appeared in **Phonology 16**.3 (1999):401-442

The inadequacy of the consonantal root: Modern Hebrew denominal verbs and Output-Output correspondence*

Adam Ussishkin
UC Santa Cruz
ussishki@email.arizona.edu

1 Introduction

Semitic languages such as Hebrew and Arabic are known for what has become characterised as their discontiguous or nonconcatenative morphology. In the overwhelming majority of the literature, in both "traditional" and generative grammar, semantically related words in such languages are described as sharing a common *root*, usually consisting of three consonants. Such consonantal roots are viewed as actual morphemes with lexical status. Words are formed by affixation to roots; the most common type of such affixation is the interleaving of vowels between the consonants of a root. Within current phonology, the morphological status of roots was originally expressed through a multi-tiered representation, where the root occupied a distinguished tier (e.g., McCarthy 1979, 1981). More recently the notion of root has been challenged by Bat-El (1994a), who argues, based on properties of the process of denominal verb formation (DVF) in Modern Hebrew (MH), that the concept of root can be eliminated.

In this paper, I present further arguments that there is no need to refer to roots in the process of DVF in MH. I also show that under such a view a

* This paper has greatly benefited from the help of many people. Junko Ito, Armin Mester, and Jaye Padgett have provided comments on numerous drafts, and I wish to offer them my sincere gratitude and appreciation for their helpful suggestions. Many thanks also to Judith Aissen for her detailed comments on a previous draft of this paper. In addition, I would like to thank Gene Buckley, Edit Doron, Sharon Rose, Donca Steriade, Bernard Tranel, Rachel Walker, and Andrew Wedel, who have all provided very thoughtful questions, discussions and suggestions with respect to the issues under consideration here. I would also like to express my deep gratitude to the many native speakers I have worked with as informants in Santa Cruz, Jerusalem, and Tel-Aviv: Danny Buchholz, Edit Doron, Rachel Giora, Shulamit Kuriansky, Na'ama Langholz, Noga Langholz, Gil Rilov, Ilan Yaniv, Keren Yaniv, and Oded Yaniv. Various versions of this paper have been presented at the 4th Southwestern Optimality Theory Conference, the Hebrew University of Jerusalem, and the 14th annual meeting of the Israel Association of Theoretical Linguistics, and I thank the audiences there for many useful questions, comments, and suggestions. Finally, I would like to thank the editors of *Phonology* for their useful comments, suggestions, and advice, and Outi Bat-El and two anonymous *Phonology* reviewers whose questions and comments have been quite valuable, and whose input has aided in clarifying many issues discussed here. Any errors are, of course, my own.
The author's name has recently changed from Adam Sherman to Adam Ussishkin.

unified, comprehensive treatment of DVF in MH is possible within Optimality Theory (OT; Prince & Smolensky 1993). This analysis goes beyond that originally presented in Bat-El (1994a) in that it has the power to predict the surface pattern of biliteral denominal verbs, whose outputs exhibit variation.

The analysis I argue for involves several important theoretical points. Besides showing that there is no need for consonantal roots in MH denominal verb formation, I illustrate that the variation attested in biliteral MH denominal verbs can be accounted for through constraints of Correspondence Theory (McCarthy & Prince 1995). This approach allows for a straightforward explanation of the variation. In addition, I expand the correspondence-theoretic family of ANCHOR constraints (McCarthy & Prince 1995) in order to explain the well known 'Left-to-Right spreading mechanism' which has emerged as a salient property of Semitic morphology. I develop a new set of ANCHOR constraints that provide a clear explanation of why only rightmost base consonants may have multiple correspondents, further challenging the 'root-and-pattern' models used in other analyses.

The structure of this paper is as follows: In section 2, I introduce the framework of Correspondence Theory (McCarthy & Prince 1995) and briefly discuss the concept of Output-Output Correspondence (e.g., Benua 1995, 1997; Burzio 1998). In section 3, I provide data illustrating denominal verb formation in MH. We will explicitly discuss the subset of biliteral forms, in which a range of possible surface patterns becomes evident. In addition, data demonstrating forms with three or more consonants will be briefly discussed. Section 4 includes a discussion of the theoretical and empirical issues involved in relying on the consonantal root versus the entire base form as the input to DVF. I turn next in section 5 to a discussion of perhaps the most salient characteristic of MH denominal verbs, which is that they are all bisyllabic. This bisyllabicity is analyzed as a prosodic effect resulting from minimal/maximal word requirements. In section 6, I combine these prosodic requirements with correspondence-theoretic constraints to develop an analysis of the biliteral denominal verbs. The analysis begins with cases of consonant doubling, and is followed by cases involving denominal verbs with medial [j] and [v]. I then provide an account of cases involving total reduplication, where I argue that such cases are the only instances in which a reduplicative morpheme is present. Following this discussion, the paper concludes in section 7.

2 Correspondence Theory

Correspondence Theory, a development within Optimality Theory (Prince & Smolensky 1993), is a framework originally adopted by McCarthy & Prince (1993a) to account for phenomena involving reduplication. Similar to the relations that exist between inputs and outputs, Correspondence Theory motivates similar types of relations between reduplicants (the surface realisations of the morpheme RED) and their bases of reduplication. Given this relation between reduplicants and bases, McCarthy & Prince (1995) propose a formal mechanism enforcing identity between them. This relation is similar to that between inputs and outputs, and is defined below:

(1) Correspondence (McCarthy & Prince 1995:262)
Given two related 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 $\alpha \Re \beta$.

In cases of morphological reduplication, S_1 is taken as the base of reduplication, while S_2 is taken as the reduplicant. The theory extends naturally to the dimension involving the relations between inputs and outputs, where S_1 is taken as the input and S_2 as the output.

As will be made explicitly clear in the following sections, the account presented here relies on Output-Output Correspondence (e.g., Benua 1995, 1997; Burzio 1998). Within such a framework, the same types of correspondence relations that hold between bases and reduplicants, and between inputs and outputs, also hold between surface forms. I claim that the process of DVF in MH is an output-based process. In other words, denominal verbs are formed from bases that already exist as independent words (typically nouns) in the language. This is directly relevant to and supported by several empirical observations. First of all, there is a correlation between the vowel of a base and the second consonant of its related denominal verb.[1] In addition, as pointed out by Bat-El (1994a), in bases with consonant clusters it is almost always the case that such clusters are preserved in the related denominal verb. These observations are captured within an output-based account that relies on properties of the base in determining the optimal shape of denominal verb. The following diagram illustrates this type of correspondence:

(2) *Correspondence relations in MH*

Base form

$\updownarrow$ *O(utput)-O(utput) Correspondence*

Denominal verb

I turn now to a description of DVF in MH.

[1] "Direct correlation" here means statistically extremely significant. Within the data presentaly available, the correlation is nearly absolute.

3 Denominal Verb Formation

Modern Hebrew exhibits a phenomenon whereby verbs may be derived from nominal (and occasionally adjectival) bases. These denominal verbs provide a rich set of data, many of which have traditionally been taken to involve reduplication (Bat-El 1994a, McCarthy 1979, 1981, Yannai 1970) or doubling (Bat-El 1989). Denominal verbs can be divided into two broad categories. The first of these involves verbs whose bases have two consonants; the second category involves verbs whose bases contain more than two consonants. Forms whose bases have two consonants, known as biliteral forms, have four possible output configurations (see Bat-El 1989, 1994a, *inter alia*, for three of these). The data below are representative of these configurations.[2]

3.1 Biliteral forms: the four patterns

(3) illustrates the four possible patterns for biliteral denominal verbs.

(3) *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 with the second consonant appearing twice (1a), with [j] or [v] occupying the second onset position (1b,c), or with each base consonant appearing twice (1c). In the overwhelming majority of these verbs, the vocalic pattern is […i…e…]. This pattern is characteristic of the verbal class to which all of these verbs belong; I will focus only on this pattern here.[3] Let us now turn to some actual data that illustrate these patterns.

3.1.1 Consonant doubling: $C_1iC_2eC_2$

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 low vowels in the base. Both monosyllabic and bisyllabic bases are realised similarly as denominal verbs; such cases of consonant doubling result in the pattern $C_1iC_2eC_2$:[4]

---

[2] The full list of data is presented in the appendix.
[3] These classes are known in the traditional literature as *binyanim* (plural of *binyan*).
[4] The forms cited are all third person masculine past tense verbs. I do not mark stress on denominal verbs throughout the paper; stress is always final in these forms. I use a fairly standard IPA transcription in the paper. [c] represents the affricate [$\widehat{ts}$].

(4) $C_1iC_2eC_2$

Base	*Gloss*	*Related denominal verb*	*Gloss*
cad	‘side’	cided	‘to side’
sam	‘drug’	simem	‘to drug, to poison’
dam	‘blood’	dimem	‘to bleed’
xad	‘sharp’	xided	‘to sharpen’
mana	‘portion’	minen	‘to apportion’

3.1.2 C_1ijeC_2 and C_1iveC_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 either [j] or [v], resulting in the shapes C_1ijeC_2 and C_1iveC_2. Again, we see that both monosyllabic and bisyllabic bases behave similarly.

(5) [j]-*forms*

Base	*Gloss*	*Related denominal verb*	*Gloss*
tik	‘file’	tijek	‘to file’
bul	‘stamp’	bijel	‘to stamp’
ʔir	‘city’	ʔijer	‘to urbanise’
kis	‘pocket’	kijes	‘to pickpocket’
buʃa	‘shame’	bijeʃ	‘to put to shame’

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

(6) [v]-*forms*

Base	*Gloss*	*Related denominal verb*	*Gloss*
sug	‘kind, type’	siveg	‘to classify, to sort’
ʃuk	‘market’	ʃivek	‘to market’
hon	‘capital, wealth’	hiven	‘to capitalise’
tox	‘inside, midst’	tivex	‘to mediate, to arbitrate’
luax	‘table’	liveax	‘to tabulate’

In (6), every base contains a round vowel ([u] or [o]).

3.1.3 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*.

