Theoretical issues in Modern Hebrew phonology

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ISBN 978-94-6093-384-4
DOI https://dx.medra.org/10.48273/LOT0599

:LOT Netherlands Graduate School of Linguistics
Landelijke Onderzoekschool Taalwetenschap

:LOT
599

Itsik Pariente

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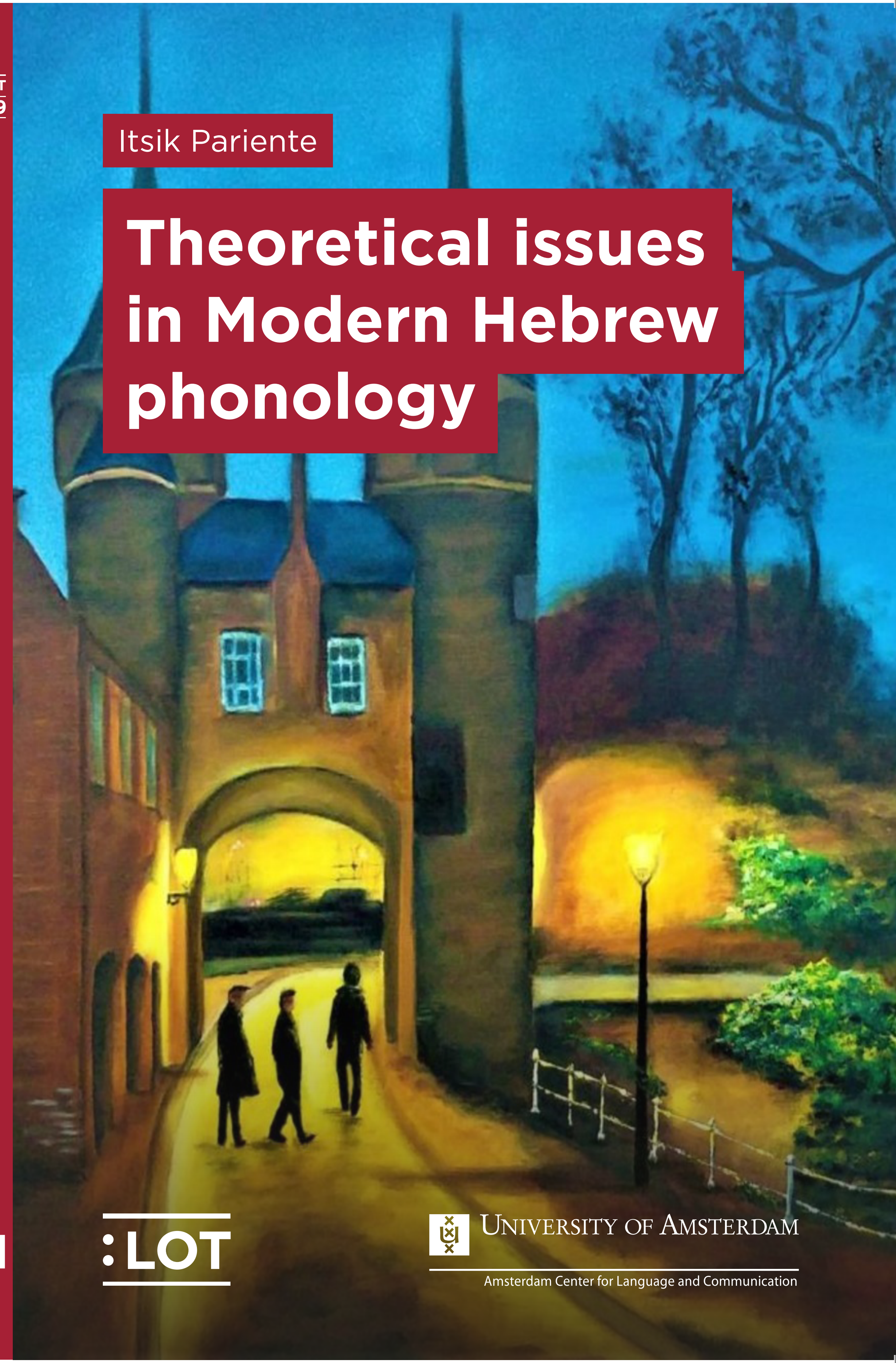

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:LOT

University of Amsterdam
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Published by
LOT
Kloveniersburgwal 48
1012 CX Amsterdam
The Netherlands

phone: +31 20 525 2461
e-mail: lot@uva.nl
http://www.lotschool.nl

ISBN: 978-94-6093-384-4
DOI: https://dx.medra.org/10.48273/LOT0599
NUR: 616

Theoretical issues in Modern Hebrew phonology

ACADEMISCH PROEFSCHRIFT

ter verkrijging van de graad van doctor
aan de Universiteit van Amsterdam
op gezag van de Rector Magnificus
prof. dr. ir. K.I.J. Maex
ten overstaan van een door het College voor Promoties ingestelde commissie,
in het openbaar te verdedigen in de Agnietenkapel
op dinsdag 5 oktober 2021, te 12.00 uur

door Itsik Pariente

geboren te Ashdod

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אַסְתָּר שָׁמִיר

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Acknowledgments

I would like to thank my Promotor Paul Boersma for his guidance in writing this dissertation. I am also thankful to my Copromotor Silke Hamann for her patience and eagle eye for every detail of the dissertation.

I would also like to thank Shmuel Bolozky, Justim Cammy and Gilya Schmidt for their continued support over the years.

I was lucky to have friends like Mary Fletcher, Matt Henry Riqi Kosovsky, Dylan Mulkey, Alexander Prezas, David Seidenberd and Elanit Weisbaum. You are all dear to my heart.

Finally, I would like to thank Astar Shamie for allowing me to use a verse from one of her beautiful poems, and my BGFF Gal Fridman for allowing me to use one of his most beautiful pictures for the cover of the book.

1 Introduction

This dissertation is a collection of four papers that deal with several issues in the phonology of Modern Hebrew (MH). The first two papers, which form chapters 2 and 3, deal with the effects of the pharyngeal consonants in MH. MH consists of only two dialects: General Modern Hebrew (GMH), which is the standard dialect (also known as “Modern Koiné” (Yaeger-Dror 1988)), and Sephardic Modern Hebrew (SMH) (also known as “Mizrahi Hebrew” (Yaeger-Dror 1988) or “Oriental Hebrew” (Blanc 1968)). The two dialects differ only in their consonant inventories; SMH has retained the historical pharyngeal consonants (IPA: ħ and ʕ), while GMH has collapsed them with non-pharyngeals (ħ → x and ʕ → ʔ/a/Ø). Chapter 2 deals with non-lexical vowels that are triggered by the pharyngeal consonant, while chapter 3 deals with the effects of the pharyngeal consonant on adjacent vowels.

Chapter 4 deals with the synchronic influence of historical pharyngeals in GMH. In this chapter it is argued that in GMH, historical ʕ emerges as a low vowel [a] and ħ as [ax]. The manifestation of these root vowels stands in correspondence to the moraic structure of other forms in the same template; root vowels appear in the surface only if their corresponding consonant is moraic.

The fifth chapter deals with stress syncope and epenthesis in MH. A full analysis of stress and syncope is given, followed by a description of cases in which syncope creates an illicit three-consonant cluster that is broken by epenthesis. In these forms stress shifts to the ultimate syllable and the penultimate vowel changes to [e]: tixt**ó**v-i → tixt**e**ví. It is argued that this seemingly serial interaction between phonological processes can be adequately analyzed within a parallel model of phonology, i.e. the non-derivational version of Optimality Theory.

The remainder of the introduction provides some background information about Modern Hebrew which is relevant to the dissertation, but not discussed in details in the chapters themselves.

1.1 Modern Hebrew – history and sociolinguistics in brief

At the time of the revival of the language, Zionist ideologists looked at Biblical Hebrew as a model language. This resulted in MH inheriting the morpho-phonology of Biblical Hebrew in both dialects, but not the full inventory of phonemes, nor the prosodic structure of it. Most importantly, the majority of the speakers (of European origin) did not “recover” the pharyngeals. However, a small group of people (of Sephardic origin) did “recover” the pharyngeals as they were native speakers of Arabic, a Semitic language which has pharyngeal consonants. Since the morpho-phonology of the two groups was directly adopted from Biblical Hebrew, two distinct grammars emerged to account for the surface effects of the pharyngeals.

1.1.1 Ethnicity in Israel

The population of the state of Israel is divided into a Jewish majority (76%) and non-Jewish minorities, mostly Muslim Arabs (17%), with a strong correlation between ethnicity and language. Arabs are mostly native speakers of Arabic, while Jews speak mostly Hebrew. Traditionally the Jewish population is divided ethnically into Jews of central and eastern European descent, known as Ashkenazi Jews, and Jews of Spanish, Portuguese and Middle Eastern descent known as Mizrahi (or Sephardi) Jews (e.g. Swirski 1981; Ram 2002; Shalom Chetrit 2009). Ethnic origin is defined by the Israeli Central Bureau of Statistics as one’s country of birth or, for Israeli-born individuals, by the father’s country of birth. A third of the Jewish population is defined as being of Israeli origin. These definitions make it hard to collect data on third generation Jews and on Israelis of mixed heritage (Cohen 2002).

From the 2nd century BC up to the 19th century AD, very few Jews lived in the land of Israel. During this time period most Jews lived in the Diaspora (mostly in Eastern Europe and the Middle East). These communities had a very limited connection between them. Diaspora Jews spoke either the native language of the general population or a Jewish dialect of that language (e.g. Yiddish, Ladino).

The rise of the Zionist movement among European Jews initiated waves of immigration to the land of Israel as Zionist ideologists saw Judaism as not just a religion, but as a nationality as well, a nationality that deserved a homeland in its ancestral territory.

At the time of the creation of the state of Israel, these waves of immigration from the European Diaspora (1948) resulted in a Jewish population that was comprised of 88% Ashkenazi and 12% Sephardi (Goldscheider 2002), as Sephardic Jews immigrated to the land of Israel in very small numbers for centuries.

In May of 1948 the state of Israel declared its independence. Immediately after, it was attacked by its Arab neighbours. Israel's war for independence lasted two years and cost 1% of the lives of the state's population (6000 people). One of the results of the war was a dramatic increase in persecution of Jews in the Arab world. By the 1950's massive waves of population transfer (immigration by deportation) of Jews from Arab and Muslim countries took place. By 1961 Sephardi Jews were 44% of the Jewish population in Israel (Goldscheider 2002).

Inequality and a lower socio-economic status of Sephardic Jews, in comparison to Ashkenazi Jews, became a fact in the first decade of independence (Swirski 1990). This fact has not changed even when Sephardic Jews became a majority (Yaeger-Dror 1988).

Although ethnic inequality is in constant decline, as more and more Sephardic Jews occupy high profile positions (e.g. Moshe Katzav, the eighth president of Israel in 2000–2007 and Gadi Eizenkot, the current Chief of the General Staff of the Israel Defense Forces), and inter-ethnic marriages between Ashkenazi and Sephardic Jews are very common in Israel (Gshur and Okun 2003), ethnic inequality is still not a thing of the past. For example, Swirski et al. (2008) found that the average earnings of Ashkenazi Jews are more than 30% higher than those of Sephardic Jews.

Ethnicity among Jews in Israel is unique due to two key differences of other multi-ethnic societies: (a) both Ashkenazi and Sephardic Jews are white (as opposed to e.g. race relations in America) (Tzur 2008); (b) Ashkenazi and Sephardic Jews perceive themselves as belonging to the same "race" (Frankel 2012).

1.2 From ethnicity to language

As Sephardic Hebrew was considered closer to the Semitic roots of ancient Hebrew, it was considered more prestigious among Zionist ideologists (Zuckermann 2005). In fact, newscasters had to use this variety of the language until recent years (Gafter 2014). This unique situation however did not elevate the status of Sephardic Hebrew in the general population, and standard General Hebrew became the dominant dialect used in the media and by the majority of Israelis (both Ashkenazi and Sephardic).

Sephardic Modern Hebrew has all but disappeared amongst Sephardic Jews, except for some Yemenite Jews. In fact, the dialect is spoken only in communities composed completely or almost completely by Yemenites (e.g. Geftar collected his data in Rosh Ha'ayin, a city of 37,900 people, most of whom are Yemenites, and the present author collected data in Moshav Ahihud, which has a similar demography).

Why only (some) Yemenite Jews did not shift to General Hebrew is a sociolinguistic question that is beyond the scope of this study. Gafter (2014) studies this question in length and comes to some complicated issues suggesting that speaking Sephardic Hebrew for Rosh Ha'ayin Yemenites is connected to language ideology, identity and authenticity.

Modern Hebrew is the main language of the state of Israel. It is the mother tongue of the native Jewish population and the second (or third) language of the new immigrant and the local Arab population. MH is the primary language of communication, media and official documents. MH is a relatively "new" (live, revived) language. The starting point of the current state of the language can be dated back to the end of the nineteenth century when it was revived as a spoken language as part of Zionist ideology (Schwarzwald 2001). Hebrew was not employed as a spoken means of communication for about 1700 years. Ancient Hebrew was spoken by Jews from approximately the thirteenth century BC until the second century AD. The Hebrew spoken by Jews in the land of Israel dates back to circa 1000-500 BC and is known as Biblical Hebrew and later as Mishnaic Hebrew. From approximately 200 AD, Hebrew ceased as a spoken language and was replaced by Aramaic. After the second century AD Hebrew served as a liturgical and literary language and to an extent even as a kind of lingua franca between Jews of the Diaspora when interlocutors from different communities had no common language for communication.

Biblical Hebrew is the main source of the Modern Hebrew vocabulary (Ravid 1995). The genetic affiliation of MH is regarded by most scholars as Semitic, based mostly on the *root-and-pattern* morphology of the verb system which is common within Semitic languages (e.g. Rabin 1974). Some scholars, however, have made a variety of suggestions excluding Hebrew from the Semitic family.

In his 1990 book Wexler asserts that Hebrew is a direct descendent of Yiddish and that Yiddish is a Slavic language; hence Hebrew must also be a Slavic language. Horvath and Wexler **(**1997) argue that Hebrew was created by relexification of Yiddish, i.e. Hebrew is merely Yiddish with Hebrew vocabulary.

The most interesting (and in my opinion, the most accurate) view can be found in Zuckermann (2006). Zuckermann, who insists on calling the language *Israeli* to distinguish it from classical (Biblical/Mishnaic) Hebrew, suggests that the creation of Modern Hebrew is the result of *hybridization*. Zuckermann argues that Modern Hebrew is a hybrid language, both Semitic and Indo-European. The two main contributors are historical Hebrew and Yiddish. Other contributors include: Arabic, Russian, Polish, German, Judaeo-Spanish ("Ladino"), English etc. (Zuckermann 2006: 2). According to Zuckermann's theory, a language can have multiple origins with different levels of contribution to the lexicon and to the grammar of the descendant language.

