Visibility and Abstract Form:
Evidence from Spirantization in Modern Hebrew

Hadass Sheffer
University of Pennsylvania and Swarthmore College
sheffer@unagi.cis.upenn.edu

This paper addresses the issue of Spirantization in Modern Hebrew, looking at the interaction of morphological form and phonological wellformedness within the framework of Optimality Theory (Prince and Smolensky 1993). In addition, it raises the issue of visibility of faithfulness violations of input-to-output form-mapping to other constraints. Namely, whether an unparsed segment is still accessible to the Eval function. The case of spirantization — or fricativization — in Hebrew is an interesting test for an optimality evaluation, as it has posed many problems for theories in the past, as yet never receiving an exhaustive, categorical solution (Kiparsky 1971; Ben-Horin and Bolozky 1972; Barkai 1974, 1978; Prince 1975; Bolozky 1977, 1984; Doron 1981; Lederman 1987; Ravid 1988; Bat-El 1989; Adam 1994). The actual interaction of vowel and consonant in the spirantization process is problematic in and of itself, as is its selectivity towards certain consonants. Compounded to that is the problem facing a rule-based derivational approach: that the application of the spirantization rule simultaneously feeds and is fed by other rules. And, as Prince (1975) points out, the rule has to occur both at the beginning and at the end of a section of ordered rules. In Modern Hebrew there are additional worries due to the fact that spirantization is limited to three of the six original spirantizing consonants of Tiberian Hebrew, and that at a superficial level it appears to be variable if not random for some speakers. A final problem is that while Tiberian Hebrew has surface geminates which are analysed as the constructions blocking spirantization, Modern Hebrew does not allow surface geminates. These problems have led some linguists to conclude that Modern Hebrew spirantization is a random, arbitrary, lexical process. It is obvious that in Modern Hebrew spirantization is more complex than in Tiberian Hebrew and any analysis of it would automatically include a solution for the problem of spirantization in Tiberian Hebrew. Accordingly, I have chosen to analyse the case of Modern Hebrew. In this paper I show that Modern Hebrew spirantization is by no means a random or arbitrary process. The non-surfacing of spirantization in some environments is not due to morphophonemic rules, but is the result of the interaction of several other, independent phonological constraints and general principles of wellformedness. Thus, the representation of morphological units must be subject to more general prosodic constraints, in the spirit of Prosodic Morphology (McCarthy 1981, McCarthy and Prince 1986). In this paper I address the issue of verbs, where spirantization is more salient and is traditionally considered to be morphologically triggered. The analysis, however, can be expanded to account for words in other grammatical categories. This paper first addresses word formation in Modern Hebrew, it then describes the issue of spirantization and the accompanying problem of gemination. Finally, a solution is presented which explores the reaches of visibility and abstractness.

Hebrew word formation, and especially verb formation, is similar to other Semitic languages in that it exhibits a regular pattern throughout the verbal conjugation. There are five different verb patterns called binyanim. It has been argued that in Hebrew word formation the morphology supplies three non-continuous morphemes: a CV- skeleton, or template, carrying some grammatical information (grammatical category, reflexivity, etc.), a root consisting of consonants only (typically 3) and carrying the semantic meaning of the word, and a melodic sequence which supplies additional grammatical information (tense, aspect). The root and the melody are mapped onto the template, resulting in interdigitation of consonants and vowels (McCarthy 1981, Mester 1986, McCarthy and Prince 1986). Another approach (advanced by Bat-El 1989, 1994; Sharvit 1994) is that there are no templates and that consonant-vowel interdigitation is the result of systematic syllabification of morphologically specified vowels and the consonants of the root. Bat-El's analysis has been shown to be problematic, chiefly because it only stipulates the number of vowels supplied by the morphology. however, I propose that this syllabification-based solution can be made workable if we supply the number of consonants along with the number of vowels. Thus, the verb pattern, or binyan, supplies the melody and number of consonants. The root-morpheme is then syllabified accordingly. This is the approach assumed in this paper[1]. The syllabification of consonants and vowels involves ranking of the following constraints (based on motivation in Sheffer 1994, 1995 and see also Sharvit 1994):

(1) ALIGN-L (Root, L, Ft, L)
For every root, there is a foot such that the left edge of the root coincides with the left edge of the foot.