(7) $C_1iC_2C_1eC_2$

Base	*Gloss*	*Related denominal verb*	*Gloss*
hed	‘echo’	hidhed	‘to echo’
nam	‘sleep’	nimnem	‘to doze
daf	‘page’	difdef	‘to turn pages’
kav	‘line’	kivkev	‘to draw a dotted line’
pax	‘jar, vessel’	pixpex	‘to flow, to gush’

3.2 Consonant Clusters

Let us now compare the data in (4)-(7) 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 (see (8) and (9)), but as shown in (10), consonant clusters in the base may be split up in some cases.

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

Base	*Gloss*	*Related denominal verb*	*Gloss*
flirt	‘flirt’	flirtet	‘to flirt’
faks	‘facsimile’	fikses	‘to send a fax’

(9)

	Base	*Gloss*	*Related denominal verb*	*Gloss*
(a)	praklit	'lawyer'	priklet	'to practice law'
	ʃravrav	'plumber'	ʃrivrev	'to plumb'
(b)	guʃpanka	'approval, seal'	giʃpenk	'to approve, to seal'
	nostalgia	'nostalgia'	nistelg	'to be nostalgic'
(c)	transfer	'transfer'	trinsfer	'to transfer'
	streptiz	'striptease'	striptez	'to perform a striptease'

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

Base	*Gloss*	*Related denominal verb*	*Gloss*
xrop	'nap'	xarap	'to take a nap'
blof	'bluff'	bilef	'to bluff'

The data in (10) illustrate that onset clusters in a monosyllabic base are split when there are no other clusters (cf. flirt/flirtet above). The forms in (8)-(10) 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 DFV; the fact that clusters tend to be preserved illustrates that the consonantal root is not sufficient as the input to DFV, since extraction of the root from such forms obscures consonant adjacency relations. The issue of the base versus the root is the theoretical focus of this paper, and in the following section I turn to a more detailed discussion.

4 Base versus Root

4.1 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. Recall the data in (9) above, repeated below in (11) for convenience:

(11) *Cluster preservation*

	Base	*Gloss*	*Related denominal verb*	*Gloss*
(a)	praklit	'lawyer'	priklet	'to practice law'
	ʃravrav	'plumber'	ʃrivrev	'to plumb'
(b)	guʃpanka	'approval, seal'	giʃpenk	'to approve, to seal'
	nostalgia	'nostalgia'	nistelg	'to be nostalgic'
(c)	transfer	'transfer'	trinsfer	'to transfer'
	streptiz	'striptease'	striptez	'to perform a striptease'

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, Grammont 1933, Hooper 1976, Jespersen 1904, Kiparsky 1979, Saussure 1914, Sievers 1881, Selkirk 1984, Steriade 1982, Whitney 1965). For example, consider the case of .pra.klit. 'lawyer'/.pri.klet. 'to practice law' in (11a). 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, such combinations do 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*/).

Bat-El (1994a) and Lederman (1982) both provide further evidence against the root in Modern Hebrew. This argument concerns derivational morphology, which is sometimes realised 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:

(12) *Consonantal affixes appear in derived forms*

Base	*Gloss*	*Inflected base*	*Gloss*
hitkamec	'to be stingy'	kamc+an	'stingy person'
kace	'edge'	kic+on+i	'extreme'
mica	'to exhaust'	ta+mc+it	'summary'
hixzik	'to hold'	ta+xzuk+a	'a maintenance'
safar	'to count'	mi+spar	'number'

Derived verb	*Gloss*
hitkamcen	'to be stingy'
hikcin	'to bring to extremity'
timcet	'to summarise'
tixzek	'to maintain'
misper	'to enumerate'

Nominalising 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.

Additionally, Horvath (1981) presents convincing empirical arguments against the consonantal root. These concern several properties of the verbal system of Hebrew, including the facts that it is not possible to predict whether or not a particular consonantal root will appear in a particular verbal class, and that the meaning of a verb in a particular class is not predictable as the simple composition of the meaning of the root and the meaning of the verbal class.

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 needs to be realised 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 1995, Sharvit 1994): data involving denominal verbs with medial [v] (cf. (6) 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.

4.2 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 (cf. (4) above), in which both the second and third consonants of the denominal verb always corresponds 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? I claim that the entire base must be taken as input to denominal verbs. This argument 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:

(13) *Consonant doubling*

Base	*Gloss*	*Related denominal verb*	*Gloss*
cad	‘side’	cided	‘to side’
sam	‘drug’	simem	‘to drug, to poison’
dam	‘blood’	dimem	‘to bleed’
xad	‘sharp’	xided	‘to sharpen’
mana	‘portion’	minen	‘to apportion’

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].

(14) [j]-*forms*

Base	*Gloss*	*Related denominal verb*	*Gloss*
tik	‘file’	tijek	‘to file’
bul	‘stamp’	bijel	‘to stamp’
ʔir	‘city’	ʔijer	‘to urbanise’
kis	‘pocket’	kijes	‘to pickpocket’
buʃa	‘shame’	bijeʃ	‘to 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].

(15) [v]-*forms*

Base	*Gloss*	*Related denominal verb*	*Gloss*
sug	'kind, type'	siveg	'to classify, to sort'
ʃuk	'market'	ʃivek	'to market'
hon	'capital, wealth'	hiven	'to capitalise'
tox	'inside, midst'	tivex	'to mediate, to arbitrate'
luax	'table'	liveax	'to tabulate'

These observations have not been pointed out previously in the literature, as far as I am aware. The above correlations are striking; we observe an pattern which we can describe 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., <u>bul</u>/<u>bijel</u>), and there are also cases in which a base with [u] surfaces as a denominal verb with [v] (e.g., <u>sug</u>/<u>siveg</u>). This observation will be fully explored below. At this point, the generalisations 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, Kaye & Lowenstamm 1984, Levin 1985, Pike 1943, Sievers 1881, *inter alia*). 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 <u>wə</u>- "and" in Tiberian Hebrew. What is intiguing is that this prefix is not always realised as <u>wə</u>-. The data below illustrate the crucial alternation:

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

Base	*Gloss*	*'wə-' + base*	*Gloss*
napʃii	'my soul'	wənapʃii	'and my soul'
tirooʃaam	'their wine'	wətiirooʃaam	'and their wine'

(17)

ħooʃek	‘dark’	wəħooʃek	‘and dark’
ʔemet	‘truth’	wəʔemet	‘and truth’
ʕabaadim	‘servants’	waʕabaadim	‘and servants’

(18)

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 <u>və</u>- allomorph seen in Modern Hebrew we see that Tiberian Hebrew uses <u>wə</u>-. The <u>u</u>- allomorph appears before a labial consonant.[5] These data provide further evidence for the variation between [v] and [u] in Hebrew,[6] and we see that it is clear that Modern Hebrew [v] corresponds to a glide in a previous stage of the language.

There is further evidence that the vowel of the base must be part of the input to denominal verb formation. Consider the following data.

(19) *Base [o] preserved in some denominal verbs*

Base	*Gloss*	*Related denominal verb*	*Gloss*
kod	‘code’	koded	‘to encode’
ʔot	‘sign’	ʔotet	‘to signal’
xok	‘law’	xokek	‘to create a law’
rom	‘height’	romem	‘to raise, to lift’

All of the bases in (19) actually preserve their base vowel in their related denominal verbs. Denominal verbs with [o] are only found in cases where the

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

[6] Further evidence exists for treating [v] as a sonorant, as pointed out by a reviewer. When [v] is the target of regressive voicing assimilation, it behaves as an obstruent (e.g., <u>hivtiax</u> → <u>hiftiax</u> “to promise”). However, when [v] is a potential trigger, it behaves as a sonorant, in other words, it does not trigger voicing assimilation (e.g., <u>kvuca</u> but *<u>gvuca</u> “group”, although a reviewer points out that there are some speakers who do say <u>gvuca</u>). See Barkai & Horvath (1978) for more on this in Hebrew and other languages. Another reviewer mentions that many Slavic languages treat [v] as a glide rather than a fricative. Yet a third reviewer points out that it has been argued that even in Tiberian Hebrew the sound in question was pronounced [v] (see Khan 1996). This reviewer mentions further evidence, however, for treating [v] as a glide in Modern Hebrew: there are cases in which [v] alternates with a round vowel other than those discussed in this paper, such as the [v] in <u>lehivaled</u> “to be born”, and the [o] in <u>nolad</u> “was born” and <u>holid</u> “he fathered”.

base vowel is [o]. 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. My novel claim here is that the correlations discussed above concerning the data in (14) and (15) are also the manifestations of vowel transfer, the only difference being that in (14) and (15) the vowel of the base is realised 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.

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 in (19), 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 subtract the vocalic pattern.

5 Bisyllabicity

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 generalisation would be to claim that all verbs must conform to a bisyllabic template. However, recent work in OT (e.g., Gafos 1997, McCarthy & Prince 1994a, Prince 1996, 1997, Spaelti 1997, Urbanczyk 1995) has argued against the use of such templatic constraints, and instead has attempted to derive the effects of such constraints from the interaction of simpler constraints. I take this approach here, and show in particular how the so-called bisyllabic template of MH denominal verbs may be derived from the interaction between other constraints.

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 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. These constraints are given below:

(20) FTBIN (e.g., McCarthy & Prince 1986, 1993a, Prince 1980)
Every foot consists of two syllables.

(21) ALIGN (FT, R; PRWD, R) (e.g., McCarthy & Prince 1993a,b, Prince & Smolensky 1991, 1993)
The right edge of every foot must be aligned to the right edge of a prosodic word.

(22) PARSE-σ (e.g., Halle & Vergnaud 1987, Hayes 1987, Liberman & Prince 1977, Mester 1994, Prince 1980)
Every syllable must be parsed by a foot.

(23) IAMB (e.g., Hayes 1987, 1994, McCarthy & Prince 1995)
Feet are right-headed.

