwa in the initial syllable, resulting in, for instance, **bubah*, **bubəd*, **bunuʔ*, etc. However, such surface forms are routinely avoided in favor of outputs which have initial *m*, rather than initial *b* or *p*.

The proposal pursued here is that such forms involve a coalescence of two segments; specifically, the prefix-initial *m* and the stem-initial labial plosive in each case. This coalescence, which violates the faithfulness constraint UNIFORMITY, arises in order to satisfy a higher-ranking faithfulness constraint. Before elaborating on this point, however, let us focus on the phonological restriction involved in cases of compound ablaut.

The cases of compound ablaut involve labial-initial bases combining with the labial-initial prefix marking the active form and undergoing coalescence. Coalescence violates the correspondence constraint UNIFORMITY: [6]

(57) UNIFORMITY (McCarthy & Prince 1995)

No element in the output has multiple correspondents in the input.

Since the passive morpheme is coronal-initial, it is worth asking why coronal-initial bases do not undergo a similar compound ablaut. That is, we might expect an input such as /*ni-təbək*/ to surface as **nibək*, analogous to underlying /*mu-bəbah*/ surfacing

[6] See Pater (1999) for an account of coalescence in Austronesian that involves the constraint LINEARITY:

LINEARITY (McCarthy & Prince 1995)

The input is consistent with the precedence structure of the output, and vice versa.

Although I do not address this issue further, it is not clear that coalescence violates LINEARITY, since under McCarthy & Prince's definition LINEARITY is violated only when precedence relations are reversed. Whether coalescence involves a reversal of precedence relations seems unlikely. What seems more plausible is that coalescence results in a loss of precedence relations. For this reason, I adopt UNIFORMITY as the constraint violated by coalescence.

as *bubah*, yet this is never found. Clearly a distinction is made in the language between coalescence among labial segments versus coalescence among coronal segments. Coronal segments are not permitted to coalesce; otherwise we would expect to find compound ablaut applying in both the active and passive paradigms. To capture the distinction, a more specific version of UNIFORMITY is needed:

(58) UNIFORMITY-COR

No coronal element in the output has multiple correspondents in the input.

This constraint is motivated by the fact that coronal consonants, as relatively unmarked segments, are likely to compose a greater proportion of a language's phoneme inventory than more marked segments. Because of this, more lexical contrasts in the language will involve distinctions among coronals. By this logic, the constraint UNIFORMITY-COR is justified and as a specific version of UNIFORMITY its effects may only be visible if it is ranked above UNIFORMITY. In this way a coalescence output such as **nibək* is excluded:

(59) Coalescence avoided with coronals

	/n_1i_2-$t_3ə_4b_5ək$/	UNIFORMITY-COR	σ-ALIGN	ANCHOR-L *ni*	UNIFORMITY
	a. $n_1ə_2t_3ə_4b_5ək$		*!		
	b. $n_{1,3}i_2b_5ək$	*!			*
☞	c. $t_3i_2b_5ək$			*	

Returning to the actual compound ablaut data, since these forms undergo ablaut the way any form with *ə* in the initial syllable does, the fixed prosodic constraint σ-ALIGN must dominate UNIFORMITY. With UNIFORMITY dominated by σ-ALIGN, coalescence takes place in order to meet fixed prosodic requirements.

(60) Coalescence satisfies fixed prosody

/m_1u_2-$b_3ə_4b_5$ah/	σ-ALIGN	UNIFORMITY
a. $m_1ə_2b_3ə_4b_5$ah	*!	
☞ b. $m_{1,3}u_2b_5$ah		*

In the optimal candidate (b), the stem-initial b_3 has coalesced with the prefix-initial m_1 to yield $m_{1,3}$. Notice that this merger of the two segments is contingent on their sharing place features: they are both labial. Thus, the constraint MAX-OO_{PL} is satisfied in the optimal candidate, since the labial place features of both the prefix-initial *m* and the base-initial *b* are preserved. This will prevent compound ablaut from taking place with no restrictions: it is limited to strictly those cases in which the verbal stem happens to begin with a consonant of the same place of articulation of the active voice prefix.