Satisfaction of this constraint ensures that the first consonant of the root is the also the onset of the first syllable of the verb form.

(2) ALIGN-R (Ft,R, Root,R)
For every foot, there is a root such that the right edge of the foot coincides with the right edge of the root.

Satisfaction of this constraint ensures that the verb form ends with the last consonant of the root.

Other constraints come into play here. I assume familiarity with the syllabic wellformedness constraint introduced in Prince and Smolensky (1993) ONSET which stipulates that a syllable must have an onset, and the faithfullness constraints PARSE, which militates against deletion of segments, and FILL which disallows epenthesis. Another constraint is:[2]

(3) *COMP
No complex Onsets OR Codas are allowed.

---

[1]I assume that choice of binyan is not predictable. (see Ornan 1971, 1973 and many others for discussion)
[2] This constraint is borrowed from Sharvit 1994. It simply collapses the constraints *ComplexOnset and *ComplexCoda (independently motivated in Sheffer 1994), since for the purpose of verb formation based on native Hebrew roots we need not deal with each of these constraints separately.

The table in (4) illustrates the section of the constraint hierarchy of Modern Hebrew that takes part in the syllabification of root consonants and the aspectual vowel melody. Ranking of ONSET >> ALIGN-R >> PARSE is motivated in other work on Modern Hebrew verb formation[3]. The winning candidate (k) does not violate any of the constraints:

(4) Example of syllabification of a 3-consonant root and 2-vowel melody

/CCC/ + /a,a/	ONSET	AL-R	PARSE	AL-L	*COMP	FILL
a. .CCa.Ca.		*!			*	
b. .CaC.Ca.		*!				
c. .Ca.CCa.		*!			*	
d. .aC.CaC.	*!			*		
e. .a.CaCC.	*!			*	*	
f. ._aC.CaC.	(*!)[4]			*!		*
g. .Ca_.CaC.						*!
h. .Ca<C>.Ca.		*!	*			
i. .CCCa.a.	*!	*			*	
j. .aC.CCa.	*!	*		*	*	
k. ☞ .Ca.CaC.						
l. .CCaC.<a>			*!	*	*	

Tiberian Hebrew spirantization has been described in many studies and is illustrated in (5). It is an alternation of the stops /p,b,t,d,k,g/ with the fricatives /f,v,θ,∂,x,γ/. This alternation occurs post-vocalically unless blocked by morphologically conditioned gemination.

(5) Tiberian Hebrew Spirantization:

a. /sb+a+tem/	sabboθem	‘you pl. turned’
b. /y_b+la+e/	la_eveθ	‘to sit’
c. /?bd+ya+a/	ya?avo∂	‘he will work’

[3] Sheffer 1994; Sharvit 1994. Due to space limitations I adopt this ranking here. However, one of the relationships ONSET>>PARSE will receive additional support below, while ONSET>>ALIGN-R does not play a crucial role in the analysis of Spirantization.

[4] We have not specified what the epenthetic segment is. If it is a vowel it will incur an ONSET violation.

In Tiberian Hebrew all oral stops participated in spirantization. In Modern Hebrew only /p,b,k/ spirantize to /f,v,x/ respectively, due to the fact that the other oral stops do not have fricated segments sharing the same place of articulation.[5] Note that when /k/ spirantizes, it surfaces as the uvular fricative (for more discussion on this see Sheffer 1992a,b). The consonantal inventory of Modern Hebrew is presented in (6).