These constraints are inviolable, and will force every denominal verb to be a single bisyllabic iambic foot: FTBIN forces all feet to consist of two syllables, ALIGN (FT, R; PRWD, R) forces dominance of each foot by a prosodic word, PARSE-σ ensures that every syllable in an output is parsed by some foot, and IAMB mandates that all feet are right-headed. The effects of IAMB are borne out by the fact that all denominal verbs (and in general, all verbs) in MH have final stress.[7] To represent this, we will make use of the Prosodic Hierarchy, as developed in Selkirk (1980a,b). This hierarchy is as follows:

(24) *Prosodic Hierarchy*

PrWd
|
Ft
|
σ
|
μ

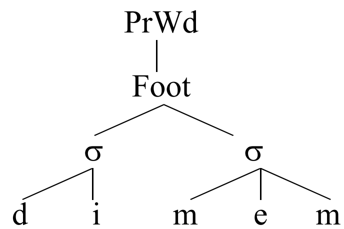
For a denominal verb such as dimem "to bleed", the four constraints above produce a prosodic structure such as that in (25):[8]

---

[7] The constraints used here are independently needed, I claim, in the analysis of Modern Hebrew stress, at least as far as the verbal system is concerned. This further supports the argument that these constraints are at work in determining stem size requirements (i.e. word binarity) for denominal verbs. A full analysis of Modern Hebrew stress is far beyond the scope of this paper of course, but is certainly warranted in further work, especially in light of developments within OT and metrical theory. For a recent OT account of Modern Hebrew stress in nouns, see Graf (1999).

[8] Moraic structure is omitted from the representation. The FTBIN constraint in Hebrew, as noted above, is relativised to syllables.

(25) *Prosodic structure of* dimem *'to bleed'*



We have achieved a bisyllabic, right-headed iambic foot dominated by a prosodic word without any reference to templates. In fact, this prosodic word is the minimal word for MH, as previously argued 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 in (25). The constraints in (20)-(23) will, for the sake of brevity, be collapsed into the single constraint MinWd.[9] This single constraint is to be understood simply as an abbreviation of the four inviolable constraints on prosodic form, and not as a templatic constraint.

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.

6.1 Consonant doubling and Strong-Anchor

Recall the data presented in (4) above, in which denominal verbs double the final consonant of the base:

[9] Deriving the notion of minimal word from the interaction among such constraints stems from work of e.g., Broselow 1982, Ito, Kitagawa, & Mester 1996, Prince 1980, McCarthy & Prince 1986, 1990a, et seq. Interestingly, it appears to be the case in Hebrew that the minimal word coincides with the maximal stem; that is, stems may not be more than two syllables, in general. However, in the ensuing discussion, only the constraint MinWd will be used.

(26) *Consonant doubling*

Base	*Gloss*	*Related denominal verb*	*Gloss*
cad	'side'	cided	'to side'
sam	'drug'	simem	'to drug, to poison'
dam	'blood'	dimem	'to bleed'
xad	'sharp'	xided	'to sharpen'
mana	'portion'	minen	'to apportion'

An important observation about MH and Semitic in general is that initial consonants are never or rarely doubled. 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:

(27) {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.
ANCHOR-RIGHT: If x = Edge(S_1, R) and y = Edge(S_2, R), then $x\Re y$.
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 also be formalised as follows:

(28) *ANCHOR-L as a conditional expression*
$\forall x, y, [(x = \text{Edge}(S_1, L)) \;\&\; (y = \text{Edge}(S_2, L))] \rightarrow [x\Re y]$

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:

(29) *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, it seems that the definition in (28) suggests additional types of ANCHOR constraints. Consider what results when we change the position of the elements in the conditional expression given in (28). For instance, consider the following rearrangement, where the second antecedent of the *if…then* expression in (28) changes places with the consequent:

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

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

(30), 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. 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 (30) 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 to (30). The diagram in (31) illustrates the effects of S-ANCHOR-L.

(31) *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 the constraint in (30) 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.

Given (30), 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. I claim that consonant doubling, a process which results in multiple correspondents of input-right-edge elements, provides motivation for a constraint similar in nature to that in (30), a constraint that must be violable. This constraint is given in (32):

(32) S-ANCHOR-R(IGHT)[10]
Let C_f = the rightmost consonant of a string:
$\forall x, y, [(x = (S_1, C_f)) \& (x \Re y)] \rightarrow [y = \text{Edge}(S_2, R)]$

The constraint in (32) penalises doubling of rightmost consonants of the base. (32) must refer specifically to consonants, due to the existence of CVCV bases. Examples of such bases and their related denominal verbs appear below:

(33) *CVCV bases behave like CVC bases: the rightmost consonant is final in the denominal verb*

Base	*Gloss*	*Related denominal verb*	*Gloss*
buʃa	'shame'	bijeʃ	'to put to shame'
bima	'stage'	bijem	'to stage'
mila	'word'	milmel	'to gabble'
mana	'portion'	minen	'to apportion'

In (33) we see that despite the presence of a vowel at the end of the base, each related denominal verb ends in a consonant. In other words, it is the consonant that must have a correspondent at the end of the denominal verb, even though this consonant is not the final element of the base. For this reason, the constraint in (32) must make explicit reference to the rightmost consonant of the base.

Such a formulation might be argued to oppose Prince's (1997) "constraints on constraints." That is, (30) refers specifically to the rightmost consonant of the base, instead of the more general rightmost edge. Therefore, one might argue that this constraint needs to be generalised, or that its effects need to be derived from more basic, general constraints. However, such a reformulation is not possible here. As shown above, referring to the rightmost edge strongly diminishes analytical power, as illustrated by the data in (33). Also, it does not appear feasible to reduce such a formulation to more basic, atomic constraints.

[10] The effects of (30) and (32), when both inviolable, 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.

Since rightmost consonants are in fact doubled (cf. for instance,dam/dimem; mana/minen), (32) must be outranked by the constraint in (30). This ranking is robustly enforced in MH (and other Semitic languages, which exhibit identical prohibitions on initial consonant doubling):

(34) *Ranking prohibiting initial consonant doubling and compelling final consonant doubling*

S-ANCHOR-L » S-ANCHOR-R

(34) guarantees that if a base element is doubled, a base-final element will be doubled in preference to doubling a base-initial element.

Throughout the data, we find that every denominal verb ends in a consonant. Such final consonantism has been noted by many researchers (Gafos 1995, McCarthy 1993a,b, McCarthy & Prince 1990a, Rose 1997, *inter alia*), and the solution to this phenomenon given in McCarthy & Prince (1993a) (and extended to Hebrew by Gafos (1995)) is the templatic constraint FINAL-C, which requires that a stem end in a consonant:

(35) 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. Its effects are derived through the interaction of other, non-templatic constraints: specifically, the constraints INTEGRITY and ANCHOR-R.

6.2 Analysis

Recall that the entire base 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. For this reason, this account is one of Output-Output (OO) Correspondence, because (part of) the input to denominal verbs is an independently occurring word (i.e. the base). Thus the constraints that mediate correspondence between the base and its related denominal verb are OO constraints. These correspondence-theoretic constraints are given below:

(36) INTEGRITY (McCarthy & Prince 1995:372)
No element of the base has multiple correspondents in the output.
("No copying/doubling")

(37) MAX-C (McCarthy 1995, McCarthy & Prince 1995:370)[11]
Every consonant of the base has a correspondent in the output.
("No deletion of consonants")

(38) MAX-V-S(TEM) (McCarthy & Prince 1995:370, Gafos 1995)
Every base vowel has a correspondent in the output.
("No deletion of stem vowels")

(39) DEP (McCarthy & Prince 1995:370)
Every element of the output has a correspondent in the base.
("No epenthesis")

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

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

(41) ANCHOR-R (cf. above)

In addition, there is a correspondence-theoretic constraint on the verbal morphology /*i e*/, which along with the base, completes the input to denominal verbs. This constraint is presented in (42):

(42) MAX-V-A(FFIX) (McCarthy & Prince 1995:370, Gafos 1995)
Every affixal vowel of the input has a correspondent in the output.
("No deletion of affix vowels")

Finally, besides the correspondence-theoretic constraints in (36)-(42), the analysis makes use of the well-formedness constraints that follow:

(43) MIN(IMAL)W(OR)D (cf. above)

(44) ONSET (Ito 1989, Prince & Smolensky 1993)
Every syllable has an onset.

I will first illustrate the analysis for consonant doubling. Consider, for example, the form dam "blood"/dimem "to bleed." The following tableau shows the interactions between several constraints.

---

[11] Although taken here to be inviolable, a few cases exist where this constraint appears to be violated. Examples include hiʃtaknez "to become Ashkenazi" from ʔaʃkenaz "Ashkenazi" (Bat-El, p.c.) and lixsen "to look sideways" from ʔalaxson "diagonal" (Bat-El 1994a:585, fn.13), where base-initial glottal stops have no correspondent in the related denominal verb. These pairs behave very similarly to Arabic broken plurals involving servile consonants, as discussed by McCarthy & Prince (1990a).

(45) [dimem] 'to bleed' from [dam] 'blood'

dam + i e	MINWD	MAX-V-A	MAX-V-S	INTEGRITY
a. damem		*!		*
b. dimam		*!		*
c. damime	*!			*
☞ d. dimem			*	*

Following standard OT practice, the optimal candidate is indicated by "☞", and fatal violations of constraints are indicated by "*!". Higher-ranking constraints appear to the left, and a solid line between constraints indicates a crucial dominance relation between them. Let us examine this particular tableau in detail. First of all, it is clear that only denominal verbs of two syllables are permitted. This is due to the inviolability of the constraint MINWD. The candidate in (45c) violates this constraint, because there is no possible representation for this candidate that satisfies MINWD, as illustrated below (syllable boundaries are designated by '.'; foot boundaries by '[' and ']'.)

(46)

(a)	[.da.mi.]me.	Violates PARSE-σ and ALIGNR
(b)	.da.[mi.me.]	Violates PARSE-σ
(c)	[.da.mi.me.]	Violates FTBIN
(d)	[.da.]mi.[me.]	Violates PARSE-σ, ALIGNR, and FTBIN
(e)	[.da.][mi.][me.]	Violates FTBIN and ALIGNR

The tableau in (45) also demonstrates that the constraint MAX-V-A dominates the constraint MAX-V-S. This is why, under the force of MINWD, the stem vowel is deleted when there are more than two vowels in the input. In candidates (45a,b), affixal vowels have been deleted, violating the higher-ranked MAX-V-A, and they are thus ruled out. Only candidate (45d) satisfies both MINWD and MAX-V-A. This comes at the cost of violating both MAX-V-S and INTEGRITY, which are both ranked low enough for such violations to be tolerable.