As mentioned above, Zionist activists started to revive Hebrew as a spoken language only at the end of the nineteenth century. The fact that the revivers and their children spoke other languages as a first language has greatly influenced the structure of the language. The lexical stock and the morphology of Tiberian Hebrew were adopted (more for verbs than for nouns); however, the phonology was heavily influenced by the phonology of the speakers' first (or substratum) languages. This situation resulted in two different dialects (which are based on Tiberian grammar) with almost identical surface forms; people who spoke Arabic as a first language had no problem articulating the historical pharyngeals, whereas people who spoke European languages (mostly Yiddish and Russian) could not articulate pharyngeals. The descendants of the first group speak Sephardic Modern Hebrew, and the descendants of the second group speak General Modern Hebrew.

An important distinction is made in the literature between **Normative** Hebrew and **Colloquial** Hebrew (Ravid 1995). Normative Hebrew is the formal language which is used in broadcasting networks, and is taught to pupils at schools and to new immigrants. The institution that regulates the 'correct' form of the language is the *Academy of the Hebrew Language*. The Academy is responsible for creating new Hebrew words to replace non-Hebrew words that were rooted in the language, and to regulate matters of spelling, pronunciation, punctuation and grammar. The differences between normative and colloquial Hebrew are wide and include semantic, syntactic and phonological changes. Colloquial Hebrew refers to the normal every-day speech as it is used by the average native speaker. In this study I will focus only on the colloquial form of the language.

1.3 Modern Hebrew – brief language background

1.3.1 Inventory

The inventory of consonantal segments, presented in the usual way from left to right according to the place of articulation, and vertically according to the manner of articulation, is as follows:

Table 1.1. The consonants of Modern Hebrew: Pharyngeals only in Sepharic Modern Hebrew

	Bilabial	Labio-dental	Alveolar	Palato-alveolar	Palatal	Velar	Uvular	Pharyn-geal	Glottal
Stop	p b		t d			k g			ʔ
Fricative		f v	s z	ʃ ʒ[1]		x		ħ ʕ	h
Affricate			ʦ	ʧ ʤ					
Nasal	m		n						
Liquids			l				ʁ		
Glides					j				

The vocalic system of SMH is identical to the vocalic system of GMH, and it includes five phonemic vowels. According to Laufer (1990), all Hebrew vowels are phonetically [–ATR], except for [o]. The low vowel [a] is central (Laufer 1990), see Table 1.2.

---

1 Some speakers use the affricate ʤ instead.

Table 1.2. The vowels in Sephardic Modern Hebrew

	Front	Back
High	i	u
Mid	e	o
Low	a	

The most frequent vowel in Modern Hebrew is [a] (Plada 1958/1959; Bolozky 1999). An acoustic examination of the vowel system was made by Amir (1995), who found a correlation between vowel height and phonetic duration: the lower the vowel, the longer the duration. Vowel length is not phonemic in Hebrew; however, stressed vowels are pronounced longer than their unstressed counterparts (Becker 2002).

The default epenthetic vowel is [e]. It is the vowel that is inserted to repair illicit structures that violate the OCP or the sonority hierarchy (e.g. [ʃalela] 'she rejected' vs. [ʃalta] 'she ruled', [jeladim] 'children' vs. [gʃaʁim] 'bridges'). Based on this and on the fact that [e] is the first vowel to undergo elision facilitating pronunciation, Bolozky (1999) argues that [e] is the "minimal" (unmarked) vowel in Hebrew.

Laufer (1990) argues that diphthongs in Hebrew consist of a vowel plus a glide. His claim is supported by the fact that the glide occupies prosodic positions that are otherwise occupied by consonants in the template (e.g. [ʁat͡suj] 'desirable' vs. [katuv] 'written', [kanaj] 'jealous (person)' vs. [ganav] 'thief'). All vowel-glide sequences are possible except high vowels and their glide counterparts (*ij and *uw). If such a sequence occurs the glide is deleted (e.g. */tijʁak/→ [tiʁak] 'you$_{sing}$ will spit' vs. [tilbaʃ] 'you$_{sing}$ will wear'). Diphthongs with /w/ are rare in the language since the consonant is found only in borrowed words. The most common diphthong is [ej].

1.3.1.1 The pharyngeal consonants

In this section I will examine the phonetics of the pharyngeal consonant in detail. The vast majority of the literature on the pharyngeal consonants focuses on the various dialects of Arabic due to the fact that pharyngeals are present in all dialects of Arabic, and the language is one of the most common languages in the world.

Studies on Arabic are relevant for contemporary Hebrew since the early speakers of Sephardic Hebrew were native speakers of Arabic dialects, and indeed Laufer and Condax (1981) and Laufer and Baer (1988) found a great deal of similarity in the pronunciation of pharyngeals in the two languages.

The pharyngeals are a subset of the gutturals (glottal, laryngeal, pharyngeal, velar and uvular). Halle (1995), Hayward and Hayward (1989), McCarthy (1991, 1994), Perkell (1980), Rose (1996) and Zawaydeh (2004) propose to group the guttural consonants as a natural group based on phonetic measurements and similar phonological behavior. McCarthy (1994), based on Ghazeli (1977), Delattre (1971) and Bukshaisha (1985), who studied the results of a cineradiographic investigation of the pharyngeals, indicates that the place of articulation of the pharyngeals is the lower pharynx. Miller (2007) criticizes these criteria and argues that gutturals are a natural group, based on acoustic voice quality attributes. Miller shows that there are voice quality attributes associated with sounds articulated in the guttural area. In this study I adopt the view that gutturals are a natural class, though the relevant (phonetic and phonological) reasons are beyond the scope of this dissertation.

The pharyngeal consonants are considered rare and marked in the languages of the world (Maddieson 1984). Extracting data from the UCLA Phonological Segment Inventory Database (UPSID), Elgendy (2001) points out that only 2.5% of 317 attested languages use the voiced pharyngeal [ʕ], and only 4% use the unvoiced pharyngeal [ħ]. The voiced pharyngeal can be found in Arabic, Ewe, (Sephardic) Hebrew, Iraqu, Kabardian, Kurdish, Shilha, Somali and Tigre.

Al-Ani (1970, 1978), Ghazeli (1977), Klatt and Stevens (1969), Alwan (1989) and especially Butcher and Ahmad (1987) show that pharyngeals have a high F_1. They also found that at the consonant–vowel boundary [ʕ] has a relatively low F_2 (1200-1400 Hz range), and that if [ʕ] appears before round vowels its F_1 is lowered. Ghazeli (1977) found that the production of the pharyngeals is often accompanied by creaky voice. However, the status of this phenomenon is not clear in SMH and still needs to be studied.

1.3.2 Spirantization

Spirantization is a stop–fricative alternation. In Tiberian Hebrew spirantization was a regular and productive process (Idsardi 1998). In Tiberian Hebrew nonemphatic non-sibilant obstruents (i.e. P, B, T, D, K, and G2) appeared as fricatives postvocalically and as stops elsewhere. Out of the six obstruents that alternate in Tiberian Hebrew only three do so in MH; [p, b], and [k] alternate with the fricatives [f, v], and [x] respectively. The fricative counterparts of t, d and g were lost (i.e. they stopped alternating).

Spirantization is limited and irregular in MH (Schwarzwald 1976; Ravid 1991; Adam 2002). According to Adam (2002) the alternation between stops and fricatives is motivated by their prosodic position; i.e. stops appear in onset position and fricatives appear in coda position (p. 147).

(1.1) Spirantization in Modern Hebrew:

pa.na 'he turned' - ji**f**.ne 'he will turn'
ba.xa 'he cried' - ji**v**.ke 'he will cry'
ka.ʁa 'he mined' - ji**x**.ʁe 'he will mine'

However if the onset is in postvocalic position it will appear as a fricative (p. 150) (e.g. [bi.ʃel] 'he cooked' – [je.va.ʃel] 'he will cook'). The situation gets even more complicated since MH also exhibits non-alternating paradigms alongside the alternating paradigms (p. 153). In these paradigms stops can appear in postvocalic positions (e.g. [ti.pes] 'he climbed' – [je.ta.pes] 'he will climb'), and fricatives can appear in non-postvocalic positions (e.g. [fi.ʃel] 'he screwed up' – [je.fa.ʃel] 'he will screw up'). These situations lead Adam to conclude that MH obstruents can be specified for the features [CONT] or [STOP]. Only if the obstruent is specified for [CONT] it will not occur as a stop in postvocalic position. If the obstruent is specified for [STOP] alternation is avoided.[3]

Due to the unstable situation[4] described above the current spirantization exhibits a great degree of variation, in word-initial position ([**p**izeʁ] ~ [**f**izeʁ] 'he

---

2 A capital letter indicates obstruents that are not specified for continuance.

3 This suggested grammar however does not resolve the non-alternating fricatives appearing in non-postvocalic positions (e.g. [fiʃel] 'he screwed up' – [jefaʃel] 'he will screw up'). Adam explains this inconsistency by arguing that MH is in a stage of "constraint demotion" that is manifested in an "inter-phase variation" (p. 163).

4 The causes for this situation are mainly historic e.g. (I) the merging of the non-alternating uvular stop *q* with the velar stop *k*, creating *k* that alternates with *x* and *k* that does not ([katav] 'he wrote' – [jixtov] 'he will write'; [kataf] 'he picked' – [jiktof]/*[jixtof] 'he will pick'); (II) the merger of the glide *w* with *v* creating a non-alternating v; (III) extensive borrowing from languages with no spirantization such as Arabic, Yiddish and

spread' but [je**f**azeʁ] ~ [*je**p**azeʁ] 'he will spread', [**b**ikeʃ] ~ [**v**ikeʃ] 'he asked' but [je**v**akeʃ] ~ [*je**b**akeʃ] 'he will ask') and also in post-consonantal position ([jiʃ**p**ot] ~ [jiʃ**f**ot] 'he will judge' but [ʃa**f**at] ~ [*ʃa**p**at] 'he judged', [jik**b**oʁ] ~ [jik**v**oʁ] 'he will bury' but [ka**v**aʁ] ~ [*ka**b**aʁ] 'he buried' (Adam 2002 §4.1.1.1).

1.4 Syllable structure

The following syllable structures are found in Hebrew: **CV** (e.g. [**si**.**ka**] 'sewing pin', [**mi**.**la**] 'word'), **CVC** (e.g. [**ʃak**.**ʁan**] 'liar', [**mig**.**dal**] 'tower'), **VC** (e.g. [ʃa.**aʁ**] 'gate', [no.**aʁ**] 'youth') and **V** (e.g. [**i**] 'island', [na.**e**] 'handsome').

Clusters: complex onsets are very common in Hebrew mostly in word-initial positions (e.g. [**gd**i] 'young male goat', [**ʃv**il] 'path') (Rosen 1973; Bolozky 1972, 1978; Bat-El 1989). All obstruent–obstruent clusters are possible, even if they violate the sonority scale as in [**xt**av] 'writing'. If the first consonant in a cluster is a sonorant some speakers break the cluster by epenthesis to avoid a violation of the sonority scale (e.g. [m**e**gila] 'scroll', [m**e**luxa] 'monarchy') and some do not ([mgila], [mluxa]). However, if the cluster is the result of truncation the cluster is never broken, in order to preserve the similarity between the base word and the truncated word[5] (Bat-El 2002).

Complex codas are not very common in Hebrew and they appear only in the past tense feminine singular form of verbs where the final segment is the feminine suffix (e.g. [kata**vt**] 'you$_{\text{fm.sing.}}$ wrote') and in loanwords (e.g. [pa**ʁk**] 'park'). Syllables with three consonants in coda or onset positions are very rare and are found only in loanwords (e.g. [**ʃpʁ**iʦ] 'spray', [te**kst**] 'text').

1.5 The chapters of this dissertation

In "Pharyngeal related non-lexical vowels in Sephardic Modern Hebrew" (**Chapter 2**), I distinguish between two kinds of non-lexical vowels which are triggered by the pharyngeal consonants: (a) true epenthetic vowels that emerge

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English; (V) the loss of geminate consonants that blocked spirantization in postvocalic positions (e.g. [sipper] 'he told'). In MH these consonants, though not geminated, still appear as stops in postvocalic positions [sipeʁ] (Adam 2002: 137–138).

5 In Hebrew one of the ways to create an imperative form is to trounce one or more segments from the beginning of the future tense form.

on the surface to repair forbidden syllable structures; (b) Vowel Intrusion (VI) which refers to cases where a vowel emerges between two consonants, but the phonology of the language ignores it. Such vowels do not add a syllable to the word.

In the study I list two environments in which epenthesis occurs. These are: (I) after a final voiced pharyngeal in order to convert the consonant from coda to onset position, see (1.2), and (II) before a final voiceless pharyngeal if the consonant is preceded by a non-low vowel, see (1.3).

(1.2) No ʕ in final coda position:

ma.nó.ʕa	'motor'	cf. ma.nóf	'crane'
ló.ʕa	'throat'	cf. ʃót	'whip'
ja.nú.ʕa	'he will move'	cf. ja.kúm	'he will get up'
tit.pa.ré.ʕa	'she will misbehave'	cf. tit.ka.dém	'she will advance'

(1.3) ħ after a stressed non-low vowel in the noun system:

ʃa.tí.aħ	'carpet'	cf. ʃa.tíl	'seedling'
mó.aħ	'brain'	df. ʃót	'whip'
iv.tí.aħ	'he promised'	cf. it.ħil	'he began'
im.lí.aħ	'he salted'	cf. it.ħíl	'he began'

In both cases, epenthesis repairs a marked structure and the epenthetic vowels are not ignored by the phonology of the language. These vowels have to be syllabic, i.e. have to create a syllable; they are parsed into feet, and feet in Hebrew are syllabic (non-moraic).

The other process described in the paper is vowel intrusion (henceforth: VI; Hall 2003, 2006) and it refers to cases where a vowel emerges between two consonants, but the phonology of the language ignores it. Such vowels do not add a syllable to the word. VI happens in consonant clusters that contain a sonorant (including gutturals). The vowel that is adjacent to the sonorant is always the vowel that overlaps this sonorant.

Syllable-related phonological processes, such as stress assignment, templatic reduplication, syncope, licensing of segmental contrasts, ablaut, and language games, ignore them. According to Hall (2006: 407), "Vowel intrusion is driven by the need to make consonants in clusters perceptible. Epenthesis, on the other hand, is a way of repairing syllables that violate a language's abstract structural rules".