(6)	Labial	dental	alveolar		Palatal		Velar	Uvular	(Laryngeal)
	p, b	t, d			k, g	?			
			c	c, j					
	f, v		s, z			x, γ		h	
				_, z					
	m		n						
			l						

There have been claims both in favor and against the idea that Modern Hebrew spirantization is a direct descendent of Tiberian Hebrew spirantization. Those in favor struggle to account for the loss of three of the original spirantizing stops — mainly by relying on substratum effects from Yiddish and Russian, the native languages of the revivalists of Modern Hebrew. Yiddish and Russian do not have /θ,∂/ and the realization of /r/ in Yiddish is identical to the fricativized form of /g/. Those against this historical hypothesis claim, correctly, I believe, that substratum effects can only partially account for this loss, since we would expect that Modern Hebrew speakers coming from Arabic speaking countries would maintain the /θ,∂,γ/ distinctions. However, this is not the case. Following Ben-Horin and Bolozky (1972), I believe that the revival or re-birth of Modern Hebrew was based on many arbitrary compromises. Some of the features of Tiberian Hebrew were adopted into Modern Hebrew while others never became a psychological reality. As a result /p,b,k/ spirantization is a feature of Modern Hebrew.

The stop/fricative alternation that underlies the process of spirantization raises the issue of the representation of the consonants involved. One view is that root consonants in Hebrew are abstract phonological representations that may never actually surface. For example, since Modern Hebrew does not treat glides as full consonants, we find that glides which are part of the root are never realized phonetically. Instead, these glides surface as vowels. A somewhat similar approach has been posited for consonants that can be spirantized: underlyingly they are abstract consonantal segments which can surface as either stops or fricatives, the feature [continuant] being dependent on lexical marking. Other analyses of Hebrew spirantization, have adopted different degrees of underspecification for assigning underlying continuancy values for root consonants depending on their position in each binyan template. In these analyses, the consonants participating in spirantization can either be specified for continuency or left unspecified, receiving the value for continuency through redundancy rules. Both types of approach assign phonological features dependent on the morphology, since the common assumption underlying these analyses is that the binyan marks the second consonant of the template as blocked for spirantization. This has been explained in one of two ways: First, a morphophonemic rule specifying that in these

---

[5]The uvular /q/ (which, in Tiberian Hebrew had pharyngeal articulation) also does not spirantize to surface as the uvular fricative [x].

* Q
|
[+cont]

For discussion see Sheffer 1992a.

environments the second consonant is expanded to a geminate construction which then blocks spirantization - exactly how gemination blocks spirantization has not been explained. Or alternatively, as an arbitrary morphological rule. A major problem is obviously the issue of arbitrariness. This could be explained as unpredictable morphological formation, but such an explanation should only be used as a last resort. The claim of the geminate-based morphophonemic rule is more interesting. It too, however, suffers from some problems. Namely, the exact nature of the blocking, and more importantly, the question of why the morphology specifies a geminate construction on the second consonant of only two of the five binyanim — or verb patterns — available in the language, but nowhere else. Finally, is there sufficient motivation for positing a geminate construction, in light of the fact that Modern Hebrew does not have surface geminates. The analysis presented in this paper shows that root consonants receive the value for the feature [continuant] in the phonological component of the grammar. This is obviously preferable to an analysis which allows the value of one feature to be specified by a morphological rule, especially since this is the only case of morphological specification of a feature value in the language.

Spirantization, then, is the product of a constraint on the melodic structure of the output form of a word:

(7) SPIR: /VC/
 |
 [+cont]

Segments are assigned [+cont] when preceded by a vowel.[6]

If satisfied, this constraint will enable the following forms to surface:

(8)

	/_PK/+/a,a/	_a**f**a**x**	'he poured'
	/X_B/+/a,a/	xa_a**v**	'he thought'
	/RKB/+/a,a/	raxavti	'I rode'
and:	/RKB/+/e-,a/	erkav	'I will ride'

The only exceptions to spirantization are in the case of two of the five verb patterns, as in the words in the right column in (9a) and word initial position[7] as in the words in the right column of (9b).