Let us more closely consider the constraint INTEGRITY, which, as seen in the previous example, is violable. In the following tableau, we see two competing INTEGRITY-violating candidates. The choice of optimal candidate in this case is given to the ANCHOR constraints:

(47) *When doubling is compelled, only final consonants may double (see (34) above)*

dam + i e	S-ANCHOR-L	ANCHOR-R	S-ANCHOR-R	INTEGRITY
a. dime		*!		
b. didem	*!			*
☞ c. dimem			*	*

Candidate (47a) is ruled out due to its violation of ANCHOR-R. This is because the final element of the base ([m]) does not have a correspondent at the right edge of the output. Thus we see that in addition to S-ANCHOR, ANCHOR-R is independently needed. All of the candidates in (47) satisfy the constraints MINWD and MAX-V-A. As we have seen, in such cases consonant doubling must take place. However, there are still two options: we may double either the initial or the final consonant. By the ranking discussed earlier, candidate (47c) 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.

Let us now consider the effects of the other relevant constraints. Consider the tableau in (48).

(48) *Epenthesis is disallowed*

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

Both the constraints ONSET and DEP 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. We thus have the following ranking schema so far.

(49) *Ranking schema*

```
MAX-V-A      MINWD    ONSET  DEP     ANCHOR-R    S-ANCHOR-L
       \      /    \      |     |            |             |
    MAX-V-S       I  N  T  E  G  R  I  T  Y       S-ANCHOR-R
```

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-R. In order to ensure a bisyllabic output as optimal, the constraint MINWD 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 MAX-V-A » MAX-V-S.[12]

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. The account detailed above goes further than Rose's account, however, 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-R and INTEGRITY. This result is welcome, 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 (cf. Gafos 1997, McCarthy & Prince 1994a, Prince 1996, 1997, Spaelti 1997, Urbanczyk 1995). In addition, the account presented here is not as complicated as Rose's account because it does not rely on richly specified inputs. As we have seen, the inputs here consist simply of inflectional morphology and a base form. By contrast, Rose (1997) derives the effects of final consonant doubling through highly stipulative input representations which include moras associated to input root consonants in a very specific pattern mimicking left-to-right association. Within her account, the doubling of final consonants is compelled by an active LINEARITY constraint with respect to these moras and their associated segments. Such an account raises many questions, including the status of input consonants as moraic.

We can also compare the account given here to that of Gafos (1995). Gafos explains the effects of rightward 'spreading' in Hebrew using a

---

[12] This ranking is the opposite of the universal ranking proposed in McCarthy & Prince (1994a, 1995:364):

Root-Affix Faithfulness Metaconstraint (RAFM):
Root-Faith » Affix-Faith.

Gafos (1995) also makes use of the opposite ranking in his analysis of denominal verb formation in Modern Hebrew, referring to Bat-El's (1994a) account. As an reviewer observes, the ranking dictated by the RAFM predicts that one of the two affixal vowels would be deleted in cases of consonant doubling, resulting in an ill-formed output such as *damem or *dimam. It is certainly significant that the ranking I propose, which is the opposite of that enforced by the RAFM, is the only ranking that permits both affixal vowels /*ie*/ to surface. Another possibility would be to adopt some version of the constraint REALIZEMORPHEME, as Jaye Padgett (p.c.) has suggested to me. However, I believe that such an approach is not successful, on the grounds that the affix in question contains two segments, so if only one of them surfaces REALIZEMORPHEME could be satisfied. For further discussion of this issue see Sherman (to appear), in which I argue, based on proposals of Revithiadou (1999), that the RAFM is too strong as a universal constraint, and that what is crucially at stake in such cases is morphological headedness.

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-R, whose effects are most clearly seen in tableau (47) above, 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.

I now 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.

6.3 Forms with medial [j] and [v]

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

(50) *Forms with* [j]

Base	*Gloss*	*Related denominal verb*	*Gloss*
tik	'file'	tijek	'to file'
bul	'stamp'	bijel	'to stamp'
ʔir	'city'	ʔijer	'to urbanise'
kis	'pocket'	kijes	'to pickpocket'
buʃa	'shame'	bijeʃ	'to put to shame'

(51) *Forms with* [v]

Base	*Gloss*	*Related denominal verb*	*Gloss*
sug	'kind, type'	siveg	'to classify, to sort'
ʃuk	'market'	ʃivek	'to market'
hon	'capital, wealth'	hiven	'to capitalise'
tox	'inside, midst'	tivex	'to mediate, to arbitrate'
luax	'table'	liveax	'to tabulate'

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, it is frequently the case that if the base vowel is [u], the related denominal verb has [j] as its medial consonant. Note the forms in (51) however, whose bases have [u]; in these case the related denominal verbs have [v] as their medial consonant. 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 MINWD (which forces only two syllables in each denominal verb), MAX-V-A, and MAX-V-S. In those cases the base vowel has no correspondent because there was no way to realise it in the denominal verb without violating high-ranking MINWD. However, in the cases where the base vowel is [i], [u], or [o], it is possible for this stem vowel to be realised in the denominal verb. This realisation is one that satisfies both MAX-V-A and MAX-V-S in addition to MINWD; namely, as a glide.[13]

6.3.1 Denominal verbs with [j]

Let us illustrate what this means. Consider the base tik 'file.' Its related denominal verb, tijek 'to file', contains correspondents for every segment of the base. The first and last consonants of the base, [t] and [k], are realised as [t] and [k] respectively in the denominal verb. More interestingly, the vowel [i] of the base is realised as [j] in the denominal verb. This is because the vowel [i] of the base may be realised in such a way that allows satisfaction of MINWD, namely as the glide [j]. Consider the following tableau.

---

[13] One reviewer mentions the possibility that glottal stop could be the non-syllabic counterpart of the low vowel [a] in Hebrew. However, as the reviewer points out, there are no denominal verbs derived from bases with [a] that have a medial glottal stop. I do not believe, however, that the glottal stop could be the non-syllabic counterpart of [a], because it is not a vocoid. Therefore, were it to appear as a correspondent of [a], it would violate high-ranking IDENT constraints. Both glottal stop and the glide [j] may function as epenthetic segments in Hebrew (/universitaot → /universitaʔot "universities"; tavnitot → tavnijot "patterns"), but this seems to be mainly phonetically determined and is fundamentally different from the issues of correspondence under consideration in the formation of denominal verbs.

(52) *Glide [j] as correspondent of high vowel in base; no doubling*

[tijek] 'to file' from [tik] 'file'

tik + i e	MinWd	Max-V-A	Max-V-S	Integrity
a. tiiek	*!			
b. tikek			*!	*
☞ c. tijek				

This tableau involves constraints we saw earlier in our analysis of consonant doubling cases; the same ranking is involved as well. Candidate (52a) contains more than two syllables, thereby violating MinWd.[14] Candidate (52b) violates Max-V-S, 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. (52b) also violates Integrity. Candidate (52c), the optimal candidate, satisfies every constraint discussed so far. The base vowel [i] has a correspondent in the denominal verb, namely [j]. Max-V-S is therefore satisfied, as is Max-V-A and MinWd.

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 we 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 relatively rare, and although the account presented here can shed some light on these cases it does not provide a conclusive explanation of their behavior.[15]

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 bijel 'to

[14] There are no long vowels in MH.

[15] Thanks to Outi Bat-El for providing some data on verbs which derive from a base noun whose vowel is [e]. Indeed, the account given here makes correct predictions for some of these verbs but not all. Given that [e] is both [coronal] and [-high], 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 gijer 'to make a convert' from ger "stranger", and ʃijem "to name" from ʃem "name". However, some bases with [e] have related denominal verbs with a doubled consonant, such as kinen "to nest" from ken "nest" and tilel "to make mounds" from tel "mound." This disparate distribution of patterns is not neatly accounted for here, and obviously merits further research.

stamp.' 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 bijel. However, establishing this relation implies a more complicated scenario than presented for tijek above. In tijek, the [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 bijel, on the other hand, the [j] shares the feature [high] with its correspondent (the [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).

(53) IDENT-PL(ACE)
Correspondents have identical specification for place features.

This two constraint force identical feature specifications for place features between corresponding elements. For [i] and [u], I assume the following (partial) geometries:[16]

(55) (a) [i/j]: high, coronal (b) [u]: high, labial

For [v], I assume the following geometry (again, only relevant specifications are given):

(56) (a) [v]: labial

Recall that [v] is the nonsyllabic counterpart of [u] in Modern Hebrew, which lacks the glide [w]. Given these geometries, we have a clearer way of assessing correspondence between [i] and [j] on one hand, and [u] and [j] or [v] on the other. One potential difficulty is characterising the correspondence that exists between [u] and [j] in a case such as bijel 'to stamp' 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]

[16] Only relevant features and nodes are shown here. Arguments for the VPlace node may be found in Clements & Hume 1995, Hume 1992, and Steriade 1987, *inter alia*. Arguments in favor of treating front vowels as coronal may be found in Clements 1976, Hume 1992, *inter alia.* Arguments for treating palatals as coronal appear in Clements 1991, Mester & Ito 1989, and Keating 1988, 1991, 1993.

and the glide [w]. Modern Hebrew has no [w], but if there is correspondence between [u] and [v], the feature [labial] of [u] is realisable in a nonsyllabic segment. That is, the grammar of Modern Hebrew contains a constraint banning a geometry such as that in (55b) in nonsyllabic positions. This may be abbreviated by the following constraint:

(57) *[w]

(57) disallows a segment with the representation in (55b) in non-nuclear positions. The next best option, therefore, is to realise as many of the features in (55b) as possible. As we have seen, this means realising either the features [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 realised 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), and as further examined by Alderete et al. (1997), I assume that such cases are handled by markedness constraints.[17] Thus we have (58):

(58) *[lab] » *[cor]

The ranking in (58) will force [coronal] to be assigned. This 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 bijel 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.[18]

[17] 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 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).