In SMH, only the voiced pharyngeal ʕ triggers vowel intrusion, see (1.4).

(1.4) SMH vowel intrusion:

Nouns:	taʕ**a**nit	'fast'	cf. tafnit	'turn-about'
	maʕ**a**mad	'status'	cf. migdal	'tower'
Verbs:	eʕ**e**niʃ	'he punished'	cf. iklit	'he recorded'
	neʕ**e**dar	'he is/was missing'	cf. niʃdad	'he is/was robbed'

In SMH, both the voiced and the voiceless pharyngeal can appear freely in onset position, and in word-medial coda position. However, the ability to appear in final coda position is limited to the voiceless pharyngeal. Since the pharyngeal in ʕC clusters (the environment that triggers VI) is always in coda position, the prohibition on ʕC clusters could be viewed as coda prohibition, and the vowel that emerges between the two consonants could be viewed as epenthetic. Under this analysis, the *ʕC prohibition would just be a specific case of *ʕ]$_σ$ (a voiced pharyngeal is disallowed in a coda position). The main evidence against such an analysis is the non-syllabic nature of these vowels.

The evidence for non-syllabicity in SMH comes primarily from the phonological prohibition on the proximity of non-low vowels to pharyngeals. SMH permits pharyngeals to appear after a non-low vowel, if the non-low vowel and the pharyngeal are not syllabified into the same syllable, i.e. the pharyngeal is in an onset position.

(1.5) Non-low vowel and pharyngeals syllabified into different syllables:

ta.p**u**.ħím	'apples'	cf. ta.pu.zím	'oranges'
j**e**.ħa.pés	'he will search'	cf. je.da.béʁ	'he will talk'
s**i**.ħék	'he played'	cf. di.béʁ	'he talked'
ma.n**ó**.ʕa	'motor'	cf. ma.nóf	'crane'
ʃ**i**.ʕéʁ	'he assumed'	cf. di.béʁ	'he talked'

However, if the pharyngeal is in the same syllable and is preceded by an unstressed non-low vowel, the vowel preceding it is always lowered to [a] in the noun system and to [e] in the verb system.

(1.6) Pharyngeal preceded by an unstressed non-low vowel:

Nouns:	maħ.nák	'suffocation'	cf. mig.dál	'tower'
	maħ.té.ret	'underground'	cf. mik.té.ret	'pipe'
Verbs:	neħ.kár	'he was interrogated'	cf. nig.mar	'it was finished'
	eħ.lít	'he decided'	cf. it.ħil	'he began'

The syllabic nature of the inserted vowels can be tested in cases where an unstressed non-low vowel precedes a ʕC cluster, creating a cluster that is the target of VI in the language. Such cases were given in (1.4). In theory, the vowels that appear between ʕ and other consonants can create a syllable: /miʕmád/ → *[mi.ʕi.mád]. Under such syllabification, the high vowel preceding the pharyngeal and the pharyngeal are not syllabified into the same syllable. As mentioned above, in that environment, high vowels stay high.

However, what does happen is that the high vowel is lowered by the rules of the language, i.e. it becomes [a] in the noun system and [e] in the verb system. If the high vowel is lowered and vowel lowering happens only in the domain of the syllable, we must conclude that the vowel inserted after the pharyngeal does not create a syllable, and the high vowel preceding the pharyngeal and the pharyngeal are syllabified in the same syllable. Since the vowel preceding the pharyngeal is lowered, the intrusive vowel must be low too since the two vowels are parts of a single vowel gesture: /miʕmád/ → [maʕa.mád].

As shown above, the vowel that appears before ʕ is not syllabic (as Vʕ triggers lowering if they belong to the same syllable); however, the vowel that emerges in verbs like [ja.nu.ʕa] is necessarily syllabic since it syllabifies the pharyngeal to an onset position and parses it into feet. An epenthesis analysis cannot explain the facts regarding this phenomenon.

The second paper "The interaction of vowel quality and pharyngeals in Sephardic Modern Hebrew" (**Chapter 3**) examines the complex interactions between pharyngeals and vowel quality in Sephardic Modern Hebrew. Phonetically similar to low vowels, gutturals in general and pharyngeals in particular tend to trigger vowel lowering and epenthesis of low vowels. Sephardic Modern Hebrew exhibits multiple strategies in order to avoid the proximity of non-low vowels to pharyngeals. The language processes take into account several factors, including the syllabic position of the pharyngeal (onset or coda), prosody (stress) and lexical category (nouns vs. verbs).

SMH permits the pharyngeals [ħ, ʕ] to appear after a non-low vowel, if the non-low vowel and the pharyngeal are not syllabified into the same syllable, i.e. the pharyngeal is in an onset position, as we saw already in (1.5).

However, when pharyngeals and non-low vowels are syllabified into the same syllable, various processes take place. If the pharyngeal appears after an unstressed high vowel, the vowel is lowered to [a] in the noun system, as in (1.7), and to [e] in the verb system, as in (1.8):

(1.7) Pharyngeal after an unstressed non-low vowel in the noun system:[6]

m**a**ʕ^a^.mád[7]	'status'	cf. mig.dál	'tower'
m**a**ʕ^a^.ʁé.xet	'systm'	cf. mik.té.ʁet	'pipe'
m**a**ħ.sán	'warehouse'	cf. mig.dál	'tower'
m**a**ħ.bé.ret	'notebook'	cf. mik.lé.det	'keyboard'

(1.8) Pharyngeal after an unstressed high vowel in the verb system:

n**e**ʕ^e^.káʁ	'it was uprooted'	cf. nig.máʁ	'it was finished'
h**e**ʕ^e^.víʁ	'he transferred'	cf. hit.ħíl	'he began'
n**e**ħ.káʁ	'he/it was investigated'	cf. nig.máʁ	'it was finished'

If, however, the unvoiced pharyngeal ħ appears after a stressed non-low vowel, [a] is inserted before it (in both nouns and verbs), as in (1.9):

(1.9) ħ after a stressed vowel:[8]

ʃa.tí.**a**ħ	'carpet'	cf. ʃa.tíl	'seedling'
mó.**a**ħ	'brain'	cf. ʃót	'whip'
bi.tú.**a**ħ	'insurance'	cf. ni.gún	'melody'
maf.té.**a**ħ	'key'	cf. mav.ʁég	'screwdriver'
hiv.tí.**a**ħ	'he promised'	cf. hit.ħil	'he began'
him.lí.**a**ħ	'he salted'	cf. hit.ħíl	'he began'
di.vé.**a**ħ	'he reported'	cf. di.béʁ	'he talked'
hit.ka.lé.**a**ħ	'he took a shower'	cf. hit.la.béʃ	'he dressed'

The multiple processes presented in (1.5)–(1.9) all aim at creating adjacency between pharyngeals and low vowels, as phonetic studies on pharyngeals (Delattre 1971; Perkell 1971) show that low vowels involve some pharyngeal

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6 An intrusive vowel is heard between the ʕ and the following consonant, represented by [a]; it is a case of an intrusive echo vowel that eases perception of consonant clusters. The value of this vowel is copied from the preceding vowel. This vowel is non-syllabic and ʕ is syllabified as coda. For general discussion, analysis and typology of intrusive vowels see Hall (2006); for SMH vowel intrusion and evidence of its non-syllabic nature, see Pariente (2010).

7 The Underlying Representation is assumed to be /miħsan/ with /i/ before the unvoiced pharyngeal and not /maħsan/ with underlying /a/ due to the fact that a maCCaC template is not present in the morphology of the language.

8 ʕ does not appear after a stressed non-low vowel in the same syllable, since an epenthetic vowel is inserted to syllabify the ʕ into an onset position:

hif.tí.ʕa	'he surprised'	cf. hit.ħil	'he began'
ʃa.vú.ʕa	'week'	cf. tap.úz	'orange'
ló.ʕa	'pharynx, throat, maw'	cf. ʃót	'whip'

constriction, with concomitant acoustic similarities between the vowel [a] and the pharyngeals (high F_1).

Chapter 3 outlines the strategies used to avoid the disallowed sequences. It is shown that SMH considers multiple factors with regard to this prohibition, such as syllabic position, stress and lexical category.

Since nouns and verbs show different behavior with respect to the processes under examination, different co-phonologies were proposed in order to analyze them separately. It was also shown that in SMH, verbs exhibit a greater resistance to vowel lowering than nouns.

The paper "Grammatical paradigm uniformity" **(Chapter 4**) aims at explaining the distribution of Root Vowels (RV) in General Modern Hebrew, which emerged from historical pharyngeals. These RV correspond to pharyngeals in SMH. This paper develops a formal model of paradigmatic relations between words not sharing a lexeme. This idea was first introduced by Burzio (1998), following whom it is argued that similarity relations between words that do not share a lexeme can also be a factor in the morphology–phonology interface. The main idea is that words with the same Morphological Structure (MS) are subject to certain similarity demands.

RVs do not appear at the surface level in all forms. The data given below lists both the environments in which RVs emerge and those in which they do not. The forms containing RVs (Table 1.3) are compared to other forms in the language which have the same Morphological Structure, i.e. the same conjugation (Vocalic Pattern and Prosodic Structure and derivational affixes of the conjugation if they exist), the same affixes, the same gender, number and person, and for verbs also the same tense. The forms in comparison (Table 1.4) do not have a RV, but rather a consonant in the same prosodic position. If a RV does not emerge in a specific environment, a different word of the same lexeme, which does contain a manifested RV, is given in the table in order to illustrate that the alternation is synchronic, which means that these lexemes did not lose the RV completely but that it is present in the Underlying Representation (UR).

Table 1.3. RVs emerge in word-final position

UR	Surface Form	Gloss	Form with the same MS and a consonant at the same prosodic position of the RV	Gloss
ʃavu**a**	ʃa.vú.**a**	week	ta.pú**z**	orange
liʃmo**a**	liʃ.mó.**a**	to hear	liʃ.mó**ʁ**	to guard
titpare**a**	tit.pa.ré.**a**	she will misbehave	tit.ka.dé**m**	she will advance

Table 1.4. Word-initial RVs do not emerge

UR	Surface Form	Gloss	Form with the same MS and a consonant at the same prosodic position of the RV	Gloss	Form of the same lexeme with a manifested RV	Gloss
aamad	a.mád	he stood up	**j**a.ʃáv	he set down	ne.e.mád	he stood up
aoneg	ó.neg	pleasure	**k**ó.deʃ	holiness	ta.**a.**núg	pleasure
aeved	é.ved	slave	**j**é.led	boy	he.**e**.ví	he employed

The data above reveals a remarkable generalization: RVs emerge only when their parallel segment in other forms with the same Morphological Structure is in coda position (though a higher ranked constraint can prevent RV from emerging), i.e. RVs emerge when their parallel segment in other forms with the same Morphological Structure is *moraic*.

An example of the OT analysis employed in the paper is given (1.11) and (1.12). The manifestation of RV depends on the moraic structure of the corresponding segment in the Grammatical Paradigm. The constraint in (1.10) encodes this similarity demand.

(1.10) IDENTMORAICSTRUCTURE^{GPU} (IDμ^{GPU}):

Let A be a segment in S_1 and B be a segment S_2. If A and B are in a correspondence relationship, then B has the same moraic structure as A. (S_1 = base, S_2 = any output form sharing the G-Paradigm of the base).

The theoretical assumptions given above make the analysis extremely simple. By ranking IDμ^{GPU} above MAX we get the right outcome for most forms in the language.

(1.11) Initial RV:

/**a**omed/ base: **k**o.tév	IDμ^{GPU}	MAX
a. **a**$^{\mu}$.o.méd	*!	
☞ b. o.méd		*

In tableau (1.11) the UR contains /a/ at the beginning of the word. In the faithful candidate (a) it emerges and so it violates the high ranked constraint IDμ^{GPU} since its corresponding segment is in onset position. The emergence of the vowel creates a mismatch in the moraic structure between the two segments. The winning candidate (b) omits the UR [a] violating MAX but satisfying IDμ^{GPU}.

(1.12) Word-medial RV that is parallel to a moraic segment in the paradigm:

/niamad/ base: ni**x**$^{\mu}$.táv	IDμ^{GPU}	MAX
a. ni.mád		*!
☞ b. ne.**e**$^{\mu}$.mád		

In tableau (1.12) the UR contains /a/ in the middle of the word in a position that is occupied by a coda segment in the G-Paradigm. In the faithful candidate (b) it emerges creating a mora and satisfying both IDμ^{GPU} and MAX. Candidate (a) omits the UR *a* thus violating MAX and being ruled out.

In the last paper "Stress, syncope, epenthesis and the Duke of York gambit in the verbal system of Modern Hebrew" (**Chapter 5**) I discuss a case of seemingly "feeding Duke of York derivation" in which the intermediate stage is utilized independently for another process: process A (deletion) creates an environment (three-consonant cluster) for process B (epenthesis) to apply. Process B reverses the syllabic structure created by process A at the same site (locus).

The verbal system of MH is rich in inflectional suffixes. When some suffixes are added to a verb, stress may shift to the suffix and syncope may occur (e.g. /gad**á**l-a/ → [gadlá]). Some verbs also exhibit vowel alternation in suffixed forms (e.g. /tixt**ó**v-u/ → [tixt**e**vú]). A serial analysis of this interaction is rejected. The key observation in the analysis is the different quality [e] of the vowel breaking the three-consonant sequences compared to the vowel [a/o] that was deleted. Since [e] is the default epenthetic vowel in MH, it was argued that this is a case of simultaneous syncope and epenthesis. It is also argued that an epenthetic vowel in the same position as the deleted vowel is less offensive in MH due to the prohibition of two adjacent unparsed stem syllables.

To conclude, the different topics in this dissertation contribute to the study of MH by presenting new data and analyzing phenomena that were not dealt with in previous studies.

2 Pharyngeal related non-lexical vowels in Sephardic Modern Hebrew*

This chapter is a slightly modified version of the paper that was published as:

Pariente, Itsik. 2010. Pharyngeal related non-lexical vowels in Sephardic Modern Hebrew. *Linguistics in Amsterdam* 3: 1–19.

Abstract

This paper examines non-lexical vowels in Sephardic Modern Hebrew. It is argued that two kinds of vowel, which are triggered by the pharyngeal consonants, should be identified: (a) true epenthetic vowels that emerge on the surface to repair illicit (marked) syllable structures, and (b) "echo-vowels" that are created by overlapping a vowel and a pharyngeal consonant. These vowels do not repair illicit syllable structures, but rather ease the perception of clusters containing a pharyngeal. These vowels are not syllabic, and phonological processes ignore them.