(9)a.	taval	'dipped'	tibel	'added spice'
	_axax	'forgot'	_ikex	'dampened'
	_afax	'poured'	hi_tapex	'waxed eloquent'
	yeva_el	'will cook'	bi_el	'cooked'
	yevorax	'will be blessed'	borax	'was blessed'

(all forms shown in 3rd person singular masculine, past tense, unless otherwise indicated.)

Spirantization is a post-vocalic effect. Its domain is the word, so word initial consonants are never spirantized (in Prescriptive Modern Hebrew, like Tiberian Hebrew, spirantization does occur across word boundaries).

---

[6] This is an over simplified explanation of the interaction between the consonant and the preceding vowel. A detailed analysis of the actual spreading of the features involved are outside the scope of this paper, but can be found in Sheffer 1995.

[7] In Modern Spoken Hebrew spirantization does not occur across word boundaries. Thus, a prosodic distinction is made between *bevakasha* 'please' and *bebakasha* 'in a request' in addition to the syntactic distinction.

Spirantization is blocked in two verb patterns: the binyanim pi?el and hitpa?el. Traditional grammars stipulate that the second consonant in these binyanim is marked by a diacritic called *Dagesh Forte* which in effect does not allow the consonant to spirantize. The traditional templatic analysis of the binyanim is shown in (10). Note in particular the optional number of consonants available in some of the binyanim.

(10) Verb binyan (pattern) for 3rd masc. singular (the uninflected form)

binyan	past	present	future
pa?al	CVCVC	CVCVC	yiCCVC
nif?al	niCCVC	niCCVC	yiCVCVC
pi?el	CV(C)CVC	meCV(C)CVC	yeCV(C)CVC
hitpa?el	hitCV(C)CVC	mitCV(C)CVC	yitCV(C)CVC
hif?il	hiCCVC	meCCVC	yaCCVC

Two of the five binyanim, pi?el and hitpa?el, have an optional consonantal slot in all tenses, to account for the fact that they can accommodate four-consonant roots. Of the 776 roots in the language which have four or more consonants, none can map onto pa?al, nif?al or hif?il. The reason being that the templates of these binyanim simply cannot accommodate four consonants. The sole exception is in the case of verbs based on loan words in which the original word contained consonant clusters. In such cases the clusters are copied as such and never split up (Bat-El 1994). Otherwise, only the two binyanim pi?el and hitpa?el allow for four-consonant roots. The way these two binyanim can accommodate four consonants has always been explained as optional expansion[8]. This seems a bit arbitrary: why is optional expansion limited to these two binyanim? Recall also that these are the only two binyanim in which spirantization of the second consonant is blocked in the case of three-consonant roots (as shown in 9a. above), but not in the case of four-consonant roots (or two consonant roots that are reduplicated to fit the template) as shown in (11):

(11)	/_KPL/	_i**x**pel	'xeroxed'
	/SFSR/	si**f**ser	'peddled'
	/?BTX/	?i**v**teax	'provided security services'
	/PK/	pi**x**pe**x**	'gurgled' (as a brook or rivulet)
	/_P/	_i**f**_e**f**	'rubbed'
	/RB/	hitra**v**rev	'boasted'

So, we find an interesting cooccurrence: in these two binyanim, there is room for a four-consonant root and there is also something which blocks spirantization in the mapping of three-consonant roots. In accordance with the view that spirantization is solely a post-vocalic effect, this blocking must be due to the invisibility of the second root consonant to the preceding vowel. This paper proposes that such invisibility can only be effected by another consonant. In the case of three consonant roots, then, I claim that there is an additional consonantal slot immediately preceding the second consonant, which if filled,

[8]See all the above plus Bat-El (1986, 1989, 1992, 1994) and Sharvit (1994).

blocks spirantization of the second consonant. The presence of such an abstract segment brings the consonantal count in such constructions to four, and the resulting construct is similar to that of the four-consonant roots. I suggest, then, that there is no optional expansion in these two binyanim, but rather that their form is specified for four consonants:

(12) Verb binyan (pattern) for 3rd masc. singular (the "bare stem")

binyan	past	present	future
pi?el	CVCCVC	meCVCCVC	yeCVCCVC
hitpa?el	hitCVCCVC	mitCVCCVC	yitCVCCVC

Syllabification of four consonants and the vocalic pattern specified for the binyan will predict the correct form due to the hierarchical ranking of the constraints involved:

(13) Example of syllabification of a 4-consonant root and 2-vowel melody

/CCCC/+/i,e/,pi?el	ONSET	AL-R	PARSE	AL-L	*COMP	FILL
a. .CCi.CeC.					*!	
b. .CiCC.Ce.		*!			*	
c. .Ci.CCeC.					*!	
d. .iCC.CeC.	*!			*	*	
e. .i.CeC.C$\underline{V}$C.	*!			*		*
f. .C$\underline{V}$.CiC.Ce.		*!				*
g. .Ci<C>.CeC.			*!			
h. .<C>Ci.CeC.			*!			
i. .Ci.<C>CeC.			*!			
j. .Ci.CeC<C>.			*!			
k.✦.CiC.CeC.						
l. .C<C>i.CeC.			*!			

As explained above, Hebrew Morphology assigns the verb root a binyan which specifies the number and quality of vowels and the number of root consonants (and in some cases affixational material). The rest is left to phonological mapping of the root and vowel melody and general wellformedness constraints. What happens in the case of three-consonant roots assigned to the pi?el and hitpa?el binyanim? The template supplies four consonantal slots, while the root only has three. The Theory of Prosodic Morphology dictates that templates must be satisfied. Satisfaction of the binyan template in this case can be achieved through two different strategies: insertion of a consonant or spreading of one of the root consonants.

Of these two strategies, the first is harder to motivate, since Modern Hebrew has no other cases of insertion of a consonant.The spreading approach is more attractive since the process of spreading will occur automatically in order to satisfy the binyan template. However, any analysis of spreading will have to account for the fact that the newly-specified consonant does not surface.

Another relevant question is why the second consonant spreads to fill the template instead of either the first or the third consonants spreading. The answer to this has been discussed in several other studies, since spreading of the second consonant of a root is a commonly occuring characteristic of Semitic languages (McCarthy 1981 and others). In traditional autosegmental terms this can be explained as the product of a universally undominated constraint against crossing association lines (ULC), reproduced in (14) and demonstrated in the “illegal” forms in (15a,b) as opposed to the wellformed, attested form in (15c):

(14) Universal Linking Convention (Pulleyblank (1986), also Goldsmith’s WellFormedness Condition (1976))

Association lines do not cross.

(15)a. * C V C C V C b. *C V C C V C c. C VC C V C

C_1 V C_2 V C_3 C_1 V C_2 V C_3 C_1 V C_2 V C_3

In addition to the ULC, constraints on syllabic well-formedness like *Comp play a role in selecting the form CVCCVC and not such forms as in (16)

(16) */CCVCVC/, */CVCVCC/ etc.

So we see that for Pi?el, in the case of a three consonant root, the second consonant spreads to fill two consonantal slots, in accordance with the Binyan specification of four consonants. The argument for hitpa?el is the same, as in (17):

(17) hitCVCCVC
| V |
C_1 C_2 C_3

The output forms predicted by this analysis would have the surface form $C_1VC_2C_2VC_3$,, which would be syllabified as two heavy syllables as shown by the optimal output candidate in (13) above, with a surface geminate construct. However, Modern Hebrew does not permit surface geminates at all. In the pi?el and hitpa?el verbs, where we would expect to find these tauto-morphemic geminates surfacing, we only find one non-spirantized consonant. Length is non-distinctive in Modern Hebrew, but these consonants are not long. Since Spirantization is strictly post-vocalic, blocking of Spirantization is an indication of the presence at some level of representation of a preceding consonant. The solution presented here claims that the spreading of C_2 is automatic, but an independent constraint against surface geminates entails the underparsing of one of the geminate consonants.