[18] 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.

(59) *Glide [j] as correspondent of [u] in base*

[bijel] ‘to stamp’ from [bul] ‘stamp’

bu$_1$l + i e	IDENT-PL	*[lab]	*[cor]
a. biv$_1$el	*	*!	
☞ b. bij$_1$el	*		*

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 realised, 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 *bivel. Candidate (b) also violates IDENT-PL, because the [labial] feature of the base vowel is not present in its correspondent. Candidate (b) emerges as optimal, because the [j] in bijel is less marked than the other option, [v].

6.3.2 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.

(60) *Denominal verbs with [v] whose bases contain [u]*

Base	*Gloss*	*Related denominal verb*	*Gloss*
sug	‘kind, type’	siveg	‘to classify, to sort’
ʃuk	‘market’	ʃivek	‘to market’
zug	‘couple’	ziveg	‘to pair’
luax	‘table’	liveax	‘to tabulate’
duax	‘report’	diveax	‘to report’

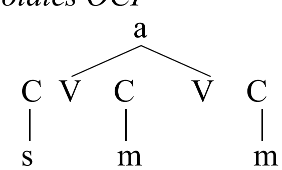
Given the analysis presented above for bijel ‘to stamp’, we might expect the denominal verbs in (60) to be different; e.g., *sijeg, *ʃijek, *zijeg, etc. In other words, our constraint ranking so far would predict [j] to be the medial consonant in every case given the markedness hierarchy between the 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 realised as [j] (as we would expect following our analysis above), a higher-ranking constraint would be violated.

This constraint is related to the Obligatory Contour Principle (OCP; cf. Goldsmith 1976, Leben 1973, McCarthy 1986, 1988, *inter alia*). As stated by McCarthy (1988) the OCP appears as follows:

(61) OCP
Adjacent identical elements are prohibited.

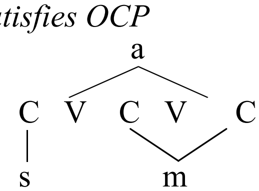
A well known example of the OCP comes from Classical Arabic. This example involves the verb <u>samam</u> 'he poisoned.' Superficially, such an example appears to violate the OCP:[19]

(62) *Violates OCP*



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 <u>samam</u>. 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:

(63) *Satisfies OCP*



In (63) the second root consonant [m] is multiply linked to the final two C-slots, resulting in <u>samam</u>. 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. 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:

[19] 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.

(64) *Identical C_1 and C_2 in MH*

Hebrew word	*Gloss*
mimen	'to finance'
mimeʃ	'to realise'
nanas	'dwarf'
dida	'to limp'

These exceptions must somehow be explained. 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:

(65) *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. Nothing in this constraint mentions whether or not these consonants are or are not correspondents. If the forms in (64) 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. Another issue concerns how such forms entered the lexicon of Modern Hebrew. This issue merits further exploration, which will not be pursued 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 1995, 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 relativised 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 (cf. (60) above). 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; rather, it is available (as manifestation of the feature [labial]) in the input (the base). The relevant OCP constraint is given below.

(66) OCP-PL(ACE)[20]
Consonants with identical place specification (labial, coronal, dorsal) are disallowed within a stem.

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

(67) [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:

[20] 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 paper, I do not mean the OCP here to specifically target consonants as though the consonants form some sort of constituent (a root). A possible elboration that allows reference to the consonants of a form without assuming a consonantal root involves the 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. non-primary place could help. This important issue is related to much current work on locality, such as work by Gafos (1996) and Ní Chiosáin & Padgett (1997).

(68) [s] — [coronal]   [j] — [coronal] [high]

This structures 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:

(69) [s] — [coronal]   [v] — [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 realises the [labial] feature at the cost of not realising the [high] feature in order to satisfy OCP-Pl show us that it is not always optimal to realise the [high] feature. Thus, we would obtain the following situation:

(70) *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, under which each constraint must outrank or be outranked by every other constraint.

We may avoid this problem, however, with our original model, in which instead of two separate Ident constraints they are both subsumed under one more 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 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 tijek 'to file,' which was discussed and analyzed above in (52). The optimal output violates the OCP, as shown in the following tableau, where crucial correspondence relations (if present) are indicated with subscript numerals.

(71)

ti$_1$k + i e	DEP	IDENT-PL	OCP-PL	*[lab]	*[cor]
a. tivek	*!			*	
☞ b. tij$_1$ek			*		*

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, because the segment [v] in *tivek has no correspondent in the base. This is in striking contrast with forms such as siveg above, where the [v] corresponds to the base vowel [u]. Of course, we must also consider a candidate whose phonetic realisation 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:

(72)

ti$_1$k + i e	DEP	IDENT-PL	OCP-PL	*[lab]	*[cor]
a. tiv$_1$ek		*!		*	
☞ b. tij$_1$ek			*		*

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 violation in this candidate. However, candidate (a) does violate IDENT-PL; it contains a [v] correspondending 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:

(73) *Bases with [o] that have [v] in their related denominal verbs*

Base	*Gloss*	*Related denominal verb*	*Gloss*
hon	'fortune'	hiven	'to capitalise'
tox	'inside, center, midst'	tivex	'to mediate, to arbitrate'
kod	'code'	kived[21]	'to code, to encode'

The number of such forms is very small. In these forms, the [labial] feature of the base vowel [o] is realised as [v], satisfying the constraint MAX-V-S. The following tableau illustrates how the optimal form is chosen:

(74)

to_1x + i e	DEP	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 *<u>tijex</u>, 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 epenthesised and therefore does not correspond to the base vowel [o], is ruled out because it incurs a fatal violation of high-ranking DEP. Candidate (c), in which the base vowel [o] is realised as [v], emerges as optimal. This candidate has [v] as its medial consonant. Therefore, the [labial] specification of the base vowel is preserved, and since this segment corresponds to the base vowel [o] there is no DEP 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 is 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

[21] 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 <u>koded</u>.

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 realisation in a form that is restricted to two syllables (cf. the discussion of the constraint MINWD above) in which the vocalism of the verbal morphology takes precedence over the stem vocalism. This is expressed through the ranking MAX-V-A » MAX-V-S.

6.3.3 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].

(75)

Base	*Gloss*	*Related denominal verb*	*Gloss*
kod	'code'	koded	'to code, to encode'
ʔot[22]	'sign'	ʔotet	'to signal'
xok	'law'	xokek	'to create a law'
rom	'height'	romem	'to raise, to lift'

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 generalisation, 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

[22] This base noun is interesting, because it has two meanings, "sign" and "alphabetical symbol." The denominal verb related to the noun "sign" is ʔotet "to signal", while the denominal verb related to the noun "alphabetical symbol" is ʔijet "to spell." ʔijet forms 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 ʔivet, in which the base [o] corresponds to the [v], but this is not the case. My suggestion for why we do not find ʔivet is that this form already exists in the language as an independent verb: ʔivet "to distort, to pervert." The reason ʔot "alphabetical symbol" is not able to have a related denominal verb ʔivet, therefore, has to do with morphological blocking. 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 epenthesised. Perhaps this is an effet of Output-Output correspondence (see references above) or Paradigm Uniformity (e.g., Steriade 1996). Interestingly, as a reviewer notes, the blocking explanation does not explain why the existence of ʔijer "to illustrate" does not block the attested form ʔijer "to urbanise" from ʔir "city."

realised as [v] in the related denominal verb. Such cases involve the realisation 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.

(76) 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, as illustrated below:

(77)

μ | to_1x + i e	DEP	OCP-PL	*[lab]	*[cor]	IDENT-μ
a. tijex	*!	*		*	*
☞ b. tiv_1ex			*		

The optimal candidate tivex, 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 realised 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 becomes undominated, resulting in an absolute need to realise the [o] as [o]. Consider the tableau below for xokek "to create a law."

(78) IDENT-μ *undominated*

μ | xo_1k + i e	IDENT-μ	MAX-V-A	MAX-V-S	*[lab]	*[cor]	INTEGRITY
b. xiv_1ek	*!			*		
☞ c. xo_1kek		*		*		*

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 that would need to be involved here is not the same as proposed by Ito & Mester (1995), for example, to account for core-periphery effects in the lexicon.[23] 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.

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. I will now turn to an analysis of denominal verbs which do constitute an instance of such morphological reduplication.

6.4 Analysis of Total Reduplication

I now turn to the cases involving what appears to be doubling of both base consonants. Following numerous researchers (e.g., Bar-Adon 1978, Gesenius 1910, Rose 1997a), I analyze such forms 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. The morphological/semantic content contributed by the reduplicative morpheme (RED) signifies either repetitive or durative action[24], as noted in recent work by Rose (1997a) on Ethio-Semitic languages which have similar phenomena. Some of the relevant data from Modern Hebrew are repeated below for convenience.

(79) *Total reduplication*

Base	*Gloss*	*Related denominal verb*	*Gloss*
hed	‘echo’	hidhed	‘to echo’
nam	‘sleep’	nimnem	‘to doze
daf	‘page’	difdef	‘to turn pages’
kav	‘line’	kivkev	‘to draw a dotted line’
pax	‘jar, vessel’	pixpex	‘to flow, to gush’

[23] Ito & Mester (1995) 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).

[24] 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 realisation. This relation necessitates the following constraint in our analysis of cases involving total reduplication:

(80) Max-BR (McCarthy & Prince 1995)
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. Max-BR must be undominated, since Red is always total. That is, both base consonants are reduplicated.