In addition, compound ablaut succeeds in satisfying the constraint ANCHOR-L, demanding that the verbal stem have a correspondent at the left edge, as well as the constraint ANCHOR-L *mu*, which demands that *mu* have a correspondent at the left edge. Coalescence achieves exactly this configuration, whereby the two segments at the left edge of each morpheme have a correspondent at the left edge of the optimal form.

(61) Coalescence satisfies Anchoring

	/m_1u_2-$b_3ə_4b_5$ah/	ANCHOR-L *mu*	ANCHOR-L	UNIFORMITY
	a. $b_3u_4b_5$ah	*!		
	b. $m_1u_2b_5$ah		*!	
☞	c. $m_{1,3}u_2b_5$ah			*

There is, however, another important candidate to consider: one in which the prefix-initial *m* and the base-initial *b* coalesce into *b*, rather than *m*, to yield **bubah*. This candidate satisfies MAX-OO$_{PL}$, yet does not surface. So far, the constraints proposed cannot decide between this form and the optimal form. What is needed is a faithfulness constraint that specifically targets the affixal segment *m* in order to force its featural specification to be realized at the cost of the base segment *b*. The constraint FAITH-AFFIX, already familiar from chapter 4, will produce the correct output if it outranks FAITH-IO:

(62) FAITH-AFFIX » IO-FAITH

	/m_1u_2-$b_3ə_4b_5$ah/	FAITH-AFFIX	FAITH-IO	UNIFORMITY
	a. $b_{1,3}u_2b_5$ah	*!	*	*
☞	b. $m_{1,3}u_2b_5$ah		*	*

Candidate (a) violates FAITH-AFFIX, since the [nasal] feature of the affix-initial m_1 has no correspondent. Candidate (b) satisfies FAITH-AFFIX, since the affix is parsed faithfully.

6.2.6 Summary

The following ranking diagram summarizes the analysis presented here:

(63) *Final Ranking*

PPN MAX-OO$_{PL}$ UNIF-COR
| | q
FAITH-AFFIX σ-ALIGN *COMPLEX
| w p q
FAITH-IO ANCHOR-L {mu, ni}
|
ANCHOR-L
|
UNIFORMITY

This section has focused on a case of fixed prosody in the Austronesian language Mukah Melanau. This language exhibits an interesting allomorphy in its active and passive verbal affixation. The two main allomorphs involve prefixation on the one hand, and ablaut on the other. A subset of ablauting forms present an additional puzzle: labial-initial bases show compound ablaut in the active paradigm.

The analysis makes use of several well-motivated faithfulness constraints. In particular, high-ranking OO-MAX-PL forces preservation of featural specifications of verbal stems, which is ultimately responsible for restricting the effects of fixed prosody to cases of stems whose initial vowel is schwa. In such cases, the fixed prosodic constraint σ-ALIGN takes effect, limiting words to two syllables.

The fixed prosodic effects observed in Mukah are widespread within a particular morphological domain: that of active and passive affixation in the verbal paradigm. However, such fixed prosody is not observed with other affixational material in the language, at least, not according to the available data. This scenario can be viewed as a consequence of the underlying forms of affixes in general in the language. From the data presented in Blust (1988), it is clear that all affixes in this language are prefixes (and in some cases, infixes). However, this is not the sole generalization that appears to hold with respect to affixation. Mukah affixes contain at most one syllable.[7] The typology of affixal segmentism is represented below:

(64) Affixational segmentism

C(ə(C))-

That is, all affixes are prefixes that consist of either a single consonant, or a consonant followed by the vowel *ə*, or the sequence *CəC*. The important generalization regarding these affixes, in contrast to the prefixing/ablauting affixes discussed at length above, is that they all contain the vowel schwa underlyingly.

By contrast, the underlying forms of the active and passive morphemes are *mu*- and *ni*-, respectively. These differ in that they crucially have full vowels specified in their inputs. This essential difference explains why ablaut occurs in the cases of the active and passive morphemes but not with any other morphemes in the language. If any affix did have a vowel other than schwa then the account here predicts that an ablauting paradigm would result, under the proper phonological circumstances: namely, when the affix is attached to a stem with schwa in its first syllable. Thus the fact that ablaut is observed only in the active and passive paradigm can be explained as a consequence of underlying representation, and supports the distinction in underlying specification.

[7] One example containing a bisyllabic prefix *tələ*- is given by Blust (1988:171), though no meaning is explicitly attributed to this prefix.

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