Another potential surface geminate structure arises in cases of heterosyllabic gemination resulting from morphological affixation. In these cases too the surface form does not reflect a longer segment. This is achieved either through non-surfacing of one of the segments (18a) vs. (18b), or non-deletion of an otherwise deleting, intervening vowel (18c) vs (18d).

(18)a.	/katav+nu/	katavnu	'we wrote'
b.	/natan+nu/	natanu	'we gave'
c.	/kavar+u/	kavru	‘they buried’
d.	/nadad+u/	nadedu	'they wandered'

So I posit a constraint against surface geminates[9]:

(19) *GEM: *X over C C (one X linked to both) ; *X X over C_i C_i

Homorganic clusters are bad.

The tableau in (20) shows the hierarchical ranking of the constraints that come into play when predicting the attested output form of (18b). Evaluation of (20b) versus (20f) shows that FILL is crucially ranked higher than PARSE. The forms (a), (c), (d), (e) and (g) show that *GEM, ONSET,and ALIGN-R must also crucially dominate PARSE.

(20)

/natan+nu/	*GEM	ONSET	AL-R	FILL	PARSE	*COMP
a. .na.tan|.nu	*!					
b ☞ .na.ta<n>|.nu					*!	
c. .na.tan|.<n>u		*!			*	
d. .na.ta.n|<u>V</u>.nu			*!	*		
e. .na.tan|.<u>V</u>.nu		*!		*		
f. .na.tan|.<u>C</u>nu				*!		*
g. .na.tan|<u>C</u>.nu			*!			*
h. .na.tan|.<u>CV</u>.nu				*!*		

The onset violation in (e) assumes that the epenthetic segment is a vowel, but this is not necessarily the case. If it is a consonant, syllabification attempts as in (f) and (g) will violate ALIGN-R and *COMP (offering a possible ranking of *COMP in domination of PARSE, but we will find other, independent evidence for this later). An attempt to build a syllable with the epenthetic consonant will violate a constraint that states that syllables must have vowels as their nuclei. I assume that this constraint is very highly ranked in Modern Hebrew, as it is in most languages (see Prince and Smolensky 1993, McCarthy and Prince 1993, for more discussion on this).

[9]Based on discussion in Selkirk (1988).

The tableau in (21) predicts the form of (18d). The evaluation of forms (21e) and (21f) as non-optimal crucially rests on the ranking of *GEM higher than PARSE and *COMP.

(21)

/nadad+u/	*GEM	ONSET	AL-R	FILL	PARSE	*COMP
a. .na.dadl.u		*!				
b ☞ .na.dal.du			*			
c. .nad.<a>.dlu	*!		*		*	
d. .na<d>.a.dlu		*!	*		*	
e. .na.d<a>dlu	*!		*		*	*
f. .nad<a>.dlu	*!		*		*	

To summarize the ranking relations that have emerged from the tableaux presented thus far:

(22)

ONSET　　　　*GEM
/ALIGN-R, FILL \ 　　|
/ PARSE , ALIGN-L, *COMP \

Based on affixational evidence, I have suggested that spirantization and a prohibition of surface geminates are constraints and, therefore, inherently violable. The next section of the paper returns to the issue of the interaction of Spirantization and *GEM in the tauto-morphemic cases of the binyanim Pi?el and hitPa?el, and shows how their hierarchical ranking presents a comprehensive analysis to the problem of spirantization in Modern Hebrew.