(81) *High-ranking Max-BR*

k a v+Red+ i e	Max-BR	Dep	Max-V-A	Max-V-S	S-Anchor-L	S-Anchor-R	Int
a. kivev	*!			*		*	*
b. kikev	*!			*	*		*
c. kijev	*!*	*		*			
☞ d. kivkev				*	*	*	**

Candidates (a)-(c) are all ruled out due to fatal violations of the undominated constraint Max-BR. Candidate (a) fails to realise the [k] in the reduplicant, while candidate (b) fails to realise the [v]. Candidate (c) fails to realise both the [k] and the [v]; in addition it incurs a violation of the constraint Dep. Candidate (d), however, reduplicates both consonants of the base and thus satisfies Max-BR.[25]

[25] As pointed out by a reviewer 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, as the reviewer observes, seem to be associated with repetitive or durative action. Examples include: xizrer "to iterate" from xazar "to return," and ʔiʃrer "to reconfirm" from ʔiʃer "to confirm." 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, the reviewer also mentions cases of total reduplication which have an alternative that does not involve total reduplication, such as lixax "to moisten" from lax "moist" (in addition to lixax there is lixlex) and mirmer "to embitter" from mar "bitter" (in addition to mirmer there is mirer/merer). At this point, I suggest that the

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 summarises each subtype:

(82) *Summary*

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

7 Conclusion

In this paper 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

---

reason for the two possibilities in such cases is simply that one option involves a reduplicative morpheme and the other does not.

consonantal root. Such a proposal is not a novel one (cf. Bat-El 1994a, Lederman 1982), and the analysis here bears out this claim. I have shown that the notion of root must be abandoned in Modern Hebrew, at least for the case of denominal verb formation. 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.

In this analysis, I argue that the consonantal root plays no role in MH denominal verb formation. However, more work is necessary to determine the status of roots in the language as a whole in order to verify if such entities may be dispensed with entirely. Previous analyses have argued for the central role of the consonantal root in all Semitic grammars. The large body of literature on Arabic phonology and morphology , for example, takes the root as a necessary element of the grammar. Further research is necessary in order to explore whether my claims against the root result in superior accounts of word formation throughout Semitic languages.

8 Appendix[26]

8.1 $C_1iC_2eC_2$ (Consonant doubling)

(a1)

Base	*Gloss*	*Related denominal verb*	*Gloss*	*Source(s) for denominal verb*[27]
dam	'blood'	**dimem**	'to bleed'	ES:128; Z:44
xam	'hot'	**ximem**	'to heat'	BE:586; ES:224; Z:92
xad	'sharp'	**xided**	'to sharpen'	ES:204; Z:84
cad	'side'	**cided**	'to side with'	BE:586; ES:592; Z:225
sam	'drug'	**simem**	'to drug, to poison'	ES:495; Z:197
kar	'cold'	**kirer**	'to chill, to cool'	ES:651; Z:244
gaf	'limb, wing'	**gipef**	'to embrace, to cuddle'	ES:107; Z:37
bad	'cloth, material'	bided	'to insulate'	ES:53; Z:20
gav	'back'	gibev	'to heap, to pile up'	ES:86; Z:31
dal	'poor'	dilel	'to dilute'	BE:586; ES:126; Z:43
mar	'bitter'	**mirer**	'to embitter'	BE:586; ES:425; Z:167
ran	'chant'	**rinen**	'to sing, to gossip'	ES:679; Z:252
has	'silence'	hises	'to hesitate'	ES:157; Z:59
kaʃ	'straw'	**kaʃaʃ**	'to gather straw'	ES:653; Z:244
mad	'gauge'	**madad**	'to gauge, to measure'	ES:342; Z:132
pat	'bread, slice, piece'	**patat**	'to crumb, to crumble'	ES:589; Z:224
mana	'portion'	**minen**	'to apportion'	BE:586; ES:390; Z:154

[26] 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 bcase 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 imporant 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 obscurring 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.

[27] BE = Bat-El 1994a; ES = Even-Shoshan 1993; Z = Zilberman 1993.

8.2 C_1ijeC_2

(a2)

Base	*Gloss*	*Related denominal verb*	*Gloss*	*Source(s) for denominal verb*
ʔiʃ	'man'	**ʔijeʃ**	'to man'	ES:23; Z:10
ʔir	'city'	**ʔijer**	'to urbanise'	ES:22; Z:10
tik	'file'	**tijek**	'to file'	BE:586; ES:759; Z:278
gis	'column, corps'	gijes	'to mobilise, to enlist'	ES:98; Z:34
min	'sort, type'	**mijen**	'to classify, to sort'	ES:371; Z:146
kis	'pocket'	**kijes**	'to pickpocket'	BE:586; ES:293; Z:114
xiki	'palatal'	xijex	'to smile'	ES:214; Z:89
sid	'whitewash'	**sijed**	'to whitewash'	BE:586; ES:487; Z:194
tiv	'(good) quality'	tijev	'to improve'	ES:251; Z:100
bima	'stage'	**bijem**	'to stage'	BE:587; ES:63; Z:23
bul	'stamp'	**bijel**	'to stamp'	BE:586; ES:63; Z:23
xug(a)	'circle, sphere'	xijeg	'to dial'	BE:587; ES:213; Z:89
xut	'thread'	**xijet**	'to sew, to tailor'	ES:214; Z:89
kur	'melting pot, furnace'	**kijer**	'to mold, to model'	ES:293; Z:114
buʃa	'shame'	**bijeʃ**	'to put to shame'	ES:65; Z:24
ʔot	'alphabetical symbol'	**ʔijet**	'to spell'	BE:586; ES:23; Z:10

8.3 C_1iveC_2

(a3)

Base	*Gloss*	*Related denominal verb*	*Gloss*	*Source(s) for denominal verb*
sug	‘kind, type’	**siveg**	‘to classify, to sort’	ES:481; Z:191
zug	‘couple, pair’	**ziveg**	‘to match, to pair’	ES:188; Z:80
ʃuk	‘market’	**ʃivek**	‘to market’	ES:704; Z:260
luax[28]	‘board, table’	**liveax**	‘to tabulate’	ES:318; Z:122
duax[29]	‘report, account’	**diveax**	‘to report’	ES:118; Z:40
kod	‘code’	**kived**	‘to code, to encode’	ES:619; Z:233
hon	‘capital, wealth’	**hiven**	‘to capitalise’	ES:143; Z:51
tox	‘inside, center, midst’	**tivex**	‘to mediate, to arbitrate’	ES:752; Z:274

8.4 $C_1oC_2eC_2$

(a4)

Base	*Gloss*	*Related denominal verb*	*Gloss*	*Source(s) for denominal verb*
rom	‘height’	**romem**	‘to raise, to glorify’	ES:669; Z:249
ʔot	‘sign’	**ʔotet**	‘to signal’	BE:586; ES:14; Z:6
xok	‘law’	**xokek**	‘to create a law’	BE:586; ES:234; Z:87
kod	‘code’	**koded**	‘to code, to encode’	Z:233

[28] 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 neutralised to [x] in most dialects of Modern Hebrew. (The denominal verb <u>liveax</u> “to tabulate” also contains the vowel [a]).

[29] This noun is actually an acronym word, from <u>**d**in-**v**ə-**x**eʃbon</u>. Note the vocalisation of [v] to [u] in the resulting acronym word <u>**du**ax</u>. This is quite interesting, especially in light of the variation between [v] and [u] in Modern Hebrew.

8.5 $C_1iC_2C_1eC_2$ (Total reduplication)

(a5)

Base	*Gloss*	*Related denominal verb*	*Gloss*	*Source(s) for denominal verb*
hed	'echo'	**hidhed**	'to echo'	ES:140; Z:49
lax	'moist'	**lixlex**	'to moisten'	ES:320; Z:123
hen	'aye, yes'	**hinhen**	'to say yes, to nod'	ES:155; Z:53
lev	'heart'	livlev	'to sprout'	ES:315; Z:121
nam	'sleep'	**nimnem**	'to doze'	ES:459; Z:182
pax	'jar, vessel'	pixpex	'to flow, to gush'	ES:560; Z:216
kav	'line'	**kivkev**	'to hatch, to shade'	BE:587; ES:625; Z:235
dal	'poor'	**dildel**	'to impoverish'	BE:587; ES:125; Z:43
daf	'page'	**difdef**	'to turn pages'	BE:587; ES:130; Z:44
mila	'word'	**milmel**	'to mutter'	BE:587; ES:383; Z:150

REFERENCES

Adam, Galit (1996). The fate of spirantization in Modern Hebrew: free variation in Optimality Theory. Ms, Tel-Aviv University.

Alderete, John, Jill Beckman, Laura Benua, Amalia Gnanadesikan, John McCarthy & Suzanne Urbanczyk (1997). Reduplication with fixed segmentism. Ms, University of Massachusetts, Amherst.

Archangeli, Diana (1984). Underspecification in Yawelmani phonology and morphology. PhD dissertation, MIT. Published 1988, New York: Garland.

Archangeli, Diana (1988). Aspects of underspecification theory. Phonology **5**:183-208.

Archangeli, Diana & Douglas Pulleyblank (1987). Maximal and minimal rules: Effects of tier scansion. In Proceedings of NELS **17**:16-35. University of Massachusetts, Amherst, GLSA.

Bar-Adon, Aaron (1978). Developments in the Hebrew Verbal System of Israeli Children and Youth. In Jazayery, Mohammad Ali, Edgar C. Polomé, and Werner Winter, eds. Linguistic and Literary Studies in honor of Archibald A. Hill **2**:151-169. Mouton Publishers, The Hague.

Barkai, Malachi & Julia Horvath (1978). Voicing assimilation and the sonority hierarchy: Evidence from Russian, Hebrew and Hungarian. Linguistics **212**:77-88.

Bat-El, Outi (1986). Extraction in Modern Hebrew Morphology. MA thesis, UCLA.

Bat-El, Outi (1989). Phonology and Word Structure in Modern Hebrew. PhD dissertation. UCLA.

Bat-El, Outi (1994a). Stem modification and cluster transfer in Modern Hebrew. NLLT **12**:571-596.

Bat-El, Outi (1994b). Onset Violation in Tiberian Hebrew. In Phonology at Santa Cruz **3**:1-12.

Bat-El, Outi (1996). Phonologically-based word formation: Modern Hebrew blends. In Studia Grammatica, "Interfaces in Phonology":231-250. Berlin, Germany.

Bell, Alan (1971). Some patterns of occurrence and formation of syllable structures. In Working Papers on Language Universals **6**:23-137. Language Universals Project, Stanford University.