2.1 Introduction

In this paper, I examine non-lexical vowels in Sephardic Modern Hebrew (henceforth SMH). The notion of non-lexical vowels refers to vowels that appear at the surface level, but are not present in the lexicon. The non-lexical vowels that will be examined here are triggered by the pharyngeal consonants. The general properties of the two different groups are summarized in Table 2.1 (for a comprehensive comparison between the two groups, see Hall 2003, §3).

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* I would like to thank Outi Bat-El, Adi Ben Arieh, Paul Boersma, Shmuel Bolozky, Evan Cohen, Paola Escudero and Nancy Hall for their comments on earlier related work on this subject. I would also like to thank two anonymous reviewers for very helpful comments. All remaining errors are my own.

Table 2.1. Non-lexical vowel properties

Property / Vowel type	Environment	Purpose	Quality	Syllabicity
Epenthetic vowels	Marked	Repair marked structures	Not copied (default)	Syllabic
Echo vowels	Unmarked	Ease perception of consonant clusters	Copied from the preceding vowel	Non-syllabic

The pharyngeal consonants (/ħ/ and /ʕ/) are marked and rare in the world's languages. In many languages, they trigger various phonological processes. In SMH, they trigger epenthesis, echo-vowels and vowel lowering. Analyses will be laid out in the framework of Optimality Theory (OT; Prince and Smolensky 1993/2004).

The paper is organized as follows: Section 2.2 gives the relevant language background. Section 2.3 describes and analyzes pharyngeal triggered epenthesis. Section 2.4 describes and analyzes pharyngeal triggered echo-vowels and section 2.5 compares both kinds of vowel, followed by conclusions.

2.2 Language background

This study is based on data from SMH, spoken by native speakers living in Israel. Hebrew today has two different dialects with almost identical grammars. In the revival of the language, people who spoke Arabic as a first language had no problem articulating the historical pharyngeals, whereas people who spoke European languages (mostly Yiddish and Russian) could not articulate pharyngeals. The descendants of the first group speak Sephardic Modern Hebrew, and the descendants of the second group speak General Modern Hebrew.[9]

The only difference between the general dialect and SMH is the existence of pharyngeal consonants in SMH. The dominant dialect in Israel is

[9] This situation is not accurate for later generations, as General Modern Hebrew is becoming the only dialect spoken, while the Sephardic dialect is dying out.

the general dialect. SMH is used in areas that are populated mostly by speakers of Sephardic descent.[10]

The consonant inventory of SMH is as given in Table 2.2. Both dialects of Hebrew have five phonemic vowels, given in Table 2.3. ATR is non-contrastive in Hebrew (Laufer 1990).

Table 2.2. The consonants of Sephardic Modern Hebrew

	Bilabial	Labio-dental	Alveolar	Palato-alveolar	Palatal	Velar	Uvular	Pharyn-geal	Glottal
Stop	p b		t d			k g			ʔ
Fricative		f v	s z	ʃ ʒ		x		ħ ʕ	h
Affricate			ʦ	ʧ ʤ					
Nasal	m		n						
Liquids			l				ʁ		
Glides					j				

Table 2.3. The vowels of Sephardic Modern Hebrew

	Front	Back
High	i	u
Mid	e	o
Low	a	

2.2.1 Root-and-Pattern Morphology

One approach to Semitic morphology (McCarthy 1979, 1981) is *root-and-pattern* morphology (R&P). This view assumes a distinction between consonantal roots and vocalic templates. Stems are formed by the interdigitation of the consonantal root and the vocalic pattern (Nonconcatenative Morphology). The consonantal root encodes the core semantic properties, while the vocalic template encodes aspect, mood, voice and other grammatical properties.

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[10] The Jewish population in Israel is traditionally divided into main groups based on their origin: Ashkenazi Jews and Sephardic Jews. Ashkenazi Jews are those who immigrated to Israel from Europe (except Spain and Portugal) and North America. Sephardic Jews immigrated to Israel from Spain, Portugal, Asia and North Africa.

Bat-El (2003a) offers a different approach which is surface-based, while eliminating the consonantal root from the grammar, using stems and words as the base for derivation, a point which is highly controversial in the literature (see Shimron 2003). This debate is outside the scope of this paper and while I will be adopting elements of Bat-El's surface-based approach, I will nevertheless assume the existence of the consonantal root as a morphological unit. The root usually consists of three consonants that appear in a fixed order.

Another layer in the structure of R&P words is the Prosodic Structure. The prosodic structure is derived by language-specific ranking of universal prosodic constraints. According to this approach, the prosodic structure is **not** an abstract structure, but rather the result of the interaction among prosodic constraints. For example, Bat-El argues that FOOTBINARITY and WORDMIN are responsible for disyllabic stems in the Hebrew verb system. The prosodic structure governs the interdigitation of the root consonants and the Vocalic Pattern (VP), which determines the syllabic structure of the stem.

VPs are the morphemes that determine the quality and the order of the conjugation vowels and are viewed by Bat-El as constraints (as she views all morphemes as constraints). The VP and the prosodic structure form the *conjugation* (in Hebrew terminology the vocalic template for verbs is called a *binyan* (B), and for nouns, a *mishkal*). Some conjugations are accompanied by an affix.

The following table gives the verbal paradigms of some consonantal roots. The verbs are given in the third person singular form.

Table 2.4. Root and template paradigms

root / template	{p,g,ʃ}	{k,t,v}	{ʃ,t,k}
B1 CaCáC	*pagáʃ* 'bump into'	*katáv* 'write'	*ʃaták* 'be quiet'
B2 niCCáC	*nifgáʃ* 'meet'	*nixtáv* 'be written'	
B3 iCCíC	*ifgíʃ* 'to bring together'	*ixtív* 'dictate'	*iʃtík* 'silence'
B4 CiCéC	----------------------	----------------	*ʃiték* 'paralyze'
B5 itCaCéC	----------------------	*itkatév* 'correspond'	*iʃtaték* 'become silent'
miCCáC	*mifgáʃ* 'meeting'	*mixtáv* 'letter'	----------------------
taCCíC	---------------------	*taxtív* 'dictate'	----------------------

2.2.2 The metrical system of Hebrew

Since pharyngeal echo vowels and epenthesis are interconnected with the metrical system of the language, I will briefly review the metrical system in this section.

Hebrew is a quantity-insensitive language with final default stress. According to Hayes (1995: 101), quantity-insensitive languages are usually trochaic; however, final stress does not characterize trochaic languages (Graf 1999). Two competing analyses arise in light of Hayes' view: (a) the Hebrew stress system consists of binary strong feet (enclosed in square brackets), either iambic or trochaic ([*yéled*], [*ganáv*]; for example, Bolozky 1982; Graf and Ussishkin 2003; Bat-El 2005); or (b) Hebrew stress consists of trochaic feet, either binary or unary ([*yéled*], *ga*[*náv*]; for example, Becker 2003).[11] I adopt here Pariente and Bolozky's (in prep.) trochaic analysis of Hebrew which claims that the accentual system of Modern Hebrew is best analyzed as consisting of trochaic feet, based on the behavior of loanwords and certain stress shifts in the language.

(2.1) Stress-related constraints:

a. FTBIN (FOOT BINARITY): Feet are binary.

b. IDENTSTRESS: The output syllable corresponding to the input's stressed syllable is stressed. [IDENTSTRESS can be active only in the presence of lexical stress and it plays no role in the absence if it.]

c. ALIGNR (Ft, PrWd): The right edge of the foot aligns with the right edge of the prosodic word.

d. FINALSTRESS: The final syllable in the prosodic word is stressed.

e. TROCHEE: The leftmost unit in the foot is prominent.

The ranking of these stress-related constraints is given in (2.2).

(2.2) TROCHEE, IDENTSTRESS >> ALIGNR(Ft,PrWd), FINALSTRESS >> FTBIN

[11] Secondary stress in Hebrew is discussed in most of the generative literature on stress in Hebrew, beginning with Bolozky (1982), where it is described as appearing on every other syllable to left of the primary stress. However, Becker (2003) finds no acoustic evidence for secondary stress either by pitch or by vowel length. In the following example, Becker identified only one point of high pitch and one long vowel: *hagamadoním* 'the little dwarfs'.

In the current analysis, that is based on (though not identical to) Becker (2003), TROCHEE is undominated so all feet are trochaic (binary or unary). In this type of analysis, TROCHEE must outrank FTBIN.

2.3 Epenthesis

Epenthesis is one type of phonological process that repairs illicit clusters in the grammar of a language. In SMH, pharyngeal triggered epenthesis takes place in two cases: after a final voiced pharyngeal in order to convert the consonant from coda to onset position (§2.3.1), or before a final voiceless pharyngeal if the consonant is preceded by a non-low vowel (§2.3.2). In both cases, epenthesis repairs a marked structure and as I will show, the epenthetic vowels are not ignored by the phonology of the language.

2.3.1 Coda prohibition epenthesis

In SMH, both the voiced and the voiceless pharyngeal can appear freely in onset position, and in word-medial coda position. However, only voiceless pharyngeals can appear in word-final coda position.[12] Consider the data in (2.3) (a dot indicates a syllable boundary). Examples are in the same vocalic templates.

(2.3) No ʕ in final coda position:

ma.nó.ʕ**a**	'motor'	cf. ma.nóf	'crane'
ló.ʕ**a**	'throat'	cf. ʃót	'whip'
ja.nú.ʕ**a**	'he will move'	cf. ja.kúm	'he will get up'
tit.pa.ré.ʕ**a**	'she will misbehave'	cf. tit.ka.dém	'she will advance'

The following constraint formulates this coda prohibition:

(2.4) Constraint on coda prohibition:
*ʕ]$_\sigma$: No ʕ in coda position.

Since word-medial codas are permitted in the language, *ʕ]$_\sigma$ must be ranked below DEP and MAX. This ranking is given in the following tableau.

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[12] Epenthesis is blocked when the pharyngeal is preceded by *a* (an OCP effect), however, this is not relevant to the current issue (see Pariente 2006).

(2.5) Medial coda evaluation:

/miʕmad/	MAX	DEP	*ʕ]$_\sigma$
a. mi.mad	*!		
b. mi.ʕa.mad		*!	
☞ c. maʕ^a.mad			*

In tableau (2.5), the winning candidate does not delete the pharyngeal or epenthesize a vowel before it (the vowel that appears before it is an echo vowel which is not the result of epenthesis (§2.4)). This ranking however gives the wrong output for ʕ in final position.

(2.6) Wrong prediction of ʕ in final position:

/paʁuʕ/	MAX	DEP	*ʕ]$_\sigma$
a. pa.ʁu	*!		
☞ b. pa.ʁu.ʕa		*!	
☛ c. pa.ʁuʕ			*

The black hand indicates the winning candidate which, in fact, is not the correct output, as opposed to a white hand which indicates the candidate which is the correct output. In tableau (2.6), the winning candidate is (c), which violates the low-ranking constraint *ʕ]$_\sigma$. The actual output in the language is (b), with an epenthetic vowel after the pharyngeal. This vowel syllabifies the pharyngeal in onset position to avoid a violation of the coda prohibition constraint. This outcome suggests the ranking of *ʕ]$_\sigma$ above DEP. However, such a ranking is not possible, due to the lack of epenthesis in medial positions.

I argue that this paradox is a case of gang effects (Keller 2006; Jäger and Rosenbach 2006; Farris-Trimble 2008; among many others). A gang effect refers to cases where two violable lower-ranked constraints gang up against a higher-ranked constraint in order to rule out a candidate that violates both of them. This results in the winning of another candidate that violates the higher-ranked constraint only once.

I argue that SMH exhibits a combined markedness effect, and that foot structure is responsible for the difference between the behavior of medial and final codas. The ranking paradox presented is the outcome of the combined forces of the markedness constraint *ʕ]$_\sigma$ and the markedness constraint FTBIN (FOOT BINARITY).

Within OT, a mechanism for gang effect was proposed by Smolensky (1995) using local conjunction (LC). In LC, two constraints can be combined; a combined constraint is violated only by candidates that violate both combining constraints. The combined constraint is ranked above its combining constraints. The tableau below shows the ranking of DEP with respect to *ʕ]$_{\sigma}$ and FTBIN.

(2.7) Ranking of DEP, *ʕ]$_{\sigma}$ and FTBIN:

/paʁuʕ/	DEP	*ʕ]$_{\sigma}$	FTBIN
☞ a. pa[ʁú.ʕa̲]	*!		
☛ b. pa[ʁúʕ]		*	*

DEP outranks each of the constraints individually, and candidate (a) is ruled out by DEP. The winning candidate (b) violates *ʕ]$_{\sigma}$ and FTBIN. However, if DEP is ranked below the combined constraint *ʕ]$_{\sigma}$&FTBIN ('no ʕ in coda position' and 'feet are binary') candidate (a) will win:

(2.8) Ranking of DEP and *ʕ]$_{\sigma}$&FTBIN:

/paʁuʕ/	*ʕ]$_{\sigma}$&FTBIN	DEP	*ʕ]$_{\sigma}$	FTBIN
☞ a. pa[ʁú.ʕa̲]		*		
b. pa[ʁúʕ]	*!		*	*

Candidate (b) is ruled out because it violates the combined constraint. The outcome is an epenthetic vowel before a final voiced pharyngeal consonant, creating an additional syllable and inverting the pharyngeal into an onset in stressed syllables only. The final ranking and evaluation of medial and final codas is given in (2.9) and (2.10).

(2.9) Evaluation of medial coda:

/miʕmad/	MAX	TROCHEE	*ʕ]$_{\sigma}$&FTBIN	DEP	*ʕ]$_{\sigma}$	FTBIN
a. mi[mád]	*!					*
b. mi.ʕa̲[mád]				*!		*
☞ c. ma[ʕᵃmád]					*	*
d. mi[ʕa̲mád]		*!		*		

(2.10) Evaluation of final coda:

/paʁuʕ/	MAX	TROCHEE	*ʕ]σ&FTBIN	DEP	*ʕ]σ	FTBIN
a. pa[ʁú]	*!					*
b. pa[ʁúʕ]			*!		*	*
☞ c. pa[ʁú.ʕa̲]				*		
d. [pa.ʁúʕ]		*!				

In tableau (2.9), candidate (a) is disqualified by MAX since the pharyngeal is deleted from the output. In candidate (b), a vowel is inserted to syllabify the pharyngeal to an onset position; however, it is disqualified by the high-ranking constraint DEP. The winning candidate (c) is the faithful one (with regard to the coda condition). The pharyngeal is syllabified as a coda even though it violates the low-ranked constraint *ʕ]$_\sigma$. The vowel that is produced between the pharyngeal and the following consonant is not syllabic and thus does not change the syllable structure. Such echo-vowels are called "Intrusive Vowels" and they are the result of gestural overlapping. This phenomenon will be addressed in section 2.4, and evidence for the non-syllabic nature of these vowels will be given.