I will start with a cautious attempt at ranking SPIR. Note that the following examples include a limited candidate set which includes only syllabically wellformed candidates (as shown in tableau (13) above). Template satisfaction must be undominated, and therefore any violation of it would result in crucial termination of the viability of the candidate, as in a form like:

(23) input: pi?el, 4 consonants, vowel melody {i,e}, root /SPR/

* C V <C> C V C
s i . f e r

(24) Input: Binyan pi?el, 4 consonants, vowel melody /i,e,/; Root /SPR/

<table>
<tr><th>/SPR/+/i,e/piʔel</th><th>*GEM</th><th>ONSET</th><th>AL-R</th><th>FILL</th><th>PARSE</th><th>*COMP</th><th>SPIR</th></tr>
<tr><td>a. C V C C V C
| | | \| | |
s i p̲. p e r</td><td>*!</td><td></td><td></td><td>*</td><td></td><td></td><td>*</td></tr>
<tr><td>b. C V C C V C
| | | \| | |
s i f̲. p e r</td><td>*!</td><td></td><td></td><td>*</td><td></td><td></td><td></td></tr>
<tr><td>c. C V C C V C
| | | \| | |
s i<p̲>.p e r</td><td></td><td></td><td></td><td>*!</td><td>*</td><td></td><td>*</td></tr>
<tr><td>d. C V C C V C
| | | \| | |
s i<f̲>.p e r</td><td></td><td></td><td></td><td>*!</td><td>*</td><td></td><td></td></tr>
<tr><td>e. C V C C V C
☞ | | |< \>| | |
s i . p e r</td><td></td><td></td><td></td><td></td><td>*</td><td></td><td></td></tr>
<tr><td>f. C V C C V C
| | | | | |
s i C̲ .p e r</td><td></td><td></td><td></td><td>*!</td><td></td><td></td><td></td></tr>
<tr><td>g. C V C C V C
| | | \| | |
s i . p̲ p e r</td><td>*!</td><td></td><td></td><td>*</td><td></td><td>*</td><td></td></tr>
<tr><td>h. C V C C V C
| | | </> | |
s i p . e r</td><td></td><td>*!</td><td></td><td></td><td>*</td><td></td><td>*</td></tr>
<tr><td>i. C V C C V C
| | | </>| | |
s i f . e r</td><td></td><td>*!</td><td></td><td></td><td>*</td><td></td><td></td></tr>
<tr><td>j. C V C C V C
| | |<\>| | |
s i . f e r</td><td></td><td></td><td></td><td></td><td>*</td><td></td><td>*!</td></tr>
</table>

Candidates (a-d, g) show the automatic spreading of the second root consonant to fill the required template. In these cases GEN supplies a full feature representation of the spread consonant, consequently violating FILL. Candidate (f) has an inserted consonant, also violating FILL. Candidates (h) and (i) fail on ONSET. These candidates, and (e) and (j) show the underparsing of the spreading process. GEN supplies these candidates without the feature-filling, but with an (empty) association node to the template. These are abstract consonants. They are consonants because of their association to a consonantal slot in the template, but they are featurally empty. This is not a violation of PARSE. The PARSE violations of these forms reflect the non-spreading. These abstract consonants satisfy *GEM and are, therefore, more optimal than the other candidates. Candidate (e) is the optimal output form since it only violates PARSE, whereas candidate (j) also violates SPIR, since the surfacing consonant is not post-vocalic. This analysis is based on the visibility of the abstract consonant to the constraint hierarchy, since SPIR must recognize it. In order to avoid violations of highly ranked constraints like *GEM, ONSET and ALIGN-R, the language allows a candidate to surface with an abstract segment. As illustrated by candidates (24d, f, e, and i) the fact that FILL dominates PARSE in the ranking hierarchy shows that the language prefers an abstract segment over spreading of features from one segment to another segment. Optimality Theory demands that violations be kept to a minimum. Thus, underparsing the spreading link from one consonant to another will entail fewer Parse violations than underparsing the fully-specified segment that is formed from the spreading. External to the theory, it is intuitively easier to accept the non-surfacing of a segment that has no featural content, than to allow complete specification for an abstract segment, and additional underparsing of that fully specified segment, since it never surfaces. In terms of Optimality Theory and violability, if we must have abstract segments, we would like them to be as limited and predictable as possible in order to minimize any violations or objections that they might incur.