Benua, Laura (1995). Identity effects in morphological truncation. In Jill N. Beckman, Laura Walsh Dickey, & Suzanne Urbanczyk, eds. University of Massachusetts Occasional Papers **18**: Papers in Optimality Theory, 77-136.

Benua, Laura (1997). Transderivational identity: phonological relations between words. PhD dissertation, University of Massachusetts, Amherst.

Berent, Iris & Joseph Shimron (1997). The representation of Hebrew words: Evidence from the Obligatory Contour Principle. Cognition **64**:39-72.

Berman, Ruth (1978). Modern Hebrew structure. Tel-Aviv Publishing Projects, Ltd. Tel-Aviv, Israel.

Bolozky, Shmuel (1978). Word formation processes in the Hebrew verb system: denominative verbs. Afroasiatic Linguistics **5**, no. 3:1-26. Los Angeles.

Broselow, Ellen (1982). On predicting the interaction of stress and epenthesis. Glossa **16**:115-132.

Broselow, Ellen (1984). Default consonants in Amharic morphology. MIT Working Papers in Linguistics **7**:15-32.

Buckley, Eugene. (1990). Edge-in associations and OCP 'violations' in Tigrinya. In Proceedings of WCCFL **9**:75-90.

Burzio, Luigi. (1998). Multiple correspondence. Lingua **104**:79-109..

Clements, George (1976). Palatalization: linking or assimilation? In Proceedings of CLS **12**:96-109.

Clements, George (1988). The sonority cycle and syllable organization. In E. Dresher, et al., eds., Phonologica 1988. Cambridge University Press, Cambridge.

Clements, George (1990). The role of the sonority cycle in core syllabification. In J. Kingston and M. Beckman, eds., Papers in Laboratory Phonology I: between the grammar and physics of speech:282-333. Cambridge University Press, Cambridge.

Clements, George (1991). Place of articulation in consonants and vowels: a unified theory. In B. Laks and A. Railland, eds. L'architecture et la géometrie des représentations phonologiques. Paris: Editions du CNRS.

Clements, George (1997). Berber phonology. In I. Roca, ed., Derivations and Constraints in Phonology: 289-330. Clarendon Press, Oxford.
Clements, George, and Samuel Jay Keyser. (1983). CV phonology. LI monograph no. 9. Cambridge. MA. MIT Press.
Clements, George & Elizabeth Hume (1995). Internal organization of speech sounds. In John Goldsmith, ed. The Handbook of Phonological Theory:245-306. Blackwell Publishers, Cambridge, MA and Oxford.
Even-Shoshan, Avraham (1993). Ha-milon Ha-ivri Ha-merukaz [The Compact Hebrew Dictionary]. Kiryat-Sefer Ltd. Publishing, Jerusalem.
Everett, Daniel & Iris Berent (1998). The comparative optimality of Hebrew roots: an experimental approach to violable identity constraints. Ms, University of Pittsburgh and Florida Atlantic University.
Fox, Danny (1994). Denominal verbs in Modern Hebrew. Ms, MIT.
Frisch, Stefan. (1998). Temporally organized lexical representations as phonological units. To appear in M. Broe and J. B. Pierrehumbert, eds. Language acquisition and the lexicon: Papers in Laboratory Phonology **5**. Cambridge University Press, Cambridge.
Frisch, Stefan, Michael Broe, & Janet Pierrehumbert (1997). Similarity and phonotactics in Arabic. Ms, Northwestern University.
Fukazawa, Haruka. (1998). Multiple input-output faithfulness relations in Japanese. Ms, [to appear in On'in Kenkyu 1997. Nohon On'in Gakkai (The Phonology Society of Japan)].
Fukazawa, Haruka, Mafuyu Kitahara, & Mitshiko Ota (1998). Lexical stratification and ranking invariance in constraint-based grammars. In Proceedings of CLS **34**.
Gafos, Adamantios (1995). On the proper characterization of "nonconcatenative" languages. Ms, The Johns Hopkins University.
Gafos, Adamantios (1996). The articulatory basis of locality in phonology. PhD dissertation, The Johns Hopkins University, Baltimore.
Gafos, Adamantios (1997). Inferring a-templatic reduplicative affixation: a lexical parameter learnability result. Handout of talk given at Hopkins Optimality Theory Workshop/Maryland Mayfest. May, 1997.
Gesenius, F.H.W. (1910). Gesenius' Hebrew Grammar. Edited by E. Kautzsch, revised by A.E. Cowley, Clarendon Press, Oxford. (original: Halle, 1813)
Goldsmith, John (1976). Autosegmental Phonology. PhD dissertation, MIT. Published 1979, New York: Garland.
Gnanadesikan, Amalia (1997). Phonology with ternary scales. PhD dissertation, University of Massachusetts, Amherst.
Graf, Dafna (1999). Metrical structure of Modern Hebrew Nominals. Magisterarbeit, Heinrich-Heine-Universität, Düsseldorf.
Grammont, M. (1933). Traité de phonétique. Paris. Librairie Delagrave.
Greenberg, Joseph (1950). The pattern of root morphemes in Semitic. Word **6**:162-181.
Halle, Morris & Jean-Roger Vergnaud (1987). An Essay on stress. MIT Press. Cambridge.

Hayes, Bruce (1987). A revised parametric metrical theory. In Proceedings of NELS **17**:274-289. University of Massachusetts, Amherst, GLSA.

Hayes, Bruce (1994). Metrical stress theory: principles and case studies. University of Chicago Press: Chicago.

Herzallah, Rukayyah (1990). Aspects of Palestinian Arabic phonology: A nonlinear approach. PhD dissertation, Cornell University. [distributed as Working Papers of the Cornell Phonetics Laboratory **4**]

Hoberman, Robert (1988). Local and long-distance spreading in Semitic morphology. NLLT **6**:541-549.

Hooper, Joan (1976). An introduction to natural generative phonology. New York: Academic Press.

Horvath, Julia (1981). On the status of vowel patterns in Modern Hebrew: morphological rules and lexical representation. In T. Thomas-Finders, ed. Extended Word-and-Paradigm Theory, Occasional Papers in Linguistics **4**:228-261. Los Angeles.

Hume, Elizabeth (1992). Front vowels, coronal consonants, and their interaction in nonlinear phonology. PhD dissertation, Cornell University. Published 1994, New York: Garland.

Ito, Junko (1989). A prosodic theory of epenthesis. NLLT **7**:217-259.

Ito, Junko & Armin Mester (1994). Japanese phonology. In J. Goldsmith, ed. The Handbook of Phonological Theory:817-838. Blackwell Publishers, Cambridge, MA and Oxford.

Ito, Junko & Armin Mester (1995). The core-periphery structure of the lexicon and constraints on reranking. In Jill N. Beckman, Laura Walsh Dickey, & Suzanne Urbanczyk, eds. University of Massachusetts Occasional Papers **18**: Papers in Optimality Theory, 181-209.

Ito, Junko & Armin Mester (1997a). Featural sympathy. In Phonology at Santa Cruz **5**:29-36.

Ito, Junko & Armin Mester (1997b). Correspondence and compositionality: The ga-gyo variation in Japanese phonology. In I. Roca, ed., Derivations and Constraints in Phonology. 419-462. Clarendon Press, Oxford.

Ito, Junko & Armin Mester (1998). The phonological lexicon. In N. Tsujimura, ed., A Handbook of Japanese Linguistics. Blackwell Publishers: Oxford.

Ito, Junko, Yoshihisa Kitagawa & Armin Mester (1996). Prosodic faithfulness and correspondence: evidence from a Japanese argot. In Journal of East Asian Linguistics **5**:217-294.

Jespersen, Otto (1904). Lehrbuch der Phonetik. Leipzig and Berlin.

Katayama, Motoko (1998). Optimality Theory and Japanese loanword phonology. PhD dissertation, UC Santa Cruz.

Kaye, Jonathan & Jonathan Lowenstamm (1984). De la syllabicité. In F. Dell, D. Hirst, and J.-R. Vergnaud, eds. Forme sonore du langage:123-160. Paris: Hermann.

Keating, Patricia (1988). Palatals as complex segments: X-Ray evidence. UCLA Working Papers in Phonetics **69**:77-91.

Keating, Patricia (1991). Coronal places of articulation. In Carole Paradis and Jean-François Prunet, eds. The Special Status of Coronals: Internal and

External Evidence: Phonetics and Phonology **2**:29-48. San Diego, Academic Press.
Keating, Patricia (1993). Phonetic representation of palatalization versus fronting. UCLA Working Papers in Phonetics **85**:6-21.
Kenstowicz, Michael (1994). Base-identity and uniform exponence: alternatives to cyclicity. Ms, MIT.
Kenstowicz, Michael (1995). Cyclic vs. non-cyclic constraint evaluation. Phonology **12**:397-436.
Kenstowicz, Michael (1997). Uniform exponence: exemplification and extension. Handout of talk given at Hopkins Optimality Theory Workshop/Maryland Mayfest. May, 1997.
Khan, Geoffrey (1996). The Tiberian pronunciation tradition of Biblical Hebrew. Zeitschrift für Althebraisk **9**.
Kiparsky, Paul (1968). How abstract is phonology? In O. Fujimura, ed. 1973. Three Dimensions of Linguistic Theory. Tokyo: TEC Co. [Reprinted in P. Kiparsky. 1982. Explanation in Phonology. Dordrecht: Foris.]
Kiparsky, Paul (1979). Metrical structure assignment is cyclic. LI **10**:421-441.
Leben, Will (1973). Suprasegmental phonology. PhD dissertation, MIT. Published 1980, New York: Garland.
Lederman, Shlomo (1982). Problems in a prosodic analysis of Hebrew morphology. Studies in the Linguistic Sciences **12**:141-163.
Levin, Juliette (1985). A metrical theory of syllabicity. PhD dissertation, MIT.
Liberman, Mark & Alan Prince (1977). On stress and linguistic rhythm. LI **8**:249-336.
Martohardjono, Gite (1989) The sonority cycle in the acquisition of phonology. In Papers and Reports on Child Language Development **28**:131-139. Stanford University.
McCarthy, John (1979). Formal problems in Semitic phonology and morphology. PhD dissertation, MIT, Cambridge, MA.
McCarthy, John (1981). A prosodic theory of nonconcatenative morphology. LI **12**:373-418
McCarthy, John (1986). OCP effects: gemination and antigemination. LI **17**:207-263.
McCarthy, John (1988). Feature geometry and dependency: A review. Phonetica **43**:84-108.
McCarthy, John (1993a). A case of surface constraint violation. Canadian Journal of Linguistics **38**:169-195.
McCarthy, John (1993b). Template form in prosodic morphology. In Proceedings of FLSM **3**:187-218.
McCarthy, John (1994). The phonetics and phonology of Semitic pharyngeals. In P. Keating, ed., Papers in Laboratory Phonology **3**:215-243. Cambridge University Press, Cambridge.
McCarthy, John (1995). Extensions of faithfulness: Rotuman revisited. Ms, University of Massachusetts, Amherst.
McCarthy, John & Alan Prince (1986). Prosodic morphology. Ms, University of Massachusetts, Amherst & Brandeis University.