Candidate (a), (b) and (c) all violate FTBIN. Candidate (d), on the other hand, epenthesizes a vowel after the pharyngeal to syllabify it as an onset, thus creating a binary foot. However, this foot is iambic and the candidate is ruled out by TROCHEE. Since the pharyngeal was not in a stressed syllable, we did not see the effect of *ʕ]$_\sigma$&FTBIN.

In tableau (2.10), however, the pharyngeal is in a stressed syllable. The high-ranking constraint *ʕ]$_\sigma$&FTBIN disqualifies the faithful candidate (b). Candidate (a), which deletes the pharyngeal, is disqualified by MAX. Candidate (d) is disqualified by TROCHEE. The winning candidate is (c), in which an epenthetic vowel is inserted to syllabify the pharyngeal into an onset position.

2.3.2 Epenthesis to prevent adjacent non-low vowels and pharyngeals

One of the best-known properties of the pharyngeals is their preference to appear next to a low vowel (McCarthy 1994). Phonetic studies on pharyngeals (Delattre 1971; Perkell 1971; among many others) show that low vowels involve some pharyngeal constriction, with concomitant acoustic similarities between the vowel [a] and the pharyngeals (high F_1).

SMH exhibits a variety of behaviors with regard to this prohibition. SMH deals with this demand in several ways depending on the nature of the pharyngeal, the syllabic position of the pharyngeal (onset or coda), the metrical position of the pharyngeal (stressed syllable vs. unstressed syllable) and the morphological system (nouns vs. verbs).

SMH permits pharyngeals to appear after a non-low vowel, if the non-low vowel and the pharyngeal are not syllabified into the same syllable, i.e. the pharyngeal is in an onset position. However, when pharyngeals are in coda position, various processes take place (only epenthesis is relevant here, see Pariente 2006 for additional details).

If ħ appears after a stressed non-low vowel, [a] is inserted between the non-low vowel and ħ (ʕ after a stressed vowel is not attested in the dialect).[13]

(2.11) ħ after a stressed non-low vowel in the noun system:

ʃatí**a**ħ	'carpet'	cf. ʃatíl	'seedling'
mó**a**ħ	'brain'	cf. ʃót	'whip'
ivtí**a**ħ	'he promised'	cf. itħil	'he began'
imlí**a**ħ	'he salted'	cf. itħíl	'he began'

Within OT, the preference of low vowels in the environment of pharyngeals can be formulated by context-sensitive markedness constraints. The prohibition on non-low vowels and pharyngeals is encoded in the constraint in (2.12).

(2.12) $*V_{-\text{low}}$PHARYNGEAL$]_\sigma$:[14]

Non-low vowels before a pharyngeal are forbidden within the syllable.

SMH prohibits non-low vowels from preceding pharyngeals. To solve such a situation, SMH implements different strategies depending on the status of the vowel preceding the pharyngeal: If the vowel is not stressed, it is lowered to [a]

---

13 ʕ does not appear after a stressed vowel in the noun system since an epenthetic vowel is inserted to syllabify the ʕ into an onset position:

ʃavú.ʕa	'week'	cf. tap.úz	'orange'
ló.ʕa	'pharynx, throat'	cf. ʃót	'whip'
if.tí.ʕa	'he surprised'	cf. it.ħil	'he began'

14 As Pariente (2006) observes, the prohibition on the proximity of non-low vowels to pharyngeals is hierarchical, i.e. the prohibition in the domain of the syllable is a stronger prohibition than the general prohibition on the proximity of non-low vowels to pharyngeals. This distinction is not relevant for this discussion.

in the noun system and to [e] in the verb system (Pariente 2006). If the vowel is stressed, it does not change; however, epenthesis of the low vowel [a] occurs if the pharyngeal is the voiceless ħ (2.11). The voiced ʕ never appears after a stressed vowel (see footnote 13).

Since epenthesis of [a] occurs, $*V_{-low}$PHARYNGEAL$]_{\sigma}$ and MAX must outrank DEP. This ranking is demonstrated in the tableau (2.13).

(2.13) Epenthesis after a stressed vowel:

/tapuħ/	$*V_{-low}$ PHARYNGEAL$]_{\sigma}$	MAX	DEP
a. tapúħ	*!		
b. tapú		*!	
☞ c. tapú**a**ħ			*

In tableau (2.13), the underlying form /tapuħ/ contains a high vowel before a pharyngeal. The faithful candidate (a) is ruled out by $*V_{+high}$PHARYNGEAL$]_{\sigma}$, which militates against high vowels before ħ in the same syllable. In candidate (b), the pharyngeal is deleted to avoid the proximity of the high vowel to it, however, it is ruled out by the high-ranking constraint MAX. In the winning candidate (c), a low vowel is inserted between ħ and the high vowel violating DEP.[15]

At this point, I would like to summarize the properties of the epenthetic vowels presented in §2.3.1 and §2.3.2. These vowels have to be syllabic, i.e. to create a syllable, since as shown in §2.3.1 they are parsed into feet, and feet in MH consist of syllables (Graf and Ussishkin 2003; Bat-El 2005).

The default epenthetic vowel in SMH is [e], suggesting that [e] is the unmarked vowel in Hebrew (see Kitto and De Lacy 1999 for a discussion on the quality of epenthetic vowels). The quality of the vowels in (2.3) and (2.11), however, is always [a]. Appearance of low vowels before pharyngeals is a case of *The Emergence of the Unmarked* phenomenon (McCarthy and Prince 1994). In SMH, all vowels (including high vowels) can appear after a pharyngeal (e.g.

[15] For simplicity reasons, this tableau ignores candidates in which the stressed high vowel is lowered. Such lowering of stressed vowels does not occur. This is a case of positional blocking of a phonological process due to the positional privilege of stressed syllables (Beckman 1998). Stressed vowels fail to undergo a process that unstressed vowels are targeted for.

ʕiʁ 'city', *ʕod* 'more', *ħof* 'beach') and no lowering takes place, i.e. the faithfulness constraint IDENT[high/low] ('the value of the feature(s) high/low in the input is identical to their value in the output') must outrank the constraint militating for lowering high vowels after pharyngeals (*PHARYNGEALV$_{-\text{low}}$: 'non-low vowels after a pharyngeal are forbidden'). However, when epenthesis takes place, the vowel that emerges is [a] and not [e], due to the impact of *PHARYNGEALV$_{-\text{low}}$, which can manifest since no faithfulness relations to the input of the vowel quality are active in epenthesis.

2.4 Vowel intrusion

This section describes and analyzes vowel intrusion (henceforth VI) in SMH. The term VI was coined by Hall (2003) and it refers to cases where a vowel emerges between two consonants, but the phonology of the language ignores it. Such vowels do not add a syllable to the word.

Within generative phonology, Steriade (1990) was the first to analyze this phenomenon as the result of overlapping. Steriade argues that these vowels are the result of gestures overlapping one another. The vowel is an audible acoustic release that results from overlapping vowels. A comparison of default and copied epenthetic vowels can also be found in Kitto and De Lacy (1999).

VI happens in consonant clusters that contain a sonorant (including gutturals). The vowel that is adjacent to the sonorant is always the vowel that overlaps this sonorant. Hall's analysis differs from Steriade's in a crucial point; while Steriade views these vowels as segmental and syllabic, Hall argues that intrusive vowels are not segments and behave unlike true epenthetic vowels.

Hall shows that syllable-related phonological processes, such as stress assignment, templatic reduplication, syncope, licensing of segmental contrasts, ablaut, and language games, ignore them. The data from SMH supports Hall's view.

The following list of properties characterizes vowel intrusion (Hall 2006: 391):

(2.14) Vowel intrusion properties:

a. The vowel's quality is either schwa, a copy of a nearby vowel or influenced by the place of the surrounding consonants.
b. If the vowel copies the quality of another vowel over an intervening consonant, that consonant is a sonorant or guttural.

c. The vowel generally occurs in heterorganic clusters.
d. The vowel is likely to be optional, have a highly variable duration or disappear at fast speech rates.
e. The vowel does not seem to have the function of repairing illicit structures. The consonant clusters in which the vowel occurs may be less marked, in terms of sonority sequencing, than clusters which surface without vowel insertion in the same language.

Intrusive vowels do not only act differently from epenthetic vowels, they also have a different purpose; according to Hall (2006: 407): "Vowel intrusion is driven by the need to make consonants in clusters perceptible. Epenthesis, on the other hand, is a way of repairing syllables that violate a language's abstract structural rules".

In SMH, only the voiced pharyngeal ʕ triggers vowel intrusion:

(2.15) SMH vowel intrusion:

Nouns:	taʕ**a**nit	'fast'	cf. tafnit	'turn-about'
	maʕ**a**mad	'status'	cf. migdal	'tower'
Verbs:	eʕ**e**niʃ	'he punished'	cf. iklit	'he recorded'
	neʕ**e**dar	'he is/was missing'	cf. niʃdad	'he is/was robbed'

2.4.1 An argument for a copied vowel analysis: the quality of the vowel

In SMH, some phonotactic restrictions trigger vowel epenthesis due to the ranking of markedness constraints such as the OCP above DEP-V.

(2.16) SMH epenthesis:

ʃal**e**la	'she revoked'	cf. katva	'she wrote'
ʃ**e**zifim	'plums'	cf. pʁitim	'items'

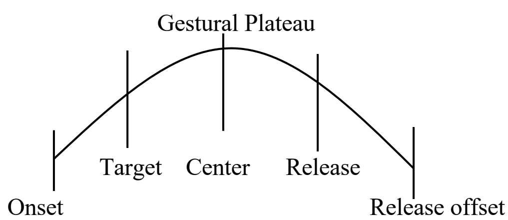
In the absence of pharyngeals, the default epenthetic vowel in SMH is [e]. However, when epenthesis takes place after a pharyngeal, the epenthetic vowel is [a] rather than [e] (consider the data in (2.3) and (2.11) where [a] is inserted to prevent ʕ from syllabifying in final coda position and to prevent the adjacency of ħ and non-low vowels respectively).

When epenthesis takes place in pharyngeal environments, [a] emerges, due to TETU. The vowels that appear within ʕC clusters in (2.15), however, are not necessarily [a] as would be expected had they been epenthetic. The vowels that do appear are identical to the vowel preceding the pharyngeal, indicating that they are not true epenthetic vowels but rather copied vowels.

2.4.2 The analysis

The analysis is based on Hall (2003) and is adopted (and somewhat reduced) to suit SMH facts. Hall's (2003) analysis uses the theory of Articulatory Phonology (Browman and Goldstein 1986, 1992a, 1992b, 1995; Byrd 1996; Gafos 2002; among others).[16] Articulatory Phonology is a theory that organizes speech by using abstract gestures. Gestures are instructions to articulators to reach a particular constriction in the vocal tract like opening/closing the glottis. Hall develops a theory called Timing-Augmented Surface Phonology (TASP) that organizes alignment of neighboring gestures. Each gesture begins with the onset of movement, then progresses to reach the target and then continues to the release and finally to the offset. The offset indicates that the articulator has completed the gestural command. When an articulator finishes the movement, it can move back to its resting point or it can receive an order of another gesture and start moving towards the next target.

Figure 2.1. Landmarks in a gestural cycle (Gafos 2002: 271)



The movement of the articulator in space is represented on the vertical axis, while the horizontal axis represents time. The middle of the gesture is called a "gestural plateau"; it is the period when the constriction is actively held. In the middle of the gestural plateau is the C-center.

Though gestures are parsed below the segment, like phonological features, there is one important difference between gestures and features: while features fall into a linear order, gestures do not; gestures can **overlap** one another.

Since gestures are on a somewhat different hierarchical level, their organization in OT grammar has to be explained with a new type of markedness

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[16] The relevant components of the theory are given very briefly. For more details see the literature mention in this section.

constraint. Hall (2003) adopts Gafos' theory of gestural coordination. According to this theory, gestures are subject to independent alignment constraints (McCarthy and Prince 1993) that maximize perceptual cues in consonant clusters and avoid types of gestural overlap that are marked perceptually or articulatorily.

(2.17) The basic form of the constraints (Gafos 2002):
ALIGN (G_1, LANDMARK$_1$, G_2, LANDMARK$_2$):
Align landmark$_1$ of gesture$_1$ with landmark$_2$ of gesture$_2$.

The constraints that are relevant to SMH are given below (from Gafos 2002):

(2.18) ALIGN (C1, CENTER, C2, ONSET):
In a C_1 C_2 sequence, the center of C_1 is aligned with the onset of C_2.

This constraint militates for some acoustic release between CC clusters.

(2.19) ALIGN (C1, RELEASE, C2, TARGET):
In a C_1 C_2 sequence, the release of C_1 is aligned with the target of C_2.
(No acoustic release between CC clusters even in heterorganic clusters).

These two constraints are in conflict. When ALIGN (C_1, CENTER, C_2, ONSET) is ranked above ALIGN (C_1, RELEASE, C_2, TARGET), vowel intrusion will occur, and when ALIGN (C_1, RELEASE, C_2, TARGET) is ranked above ALIGN (C_1, CENTER, C_2, ONSET), vowel intrusion will not occur.

The following constraint militates for alignment of the vowel with respect to the peripheral consonant, i.e. it militates for heavy overlap between the vowel and the non-peripheral consonant. This constraint ensures that the acoustic release in a consonant cluster is a copied vowel (and it will not sound like a schwa).

(2.20) ALIGN (V, OFFSET, C]$_\sigma$, CENTER) (Hall 2004):
The offset of every vowel is aligned with the center of the rightmost consonant that belongs to the same syllable as that vowel.

The last constraint militates against heavy overlapping. Therefore, if it is ranked high, the release (if there is an acoustic release) is not of a copied vowel.

(2.21) *V OFFSET PAST C CENTER (Hall 2004):
In a sequence VC, the offset of V is not later than the center of C.

Since only ʕ triggers vowel intrusion in SMH, the constraints below must be specified for ʕ. These constraints are also ranked differently from constraints that militate for vowel intrusion in other sonorants of the language. SMH ranking is given in (2.22).