This paper has presented an alternative to the past analyses of Modern Hebrew Spirantization. The presence of abstract segments is suggested as necessary for the correct analysis of spirantization as an independent phonological process that interacts with other phonological constraints of prosodic and templatic wellformedness within the grammar. Thus, the motivation for non-occurrence of spirantization, which has always been attributed to morphological specification, is now shown to be a result of pure phonological constraint interaction.

References

Adam, Galit (1994) Stop-fricative Alternations in Israeli Hebrew. ms Tel-Aviv University. (in Hebrew)

Barkai, M. (1974) On Duration and Spirantization in Biblical Hebrew, *Linguistic Inquiry* 5, 456-459.

Barkai, M. (1978) Theoretical Implications of Consonant Sequence Constraints in Israeli Hebrew. *Afroasiatic Linguistics* 6.1

Barkali, S. (1977) *The Complete (Hebrew) Verb Paradigm*, (a list of all the roots and their verb forms - in Hebrew) Rubin Mass, Jerusalem

Bat-El, O. (1989) *Phonology and Word Structure in Modern Hebrew*, UCLA Doctoral Dissertation.

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

Ben-Horin, G. and S. Bolozky (1972) Hebrew /b,k,p/ - Rule Opacity or Data Opacity? (A Reply to Paul Kiparsky). *Hebrew Computational Linguistics*, 5.

Doron (1981) Spirantization Melodies: A Prosodic Treatment of Modern Hebrew Spirantization, ms, UT Austin.

Goldsmith (1976) An Overview of Autosegmental Phonology. LA 2:23-68.

Kiparsky (1978, 1971) Historical Linguistics. in W.O. Dingwall (ed.) *A Survey of Linguistic Science* (2nd edition), Greylock Publishers, Stamford, Conneticut.

Lederman (1987) *On the Interaction of Morphology and Phonology: The Hebrew Verbal System*, U of Illinois Doctoral Dissertation.

McCarthy, J.J. (1981) A Prosodic Theory of Nonconcatenative Morphology, *Linguistic Inquiry* 12.3.

McCarthy, J.J. and A.S. Prince (1986) Prosodic Morphology, ms. UMass Amherst and Brandeis University.

McCarthy, J.J. and A.S. Prince (1993) Prosodic Morphology I: Constraint Interaction and Satisfaction, ms. UMass Amherst and Rutgers University.

Mester, Armin (1986) *Studies in Tier Structure*. Doctoral Dissertation, University of Massachussets, Amherst.

Ornan, Uzi (1971) Binyans and Bases, Derivations and Inflections. *HaOniversita* 16:15-22 (in Hebrew)

Ornan, Uzi (1973) Ordered Rules and the Phonemic Split of /b,k,p/. *Mikraa LeTorat HaHege*, Akademon Press, Jerusalem. (in Hebrew)

Prince, A.S. (1975) *The Phonology and Morphology of Tiberian Hebrew*, MIT Doctoral Dissertation.

Prince, A. S. and P. Smolensky (1993) Optimality Theory, ms. Rutgers University and University of Colorado.

Pulleyblank, Douglas (1986) Rule Application on a Noncyclic Stratum*, Linguistic Inquiry* 17.3

Ravid (1988) *Transient and Fossilized Phenomena in Inflectional Morphology: Variants of Spoken Hebrew*. Doctoral Dissertation, Tel-Aviv University.

Selkirk, E. (1988) A Two-Root Theory of Length, *UMOP* 14, GLSA, UMass, Amherst.

Sharvit, Y. (1994) Issues in the Phonology and Morphology of the Modern Hebrew Verbal System, ms Rutgers University.

Sheffer, H. (1992a) Reclassification of Historical Gutturals in Spoken Modern Hebrew, ms UPenn.

Sheffer, (1992b). Fricativization in Modern Spoken Hebrew. ms. Upenn.

Sheffer, H. (1994) An Optimality Theoretic Analysis of Accentual Stress: The Case of Modern Hebrew, paper presented at the 18th Penn Linguistics Colloquium.

Sheffer, H. (1995) The Phonology of Modern Hebrew: an Optimality Theoretic Account. ms. Upenn.