McCarthy, John & Alan Prince (1990a). Foot and word in prosodic morphology: the Arabic broken plural. NLLT **8**:209-283

McCarthy, John & Alan Prince (1990b). Prosodic morphology and templatic morphology. In M. Eid and J. McCarthy, eds. Perspectives on Arabic Linguistics: Papers from the Second Symposium: 1-51. Amsterdam, Benjamins.

McCarthy, John & Alan Prince (1993a). Prosodic morphology I: Constraint interaction and satisfaction. Ms, University of Massachusetts at Amherst & Rutgers University.

McCarthy, John & Alan Prince (1993b). Generalized alignment. In G. Booij & J. van Marle, eds., Yearbook of Morphology:79-153. Dordrecht: Kluwer.

McCarthy, John & Alan Prince (1994a). An overview of prosodic morphology. Handout of talk given at Utrecht Workshop in Prosodic Morphology. June, 1994.

McCarthy, John & Alan Prince (1994b). The emergence of the unmarked: optimality in prosodic morphology. In Proceedings of NELS **24**:333-379. University of Massachusetts, Amherst: GLSA.

McCarthy, John & Alan Prince (1995). Faithfulness and reduplicative identity. In In Jill N. Beckman, Laura Walsh Dickey, & Suzanne Urbanczyk, eds.University of Massachusetts Occasional Papers **18**: Papers in Optimality Theory, 249-384.

Mester, Armin (1986). Studies in tier structure. PhD dissertation, University of Massachusetts at Amherst. Published 1988, New York: Garland.

Mester, Armin (1994). The quantitative trochee in Latin. NLLT **12**:1-62.

Mester, Armin & Junko Ito. (1989). Feature predictability and underspecification: Palatal prosody in Japanese mimetics. Lg **65**:258-293.

Morgenbrod, H (1981). The sound structure of verb roots in Modern Hebrew. JL **17**, no. 21:11-16. Cambridge, England.

Ní Chiosáin, Máire (1995). Prosodic well-formedness and sonority constraints: epenthesis in Irish. Ms, University College Dublin. ROA-89.

Ní Chiosáin, Máire & Jaye Padgett (1993). Inherent VPlace. Report no. LRC-93-09, Linguistics Research Center, UC Santa Cruz.

Ní Chiosáin, Máire & Jaye Padgett (1997). Markedness, segment realisation, and locality in spreading. Report no. LRC-97-01, Linguistics Research Center, UC Santa Cruz.

Padgett, Jaye (1995). Stricture in feature geometry. CSLI Publications, Stanford.

Paradis, Carole & Darlene LaCharité. (1996). Saving and cost in French loanword adaptation in Fula: Predictions of the TCRS loanword model. In McGill Working Papers in Linguistics **11**:46-84.

Paradis, Carole & Caroline Lebel (1994). Contrasts from the segmental parameter settings in loanwords: Core and periphery in Quebec French. In Proceedings of the Conference on Contrast in Phonology.

Paradis, Carole & Jean-François Prunet (1991). The Special Status of Coronals: Internal and External Evidence: Phonetics and Phonology **2**. San Diego, Academic Press.
Pater, Joe (1995). Austronesian nasal substitution and other NC effects. In R. Kager, H. van der Hulst, and Z. Zonneveld, eds., Proceedings of OTS/HIL Workshop on Prosodic Morphology.
Pierrehumbert, Janet (1993). Dissimilarity in the Arabic verb roots. In Proceedings of NELS **23**:33-78.
Pike, Kenneth L. (1943). Phonetics: A critical analysis of phonetic theory and a technic for the practical description of sounds. Ann Arbor: University of Michigan Press.
Prince, Alan (1980). A metrical theory for Estonian quality. LI **11**:511-562.
Prince, Alan (1996). Aspects of mapping under OT. Handout from talk given at UC Santa Cruz. October 11, 1996.
Prince, Alan (1997). Endogenous constraints on Optimality Theory. Handout of talk presented in Hopkins Optimality Theory Workshop/Maryland Mayfest. May, 1997.
Prince, Alan & Paul Smolensky (1991). Notes on connectionism and harmony theory in linguistics. Technical report no. CU-CS-533-91. Department of Computer Science, University of Colorado, Boulder.
Prince, Alan & Paul Smolensky (1993). Optimality theory: constraint interaction in generative grammar. Ms, Rutgers University & University of Colorado, Boulder.
Pulleyblank, Douglas (1988). Vocalic underspecification in Yoruba. LI **19**:233-270.
Ravid, Dorit (1990). Internal structure constraints on new-word formation devices in Modern Hebrew. Folia Linguistica **24**:289-347. Mouton/de Gruyter, Berlin.
Revithiadou, Anthi (1999). Headmost accent wins: Head dominance and ideal prosodic form in lexical accent systems. Ph.D. dissertation, University of Leiden, Holland. Published by Holland Academic Graphics, The Hague.
Rose, Sharon (1997a). Theoretical issues in comparative Ethio-Semitic phonology and morphology. PhD dissertation, McGill University.
Rose, Sharon (1997b). Epenthesis and syllable contact: pooling violations. Handout of talk presented at SWOT, UCLA, June 1, 1997.
Saciuk, Bohdan (1969). The stratal division of the lexicon. Papers in Linguistics **1**:464-532.
Sáenz-Badillos, Angel (1993). A history of the Hebrew language. Translated by John Elwolde. Cambridge University Press.
Samek-Lodovici, Vieri (1993). Morphological gemination. Talk given at ROW-1, October, 1993.
Saussure, Ferdinand de (1914). Cours de linguistique général. Lausanne and Paris: Payot.
Selkirk, Elisabeth (1980a). Prosodic domains in phonology: Sanskrit revisited. In M. Aranoff & M.-L. Kean, eds., Juncture:107-129. Anma Libri. Saratoga, California.

Selkirk, Elisabeth (1980b). The role of prosodic categories in English word stress. LI **11**:563-605.
Selkirk, Elisabeth (1984). On the major class features and syllable theory. In M. Aranoff & R. Oehrle, eds., Language Sound Structure:107-136. MIT Press, Cambridge.
Selkirk, Elisabeth (1993). [Labial] relations. Ms., University of Massachusetts, Amherst.
Sharvit, Yael (1994). Issues in the phonology and morphology of the Modern Hebrew Verbal System: an optimality-theoretic analysis. Ms, Rutgers University.
Sherman, Adam (to appear). Morphological head dominance and Modern Hebrew prosodic morphology. To appear in Sherman, A., D. Herrick, K. Kurisu, and N. Sanders, eds., Phonology at Santa Cruz **6**.
Shinohara, Shigeko (1997). Analyse phonologique de l'adaptation japonaise de mots étrangers. Thèse pour doctorat. Université de la Sorbonne nouvelle, Paris III.
Sievers, E. (1881). Grundzüge der Phonetik. Leipzig: Breitkopf and Hartel.
Smolensky, Paul (1993). Harmony, markedness and phonological activity. Paper presented at Rutgers Optimality Workshop 1, Rutgers University, October 1993.
Smolensky, Paul (1995). On the internal structure of the constraint component CON of UG. Paper presented at Johns Hopkins University, March 1995.
Spaelti, Philip (1997). Dimensions of Variation in Multi-Pattern Reduplication. PhD dissertation, UC Santa Cruz.
Steriade, Donca (1982). Greek prosodies and the nature of syllabification. PhD dissertation, MIT.
Steriade, Donca (1987). Locality conditions and feature geometry. In Proceedings of NELS **17**:595-617. University of Massachusetts at Amherst, GLSA.
Steriade, Donca (1988). Reduplication and syllable transfer in Sanskrit and elsewhere. Phonology **5**, no. 1:73-155.
Steriade, Donca (1996). Paradigm uniformity and the phonetics-phonology boundary. Ms, UCLA.
Tobin, Yishai (1990). Principles for a contrastive phonotactics: The Hebrew triconsonantal (CCC) root system a case in point. In Papers and Studies in Contrastive Linguistics **26**:137-153. Poznan, Poland.
Urbanczyk, Suzanne (1995). Double reduplications in parallel. In Jill N. Beckman, Laura Walsh Dickey, & Suzanne Urbanczyk, eds. University of Massachusetts Occasional Papers **18**: Papers in Optimality Theory, 499-531.
Whitney, W.D. (1865). The relation of vowel and consonant. Journal of the American Oriental Society **8**. Reprinted in W.D. Whitney, Oriental and Linguistic Studies, second series, Charles Scribner's Sons, New York: 1874.
Yannai, Igal (1970). The quadriradical verb in the Hebrew language. PhD dissertation, UCLA.

Yip, Moira (1988). Template morphology and the direction of association. NLLT**6**:551-577.

Yip, Moira (1989). Feature geometry and cooccurrence restrictions. Phonology **6**:349-375.

Zilberman, Shimeon (1993). Milon Angli-Ivri Ivri-Angli Adkani [The Up-to-Date English-Hebrew Hebrew-English Dictionary]. Published by Zilberman, Jerusalem.