(2.22) SMH ranking:

ALIGN (ʕ$_1$, CENTER, C$_2$, ONSET)

ALIGN (ʕ$_1$, RELEASE, C$_2$, TARGET)   ALIGN (R$_1$[17], RELEASE, C$_2$, TARGET)

ALIGN (R$_1$, CENTER, C$_2$, ONSET)

ALIGN (V, OFFSET, C]$_\sigma$, CENTER)

*V OFFSET PAST C CENTER

(2.23) SMH vowel intrusion:

/maʕnak/	ALIGN (ʕ$_1$, CENTER, C$_2$, ONSET)	ALIGN (ʕ$_1$, RELEASE, C$_2$, TARGET)	ALIGN (V, OFFSET, C]$_\sigma$, CENTER)	*V OFFSET PAST C CENTER
a. maʕnak	*!			
☞ b. maʕanak		*		*
c. maʕənak		*	*!	

[17] R stands for all other sonorants in the language.

(2.24) Non-triggering vowel intrusion cluster:

/milga/	ALIGN (R_1, RELEASE, C_2, TARGET)	ALIGN (R_1, CENTER, C_2, ONSET)	ALIGN (V, OFFSET, $C]_\sigma$, CENTER)	*V OFFSET PAST C CENTER
☞ a. milga		*		
b. miliga	*!			*
c. miləga	*!		*	

In the tableaux above, the two inputs /maʕmad/ and /milga/ are subject to the SMH hierarchy. In tableau (2.23), the vowel gesture extends to the center of [n] to satisfy ALIGN (V, OFFSET, $C]_\sigma$, CENTER). The result is a copied [a]. In tableau (2.24), ALIGN (R_1, RELEASE, C_2, TARGET) blocks the vowel gesture from extending to the center of [g], and no vowel is heard between [l] and [g].

2.4.3 Why not epenthesis

Analysis of the vowel that is produced between two consonants in ʕC clusters in SMH as epenthetic can be appealing at first glance. Epenthesis is common in SMH, especially in a pharyngeal environment (Pariente 2006), so assuming that these vowels are epenthetic does not require the assumption of two distinct phenomena in the phonology of the language.

Recall that in SMH, both the voiced and the voiceless pharyngeal can appear freely in onset position, and in word-medial coda position. However, the ability to appear in final coda position is limited to the voiceless pharyngeal. Since the pharyngeal in ʕC clusters (the environment that triggers VI) is always in coda position, the prohibition on ʕC clusters could be viewed as a coda prohibition, and the vowel that emerges between the two consonants could be viewed as epenthetic. Under this analysis, the *ʕC prohibition would just be a specific case of $*ʕ]_\sigma$, as shown in the tableau below.

(2.25) Alternative analysis of *ʕC as $*ʕ]_\sigma$:

/miʕmad/	MAX	$*ʕ]_\sigma$	DEP
a. mi.mad	*!		
b. miʕ.mad		*!	
☞ c. ma.ʕ**a**.mad			*

This analysis would raise two problems: (a) the quality of the vowel following the pharyngeal, and (b) non-syllabicity.

2.4.3.1 The quality of the vowel following the pharyngeal

In the absence of pharyngeals, the default epenthetic vowel in SMH is [e]. Assuming that epenthesis takes place in ʕC clusters (2.25), we get the following observations: (a) in the noun system, when epenthesis takes place after ʕ, the vowel that emerges is [a] (maʕ**a**mad and not *maʕ**e**mad); (b) the vowel that appears within ʕC clusters in the verb system is [e] (neʕ**e**daʁ). This vowel is identical to the vowel preceding the pharyngeal.

Since epenthetic vowels are not copied, the value of the vowel can be considered as the value of the default epenthetic vowel in SMH, which is [e]. The only way to explain the emergence of [e] after ʕ in the verb system is to assume that TETU effects, which cause the value of an epenthetic vowel to be [a] after a pharyngeal, are blocked somehow in the verb system so that the default vowel is [e] in the verb system.

Solving this paradox, however, leads as to another one. If the default vowel in the verb system is [e] even after a pharyngeal, why is the vowel that emerges after a final voiced pharyngeal consonant (creating an additional syllable inverting the pharyngeal to an onset) always [a] (2.3)? The vowel that emerges in verbs like [ja.nu.ʕ**a**] suggests that TETU is **not** blocked in the verb system. If the impact of TETU is indeed apparent, the epenthesis analysis cannot explain the emergence of two different vowels ([e] and [a]) in the same environment.

2.4.3.2 Non-syllabicity

The evidence for non-syllabicity in SMH comes primarily from the phonological prohibition on the proximity of non-low vowels to pharyngeals. SMH permits pharyngeals to appear after a non-low vowel, if the non-low vowel and the pharyngeal are not syllabified into the same syllable, i.e. if the pharyngeal is in onset position.

(2.26) Non-low vowel and pharyngeals syllabified into different syllables:

ta.p**u**.ħím	'apples'	cf. ta.pu.zím	'oranges'
j**e**.ħa.pés	'he will search'	cf. je.da.béʁ	'he will talk'
s**i**.ħék	'he was playing'	cf. di.béʁ	'he talked'
ma.n**ó**.ʕa	'motor'	cf. ma.nóf	'crane'
ʃ**i**.ʕéʁ	'he assumed'	cf. di.béʁ	'he talked'

However, if the pharyngeal is preceded by an unstressed non-low vowel, the vowel preceding it is always lowered to [a] in the noun system and to [e] in the verb system.

(2.27) Pharyngeal preceded by an unstressed non-low vowel:

Nouns:	m**a**ħ.nák	'suffocation'	cf. mig**.**dál	'tower'
	m**a**ħ.té.ʁet	'underground'	cf. mik.té.ʁet	'pipe'
Verbs:	n**e**ħ.káʁ	'he was interrogated'	cf. nig.maʁ	'it was finished'
	eħ.lít	'he decided'	cf. it.ħil	'he began'

The syllabic nature of the inserted vowels can be tested in cases where an unstressed non-low vowel precedes a ʕC cluster, creating a cluster that is the target of VI in the language. Such cases were given in (2.15). In theory, the vowels that appear between ʕ and other consonants can create a syllable: /miʕmád/ → *[miʕi̱.mád]. Under such syllabification, the high vowel preceding the pharyngeal and the pharyngeal itself are not syllabified into the same syllable. As mentioned above, in that environment, high vowels stay high.

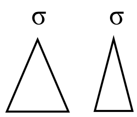
(2.28) Syllabification of the intrusive vowel as syllabic:

σ σ σ

miʕmád → *mi ʕi̱ mád

However, what does happen is that the high vowel is lowered by the rules of the language, i.e. it becomes [a] in the noun system and [e] in the verb system. If the high vowel is lowered and vowel lowering happens only in the domain of the syllable, we must conclude that the vowel inserted after the pharyngeal does not create a syllable, and the high vowel preceding the pharyngeal and the pharyngeal itself are syllabified in the same syllable. Since the vowel preceding the pharyngeal is lowered, the intrusive vowel must be low too, since the two vowels are parts of a single vowel gesture.

(2.29) Syllabification of the intrusive vowel as non-syllabic:



miʕmád → maʕa mád

As shown above, the vowel that appears within ʕC clusters is not syllabic; however, the vowel that emerges in verbs like [ja.nu.ʕ**a**] is necessarily syllabic, since it syllabifies the pharyngeal to onset position and is parsed into a foot. Again, an epenthesis analysis cannot explain all the facts regarding the phenomenon.

2.4.4 Why not rule ordering

An approach to neutralize the problem of non-syllabicity is to analyze the emergent vowel between ʕ and the following consonant as an epenthetic vowel that is created via derivation. In such a scenario, vowel lowering precedes epenthesis between the pharyngeal and the following consonant:

(2.30) Derivation of vowel lowering and epenthesis:

/miʕmad/	UR
m**a**ʕmad	Vowel lowering
maʕ.mad	Syllabification
maʕ**a**mad	Epenthesis (to prevent ʕ from being syllabified as coda)
ma.ʕa.mad	Re-syllabification
[maʕ**a**mád]	FF

In this analysis, vowel lowering precedes epenthesis and since syllabification occurs after vowel lowering, the syllabified form *maʕ.mad* triggers epenthesis. Following this analysis, there is no need to assume that the vowel that emerges between the pharyngeal and the following consonant is not syllabic, since syllabification is a recursive process. However, such derivation wrongly predicts words with ʕ in final position:

(2.31) Derivation of vowel lowering and epenthesis of words with ʕ in final position:

/manoʕ/	UR
man**a**ʕ	Vowel lowering
ma.naʕ	Syllabification
manaʕ**a**	Epenthesis
ma.na.ʕa	Re-syllabification
[manáʕ**a**]	FF

The actual form is [ma.no.ʕa] with no vowel lowering occurring since ʕ is syllabified as an onset. The data supports the OT grammar; it seems that all processes (the prohibition of adjacent non-low vowels and pharyngeals, syllabification and epenthesis) are evaluated together, and intermediate levels and re-syllabification actually predict the wrong outcome.

2.4.5 Typological observation

Hall (2003) points out that VI is restricted only to sonorants. And in some languages, it is restricted to only a subset of sonorants. Hall (2003: 28) gives the following hierarchy:

(2.32) Vowel intrusion triggers:

(Obstruents, if ever) → other approx. or nasals → [r] → [l] → [ɾ, ʁ] → gutturals

Among nasals: [m] → [n]

So if [m] triggers VI in a language, [n] will trigger it as well. Regarding gutturals, Hall says the following:

> In languages that have vowel intrusion with gutturals, there are no cases where only a subset of the gutturals triggers it (unless one of the gutturals does not occur in the correct position, like Kekchi [h]). No implicational hierarchy within the guttural class can be established at present. (Hall 2003: 28)

SMH is a language in which [ʕ] triggers VI but [ħ] does not. Based on these data, Hall's observation can be expanded by stipulating that if [ʕ] triggers VI in a language; [ħ] will not necessarily trigger it as well.

(2.33) Hierarchy among the pharyngeals:
*([ʕ] → [ħ])

A language can allow heavy overlap between vowels and ʕ, without allowing the same degree of overlap between vowels and ħ.

2.5 Conclusion

In this paper, I have examined the two types of vowels that appear in the surface forms due to processes that are triggered by the pharyngeal consonants in SMH. It was argued that these two types are different from one another and that they exhibit different properties. Table 2.5 summarizes these differences.

Table 2.5. Non-lexical vowel properties

Property / Vowel type	Environment	Quality	Syllabicity
True epenthetic vowels	(a) After final ʕ that is preceded by a stressed vowel (b) Between non-low stressed vowel and final ħ	Always [a]	Syllabic
Intrusive echo vowels	Between ʕ and another consonant	Depends on the vowel preceding the pharyngeal (copied); [a] or [e]	Non-syllabic

Arguments for different analyses were presented and it was shown that an epenthesis analysis of intrusive vowels collapses.

3 The interaction of vowel quality and pharyngeals in Sephardic Modern Hebrew

This chapter is a slightly modified version of the paper that was published as:

Pariente, Itsik. 2015. The interaction of vowel quality and pharyngeals in Sephardic Modern Hebrew. *Folia Linguistica* 49(2): 421–438.

Abstract

This paper examines the complex interactions between pharyngeals and vowel quality in Sephardic Modern Hebrew. Phonetically similar to low vowels, gutturals in general and pharyngeals in particular tend to trigger vowel lowering and epenthesis of low vowels. Sephardic Modern Hebrew exhibits multiple strategies in order to accomplish this proximity. The language processes take into account several factors, including the syllabic position of the pharyngeal (onset or coda), prosody (stress) and lexical category (nouns vs. verbs).

3.1 Introduction

This paper describes and analyzes the phonological prohibition on the proximity of non-low vowels to pharyngeals in Sephardic Modern Hebrew (henceforth SMH) in the framework of Optimality Theory (OT) (Prince and Smolensky 1993/2004). One of the best-known properties of pharyngeals is their preference to appear next to low vowels (McCarthy 1994).

SMH exhibits a multitude of behaviors with regard to this prohibition, depending on the syllabic position of the pharyngeal (onset or coda), the metrical position of the pharyngeal (stressed syllable vs. unstressed syllable) and the morphological system (nouns vs. verbs).

3.1.1 Data and generalizations

SMH permits pharyngeals to appear after a non-low vowel, if the non-low vowel and the pharyngeal are not syllabified into the same syllable, i.e. the pharyngeal is in onset position, see (3.1).

(3.1) Non-low vowel and pharyngeals syllabified into different syllables:

ta.p**u**.ħím	'apples'	cf. ta.pu.zím	'oranges'
j**e**.ħa.pés	'he will search'	cf. je.da.béʁ	'he will talk'
s**i**.ħék	'he played'	cf. di.béʁ	'he talked'
ma.n**ó**.ʕa	'motor'	cf. ma.nóf	'crane'
ʃ**i**.ʕéʁ	'he assumed'	cf. di.béʁ	'he talked'

However, when pharyngeals and non-low vowels are syllabified into the same syllable, various processes take place: if the pharyngeal appears after a non-stressed high vowel, the vowel is lowered to [a] in the noun system (3.2) and to [e] in the verb system (3.3):

(3.2) Pharyngeal after a non-stressed non-low vowel in the noun system:[18]

m**a**ʕ^{a}.mád[19]	'status'	cf. mig.dál	'tower'
m**a**ʕ^{a}.ʁé.xet	'systm'	cf. mik.té.ʁet	'pipe'
m**a**ħ.sán	'warehouse'	cf. mig.dál	'tower'
m**a**ħ.bé.ret	'notebook'	cf. mik.lé.det	'keyboard'

[18] An intrusive vowel is heard between the ʕ and the following consonant. This is a case of an intrusive echo vowel that eases perception of consonant clusters. The value of this vowel is copied from the preceding vowel. This vowel is non-syllabic and ʕ is syllabified as coda. For general discussion, analysis and typology of intrusive vowels see Hall (2006); for SMH vowel intrusion and evidence of its non-syllabic nature see Pariente (2010).

[19] The UR is assumed to be /miħsan/ with /i/ before the unvoiced pharyngeal and not /maħsan/ with underlying /a/ due to the fact that a maCCaC mishkal is not present in the morphology of the language.

(3.3) Pharyngeal after an unstressed high vowel in the verb system:[20]

n**e**ʕ^{e}.káʁ	'it was uprooted'	cf. nig.máʁ	'it was finished'
h**e**ʕ^{e}.víʁ	'he transferred'	cf. hit.ħíl	'he began'
n**e**ħ.káʁ	'he/it was investigated'	cf. nig.máʁ	'it was finished'
h**e**.ʕ^{e}.víʁ	'he transferred'	cf. hit.ħíl	'he began'

If the unvoiced pharyngeal ħ appears after a stressed non-low vowel, [a] is inserted before it, see (3.4):

(3.4) ħ after a stressed vowel:[21]

ʃa.tí.**a**ħ	'carpet'	cf. ʃa.tíl	'seedling'
mó.**a**ħ	'brain'	cf. ʃót	'whip'
bi.tú.**a**ħ	'insurance'	cf. ni.gún	'melody'
maf.té.**a**ħ	'key'	cf. mav.ʁég	'screwdriver'
hiv.tí.**a**ħ	'he promised'	cf. hit.ħil	'he began'
him.lí.**a**ħ	'he salted'	cf. hit.ħíl	'he began'
di.vé.**a**ħ	'he reported'	cf. di.béʁ	'he talked'
hit.ka.lé.**a**ħ	'he took a shower'	cf. hit.la.béʃ	'he dressed'

The multiple processes presented above all aim at creating adjacency between pharyngeals and low vowels, as phonetic studies on pharyngeals[22] (Delattre

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[20] This generalization has one exception: B1 (paʕal) acts like the noun system, i.e. a high vowel is lowered to [a]:

y**a**ħmod	'he will covet'	vs. yignov	'he will steal'
y**a**ħšov	'he will think'	vs. yignov	'he will steal'
y**a**ʕazov	'he will leave'	vs. yignov	'he will steal'
y**a**ʕamod	'he will stand'	vs. yignov	'he will steal'

The historical reason for this behavior is that the original vowel was [a], at some point unstressed [a] in closed syllables became [i]; this did not happen before a pharyngeal. A satisfying synchronic explanation is yet to be suggested.

[21] ʕ does not appear after a stressed non-low vowel in the language since an epenthetic vowel is inserted to syllabify the ʕ into an onset position.

hif.tí.ʕ**a**	'he surprised'	cf. hit.ħil	'he began'
ʃa.vú.ʕ**a**	'week'	cf. tap.úz	'orange'
ló.ʕ**a**	'pharynx, throat, maw'	cf. ʃót	'whip'

[22] The vast majority of the literature on pharyngeal consonants focuses on the various dialects of Arabic, due to the fact that pharyngeals are present in all dialects of Arabic and the language is one of the most common languages of the world. Studies on Arabic are relevant for contemporary Hebrew, since the early speakers of Sephardic Hebrew were native speakers of Arabic dialects, and indeed Laufer and Baer (1988) found a great deal of similarity in the pronunciation of pharyngeals in the two languages.

1971; Perkell 1971) show that low vowels involve some pharyngeal constriction, with concomitant acoustic similarities between the vowel [a] and the pharyngeals (high F_1). This shared property of low vowels and pharygeals triggers phonological processes in order to avoid the proximity of non-low vowels and pharyngeals (McCarthy 1994).

Al-Ani (1970), Ghazeli (1977), Klatt and Stevens (1969), and Butcher and Ahmad (1987) show that pharyngeals have high F_1. They also found that at the consonant/vowel boundary, ʕ has a relatively low F_2 (1200–1400 Hz range).

3.2 Relevant language background

The present study is based on data from SMH spoken by native speakers living in Israel. The data were collected by the author. Hebrew has two different dialects with almost identical grammars; in the revival of the language, people who spoke Arabic as a first language had no problem articulating the historical pharyngeals, whereas people who spoke European languages (mostly Yiddish and Russian) could not articulate pharyngeals. The descendants of the first group speak Sephardic Modern Hebrew, and the descendants of the second group speak General Modern Hebrew.

Since the morpho-phonology of the two groups was directly adopted from Tiberian Hebrew, two distinct grammars emerge to account for the surface effects of the pharyngeals (see Pariente 2012 for discussion on General Modern Hebrew). The only difference between the general dialect and SMH is the existence of pharyngeal consonants in SMH. The main dialect in Israel is the general dialect. SMH is used in areas that are populated mostly by speakers of Sephardic origin (mainly Yemenite Jews).

The inventory of consonantal segments, presented in the usual way left to right according to articulatory position, and vertically according to the type of articulation, is as follows:

Table 3.1. The consonants of Sepharic Modern Hebrew

	Bilabial	Labio-dental	Alveolar	Palato-alveolar	Palatal	Velar	Uvular	Pharyn-geal	Glottal
Stop	p b		t d			k g			ʔ
Fricative		f v	s z	ʃ ʒ		x		ħ ʕ	h
Affricate			ʦ	ʧ ʤ					
Nasal	m		n						
Liquids			l				ʁ		
Glides					j				

The vocalic system of SMH is identical to the vocalic system of General Modern Hebrew and consists of five phonemic vowels:

Table 3.2. The vowels in Sephardic Modern Hebrew

	Front	Back
High	i	u
Mid	e	o
Low	a	

Traditionally, Semitic morphology is referred to as *Root-and-Pattern* morphology. This view assumes a distinction between Consonantal Roots and Templates. Stems consist of interdigitation of the Consonantal Root and the Template (Nonconcatenative Morphology; McCarthy 1981). The Consonantal Root encodes the core semantic properties, while the Template encodes the person, number, gender, tense, aspect, mood, voice and other grammatical properties (in Hebrew terminology the Templates for verbs is called *binyanim* and for nouns *mishkalim*). The root usually consists of three consonants that appear in a fixed order. Every Template is composed of prosodic structure, Vocalic Pattern, and sometimes a prefix (see Bat-El 2003a for a detailed discussion on Modern Hebrew Verbal Templates).

Vocalic Patterns are morphemes composed of vowels. The order and quality of these vowels is arbitrary although fixed. The prosodic structure of the language is derived by language-specific ranking of universal prosodic constraints, and it determines the syllabic structure of the word.

The existence of the Consonantal Root as an independent morpheme is highly controversial in the literature. Bat-El (1994a, 2003a) and Ussishkin (1999) offer an approach which is surface-based and eliminates the Consonantal Root completely from the grammar, using stems and words as the base for derivation. This debate is outside the scope of this paper.

To sum up, every word in Nonconcatenative Morphology has to be specified for a Template in the lexicon (Bat-El 1989). The following tables overview the verbal and most common noun Templates of MH. The verbs are given in the third-person singular forms. The verb Templates (Binyanim) are abbreviated as B1, B2 etc. The list of Binyanim is adapted from Bat-El (2003a), and the list of noun Templates (Mishkalim) is adapted from Pariente (2012).

Table 3.3. Modern Hebrew Binyanim

Past	
Ca.CáC	B1
niC.CáC	B2
hiC.CíC	B3
Ci.CéC	B4
hit.CaC.éC	B5

Table 3.4. Affixed mishkalim in Modern Hebrew

Mishkal	**Example**	**Gloss**	**Example**	**Gloss**
maCCéC	mavʁég	‘screwdriver’	maʃpéx	‘funnel’
maCCeCá	makdeħá	‘drill (tool)’	matslemá	‘camera’
miCCáC	miʃtáʁ	‘regime’	mivtsáʁ	‘fortress’
miCCaCá	milħamá	‘war’	miʃtaʁá	‘police’
tiCCóCet	tiʁgólet	‘drill’	tixtóvet	‘correspondence’
taCCíC	taʁgíl	‘exercise’	taxtív	‘dictate’
taCCúC	taʃlúm	‘payment’	tamʁúʁ	‘road sign’
taCCuCá	tavʁuʔá	‘sanitation’	taħbuʁá	‘transport’
miCCéCet	mivʁéʃet	‘brush’	mizħélet	‘sled’
ʔaCCaCá	ʔazkaʁá	‘memorial’	ʔavħaná	‘diagnosis’
miCCóC	mitsbóʁ	‘accumulation’	mizmóʁ	‘psalm’

Since pharyngeal-triggered lowering and epenthesis are interconnected with the metrical system of the language, I review it here briefly. Hebrew is a quantity-insensitive language with default final stress. Two competing analyses arise to account for these facts: (a) the Hebrew stress system consists of binary strong feet (enclosed in square brackets), either iambic or trochaic ([*ganáv*], [*yéled*]; for example, Bolozky 1982; Graf and Ussishkin 2003; Bat-El 2005); (b) Hebrew stress consists of trochaic feet, either binary or degenerate (*ga*[*náv*], [*yéled*]; for example, Becker 2003; Pariente and Bolozky 2014).[23] I adopt the trochaic analysis of Hebrew, which claims that the accentual system of Modern Hebrew is best analyzed as consisting of only trochaic feet (see Pariente and Bolozky 2014 for discussion).

(3.5) Stress-related constraints:

a. TROCHEE (Prince and Smolensky 1993/2004; McCarthy and Prince 1993):
Feet are left-headed.

b. FOOTBINARITY (FTBIN) (Prince 1980; Prince and Smolensky 1993/2004):
Feet must be binary under syllabic or moraic analysis.

c. RIGHTMOST (ALIGN (PRWD, R, HEAD-FT, R)) (Cohn and McCarthy 1994):
The right edge of every prosodic word is aligned with the right edge of some head foot.

I assume that feet are always trochaic in the language (binary or unary). This means that TROCHEE is undominated in the language and must outrank FTBIN.

(3.6) Stress and foot structure in Hebrew verbs:

/katav/	TROCHEE	RIGHTMOST	FTBIN
☞ a. ka[táv]			*
b. [ka.táv]	*!		
c. [ká.tav]		*!	

In tableau (3.6). candidate (c) has non-final stress, so it is ruled out by RIGHTMOST. Candidates (a) and (b) both have final stress, but a different foot

[23] Secondary stress in Hebrew is discussed in most of the generative literature on stress, beginning with Bolozky (1982), where it is described as appearing on every other syllable to the left of the primary stress. However, Becker (2003) finds no acoustic evidence for secondary stress either by pitch or by vowel length. In the following example he identified only one point of high pitch and one (phonetically) long vowel: *hagamadoním* 'the little dwarfs'.

structure: binary iamb (b) and unary (a). Candidate (a) is chosen over (b) due to the ranking of TROCHEE above FTBIN.

3.3 OT analysis

The data above denote that the prohibition on the proximity of non-low vowels to pharyngeals is hierarchical, i.e. the prohibition in the domain of the syllable is a stronger prohibition than the general prohibition on the proximity of non-low vowels to pharyngeals. Formulating a general constraint and a syllable-domain constraint can capture this hierarchy:

(3.7) $*V_{+high}$PHARYNGEAL:
High vowels before a pharyngeal are forbidden.

(3.8) $*V_{+high}$PHARYNGEAL$]_\sigma$ ($*V_{+high}$PHAR$]_\sigma$):
High vowels before a pharyngeal are forbidden within the domain of the syllable.

These constraints are in a fixed ranking in which the constraint militating against the more marked structure outranks the constraint militating against the less marked structure (in accordance with the markedness hierarchy of Smolensky 1993). A language cannot allow a non-low vowel to precede a pharyngeal within the domain of the syllable without allowing it when the vowel and the pharyngeal are syllabified into different syllables.

(3.9) $*V_{+high}$PHARYNGEAL$]_\sigma$ >> $*V_{+high}$PHARYNGEAL

Nowhere in the language can we find the effects of the constraint $*V_{+high}$PHARYNGEAL; however, the constraint $*V_{+high}$PHARYNGEAL$]_\sigma$ affects the phonological system of SMH in different ways, suggesting the following ranking:

(3.10) $*V_{+high}$PHARYNGEAL$]_\sigma$ >> FAITH >> $*V_{+high}$PHARYNGEAL

Since high vowels and mid vowels can act differently with regard to the prohibition of adjacent non-low vowels and pharyngeals, different constraints must be formulated for high vowels and for mid vowels. The following constraint encodes the prohibition on mid vowels preceding pharyngeals.

(3.11) $*V_{-low}$PHARYNGEAL$]_\sigma$ ($*V_{-low}$PHAR$]_\sigma$):

Non-low vowels before a pharyngeal are forbidden within the domain of the syllable.

Since there is more similarity between the pronunciations of mid vowels and pharyngeals than between the pronunciations of high vowels and pharyngeals, these constraints are also in a fixed ranking. A language cannot allow a high vowel to precede a pharyngeal within the domain of the syllable without allowing a mid vowel to precede a pharyngeal within the domain of the syllable.

(3.12) $*V_{+high}$PHARYNGEAL$]_\sigma$ >> $*V_{-low}$PHARYNGEAL$]_\sigma$

3.3.1 Co-phonology

As shown in the data above, the noun system and the verb system in SMH are subject to different processes with regard to the prohibitions on the proximity of high and mid vowels to pharyngeals. Different rankings in one language – one for the noun system and one for the verb system – can explain the fact that nouns act differently to verbs.

In OT, morphologically conditioned phonology (i.e. the nature of a process depends on the morphological category, namely the noun system and the verb system) has been approached in two ways. One approach is to posit a single fixed constraint ranking for the entire language. Constraints within that fixed ranking are parameterised to apply to designated morphological categories, e.g. verbs vs. nouns, words vs. phrases etc. This approach is known as the indexed constraints approach (McCarthy and Prince 1995; Urbanczyk 1996; Pater 2000; among others).

The second approach is to keep phonological constraints purely phonological, but posit a range of distinct co-phonologies (Orgun 1996; Anttila 2002; Inkelas and Zoll 2007; among others).

Following Anttila (2002), who examines data from Finnish and provides persuasive arguments in favor of the co-phonology hypothesis (for example, it is shown that indexed constraints predicts unattested systems), I adopt the co-phonology mechanism in my analysis (see also Inkelas and Zoll 2008 for further arguments in favor of the co-phonology approach).

3.3.2 The noun system

The SMH noun system prohibits non-low vowels from preceding pharyngeals. To solve such a situation, the noun system implements different strategies depending on the status of the vowel preceding the pharyngeal: if the vowel is not stressed, it is always lowered to [a] (2); if the vowel is stressed, it does not change; however, epenthesis of a low vowel occurs if the pharyngeal is the unvoiced ħ (4). The voiced ʕ is never syllabified as the coda of a stressed syllable (see footnote 21).

Since lowering of a non-low vowel occurs, $*V_{+high}$PHARYNGEAL$]_\sigma$ and DEP-IO must outrank the faithfulness constraint militating for identity value of height: IDENT-IO [high/low] (Prince and Smolensky 1993/2014).

(3.13) IDENT-IO [high/low]:

An output vowel, and its input correspondent, has identical values for the feature [high/low].

This ranking is demonstrated in the tableaux below.

(3.14) Noun system lowering:

/miħsan/	$*V_{+high}$ PHAR$]_\sigma$	$*V_{-low}$ PHAR$]_\sigma$	DEP	IDENT [high]	IDENT [low]
a. miħ.sán	*!	*			
b. mi.aħ.sán			*!		
c. meħ.sán		*!		*	
☞ d. maħ.sán				*	*

In tableau (3.14) the underlying form /miħsan/ contains a high vowel before a pharyngeal. The faithful candidate (a) is ruled out by $*V_{+high}$PHAR$]_\sigma$, which militates against high vowels before a pharyngeal in the same syllable. In candidate (b) a vowel is inserted between ħ and the high vowel; however, it is ruled out by the high-ranking constraint DEP. In candidate (c) the high vowel [i] is lowered to the mid vowel [e] so it does not violate $*V_{+high}$PHAR$]_\sigma$; however, it violates the high-ranked constraint $*V_{-low}$PHAR$]_\sigma$ that militates against mid vowels before a pharyngeal in the same syllable, and is therefore ruled out. In the winning candidate (d), the high vowel [i] is lowered to the low vowel [a], so none of the high constraints are violated but the low-ranked IDENT constraints are both violated.

Stressed vowels, however, do not change to satisfy $*V_{+high}PHAR]_{\sigma}$. This is a case of positional blocking of a phonological process due to the positional privilege of stressed syllables (Beckman 1998). Stressed vowels fail to undergo a process which unstressed vowels are targeted for. This blocking of vowel lowering in stressed syllables results from the effect of the high-ranked positional faithfulness constraints, IDENT-σ́ [high/low] (Beckman 1998).

(3.15) IDENT-σ́ [high/low]:
Output segments in a stressed syllable and their input correspondents must have identical specifications for the feature [high/low].

In words with ħ after a stressed vowel, epenthesis takes place (ta.pú.**a**ħ). This result means that IDENT-σ́ [high/low], $*V_{+high}PHAR]_{\sigma}$ and $*V_{-low}PHAR]_{\sigma}$ are all ranked above DEP:

(3.16) Noun system epenthesis after a stressed high vowel:

/tapuħ/	IDENT-σ́ [high]	IDENT-σ́ [low]	$*V_{+high}$ $PHAR]_{\sigma}$	$*V_{-low}$ $PHAR]_{\sigma}$	DEP	IDENT [high]	IDENT [low]
a. ta.púħ			*!	*			
b. ta.páħ	*(!)	*(!)				*	*
c. ta.póħ	*!					*	
☞ d. ta.pú.**a**ħ					*		

In tableau (3.16) the underlying form /tapuħ/ contains a high vowel before a pharyngeal. The faithful candidate (a) is ruled out by $*V_{+high}PHAR]_{\sigma}$. In candidate (b) the high vowel [i] is lowered to the low vowel [a] and it is ruled out by IDENT-σ́ [high/low]. In candidate (c) the high vowel [i] is lowered to the mid vowel [o] and it is ruled out by IDENT-σ́ [high]. In the winning candidate (d), a low vowel is inserted between ħ and the high vowel violating DEP.

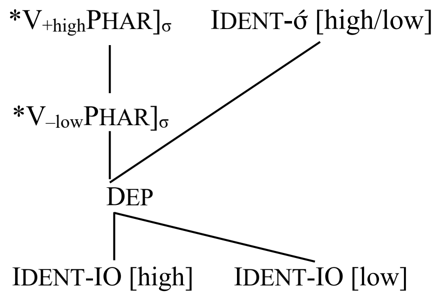
The tableau below demonstrates that the same ranking yields the same result (epenthesis) when the vowel preceding the pharyngeal is a mid-vowel.

(3.17) Noun system epenthesis after a stressed mid vowel:

/moħ/	IDENT-σ́ [high]	IDENT-σ́ [low]	$*V_{+high}$ $PHAR]_{\sigma}$	$*V_{-low}$ $PHAR]_{\sigma}$	DEP	IDENT [high]	IDENT [low]
a. móħ				*!			
b. máħ		*!					*
☞ c. mó**a**ħ					*		

The ranking of the noun system is given in (3.18).

(3.18) Ranking of the noun system:



3.3.3 The verb system

The SMH verb system also prohibits non-low vowels from preceding pharyngeals, but is slightly less strict than the noun system. In the verb system, when a high vowel precedes a pharyngeal, it is lowered; however, the lowering is not total, in the sense that the vowel is not lowered to [a], but rather to [e]. The data from (3.3) are repeated in (3.19).

(3.19) Pharyngeal after an unstressed high vowel in the verb system:

n**e**ʕ^{e}.kaʁ	'it was uprooted'	cf. nig.maʁ	'it was finished'
h**e**ʕ^{e}.viʁ	'he transferred'	cf. hit.ħil	'he began'
n**e**ħ.kaʁ	'he/it was investigated'	cf. nig.maʁ	'it was finished'
h**e**.ʕ^{e}.viʁ	'he transferred'	cf. hit.ħil	'he began'

Semi-lowering is optimal if IDENT-IO[high] and IDENT-IO[low] are ranked above $*V_{-\text{low}}\text{PHAR}]_\sigma$.

(3.20) Semi-lowering in the vowel system:

/niħkaʁ/	$*V_{+\text{high}}$ PHAR]$_\sigma$	DEP	IDENT [high]	IDENT [low]	$*V_{-\text{low}}$ PHAR]$_\sigma$
a. niħ.kaʁ	*!				*
☞ b. neħ.kaʁ			*		*
c. naħ.kaʁ			*	*!	
d. ni.aħ.kaʁ		*!			

In tableau (3.20) the underlying form /niħkaʁ/ contains a high vowel before a pharyngeal. The faithful candidate (a) is ruled out by $*V_{+high}$PHAR]$_\sigma$. In candidate (c) the high vowel [i] is lowered to the low vowel [a], so it violates the IDENT constraints and is ruled out. In candidate (d) a vowel is inserted between ħ and the high vowel and it is ruled out by DEP. In candidate (b) the high vowel [i] is lowered to the mid vowel [e], so it does not violate $*V_{+high}$PHAR]$_\sigma$, though it violates $*V_{-low}$PHAR]$_\sigma$, which militates against mid vowels before ħ at the same syllable. Since in the verb system this constraint is ranked lower than the IDENT constraints and in fact it is the lowest constraint in the hierarchy, (b) is the winning candidate.

As in the noun system, stressed vowels in the verb system do not change to satisfy $*V_{+high}$PHAR]$_\sigma$ and epenthesis takes place when the pharyngeal is ħ. Consider some of the data from (3.4) repeated here as (3.21). The voiced ʁ is never syllabified as the coda of a stressed syllable (see footnote 21).

(3.21) ħ after a stressed vowel in the verb system:

hiv.tí.**a**ħ	'he promised'	cf. hit.ħil	'he began'
him.lí.**a**ħ	'he salted'	cf. hit.ħíl	'he began'

(3.22) Verb system epenthesis after a stressed high vowel:

/himliħ/	IDENT-σ́ [high]	IDENT-σ́ [low]	$*V_{+high}$ PHAR]$_\sigma$	DEP	IDENT [high]	IDENT [low]	$*V_{-low}$ PHAR]$_\sigma$
a. him.líħ			*!				*
b. him.láħ	*(!)	*(!)			*	*	
c. him.léħ	*!				*		
☞ d. him.lí.aħ				*			

The ranking of IDENT-σ́ [high] above DEP ensures that epenthesis will be preferred over vowel lowering.

3.3.3.1 Ranking paradox

The ranking given in (3.22) however, gives the wrong output when underlying /e/ surfaces as the stressed vowel. By the ranking established so far, epenthesis should not take place before the pharyngeal consonant; however, epenthesis does occur in such verbs.

(3.23) Ranking paradox:

/ʃoleħ/	IDENT-σ́ [high]	IDENT-σ́ [low]	*V$_{+high}$ PHAR]$_σ$	DEP	IDENT [high]	IDENT [low]	*V$_{-low}$ PHAR]$_σ$
☜ a. ʃoléħ							*
b. ʃoláħ		*!				*	
☞ c. ʃoléaħ				*!			

According to Beckman (1998, ch. 3) stressed syllables are more prominent than unstressed syllables, and thereby the languages of the world exhibit stress-based positional neutralization, stress-based triggering of processes and stress-based blocking of phonological processes. However, a case where a marked structure can appear in unstressed syllables (a mid vowel before a pharyngeal as in the word *neħkáʁ*) but is blocked in stressed syllables (as in the word *ʃoléaħ* where [a] is inserted between the mid vowel and the pharyngeal) as in SMH, is not attested in the languages of the world.

I argue that the above described paradox is a case of Gang Effect (Keller 2006; Farris-Trimble 2008; Pater 2009). A Gang Effect refers to cases where two violable lower-ranked constraints "gang up" against a higher-ranked constraint in order to rule out a candidate that violates both of them. This results in a win by another candidate – the one that violates the higher-ranked constraint only once. I argue that this ranking paradox is the outcome of the combined forces of the markedness constraint *V$_{-low}$PHAR]$_σ$ and the constraint FTBIN.

Gang Effects are usually analyzed within the theoretical framework of Harmonic Grammar (Legendre, Miyata and Smolensky 1990), since Gang Effects can be easily analyzed in a theory that consists of weighted constraints rather than strict domination. Within OT a solution to gang effects was proposed by Smolensky (1995) using Local Conjunction (LC). In LC two constraints can be combined, and a combined constraint is violated only by candidates that violate both combining constraints. The combined constraint is ranked above its combining constraints. The tableau below shows the ranking of DEP in respect of *V$_{-low}$PHAR]$_σ$ and FTBIN.

(3.24) The ranking of DEP in respect of *V$_{-low}$PHAR]$_{\sigma}$ and FTBIN:

/ʃoleħ/	DEP	*V$_{-low}$ PHAR]$_{\sigma}$	FTBIN
☜ a. ʃo[léħ]		*	*
☞ b. ʃo[léaħ]	*!		

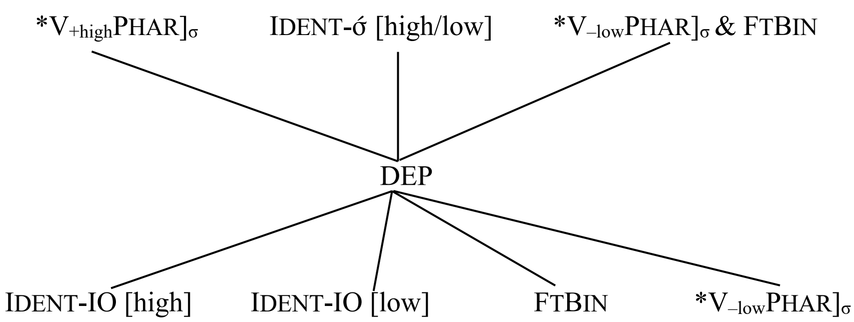
DEP outranks each of the constraints individually, candidate (b) is ruled out by DEP, and candidate (a) violates both *V$_{-low}$PHAR]$_{\sigma}$ and FTBIN. However, if DEP is ranked below the combined constraint *V$_{-low}$PHAR]$_{\sigma}$&FTBIN ('no mid vowels before a pharyngeal within the domain of the syllable' and 'feet are binary'), candidate (b) will win:[24]

(3.25) The ranking of DEP and *V$_{-low}$PHAR]$_{\sigma}$&FTBIN:

/ʃoleħ/	*V$_{-low}$PHAR]$_{\sigma}$ & FTBIN	DEP	*V$_{-low}$ PHAR]$_{\sigma}$	FTBIN
a. ʃo[léħ]	*!		*	*
☞ b. ʃo[léaħ]		*		

Candidate (a) is ruled out because it violates the combined constraint. The combined constraint will have no effect over words like *neħ[káʁ]*, since word stress is ultimate and epenthesis will not create a binary foot (**neaħ[káʁ]*). So the ranking of the noun system is:

(3.26) Ranking of the verb system:



[24] I again do not consider a candidate such as [ʃoléħ] in the tableau since feet are always trochaic in the language (Becker 2003, Pariente and Bolozky 2014). A candidate such as [ʃóleħ] does not appear in the tableau since it will be ruled out by the high ranking constraint RIGHTMOST that militates against non-final stress.

3.4 Discussion – co-phonology and privilege

Category-specific phonological processes are becoming the interest of large growing linguistic investigations (Myers 2000; Smith 2001, 2011; Bobaljik 2008 among others). It has been argued that nouns are more privileged than verbs, thus allowing for more marked features (Smith 2011). Verbs are arguably less faithful to the UR and allow for more changes to the UR material. This argument was made for suprasegmental and prosodic processes. In this section I examine this hypothesis in a featural process and show that in the case of pharyngeal triggered vowel lowering, verbs are more faithful and preserve more UR material than nouns.

In a cross-linguistic survey of phonological differences among lexical categories, Smith (2011) has found that nouns exhibit more preservation of lexical material in most languages. For example, in Spanish, stress can be antepenultimate or penultimate, i.e. stress is contrastive: [sáβana] 'sheet' versus [saβána] 'savanna'. In verbs, on the other hand, stress is predictible and is determined by inflection: [láβ-o] 'wash-1SG.PRESENT.INDIC' versus [laβ-é] 'wash-1SG.PRETERITE.INDIC'.

This tendency is, however, restricted to suprasegmental and prosodic effects: "the overwhelming majority of cases involve prosodic and suprasegmental phenomena rather than segmental or featural phenomena" (Smith 2011: 20). SMH is an example of a language that has different featural phenomena for different lexical categories (Nouns vs. Verbs).

In the noun system, high vowels cannot appear before a pharyngeal and the vowel is lowered to [a] (*m**a**ʕ*^{a}*mád* 'status', *m**a**ħsán* 'warehouse'). In the verb system, high vowels also cannot appear before a pharyngeal; however, the vowel is lowered to [e] (*n**e**ʕ*^{e}*kaʁ* 'it was uprooted', *n**e**ħkaʁ* 'he/it was investigated').

SMH exhibits a case of verbal privilege with regard to pharyngeal triggered vowel lowering. In featural terms the generalization can be formulated as follows: In the verb system, a vowel which is specified for [+high] cannot appear before a pharyngeal in the domain of a syllable. In the noun system, a vowel which is specified for [–low] cannot appear before a pharyngeal in the domain of a syllable.

In SMH the prohibition on adjacent non-low vowels and pharyngeal is stricter in the noun system than in the verb system. This results in a full lowering of high vowels to low vowels in nouns and semi-lowering of high vowels to mid vowels in verbs. Full lowering from a high vowel to a low vowel changes both the value of the feature [high] from [+high] to [–high] and the value of the feature [low] from [–low] to [+low]. Semi-lowering from a high vowel to a mid vowel changes only the value of the feature [high] from [+high] to [–high] but not the value of the feature [low] which stays [–low]. Changing the value of only one feature is more faithful to the UR than changing the value of two features. This less marked situation is found in verbs in SMH.

3.5 Conclusion

This paper presented an optimality-theoretic analysis of the behaviour of pharyngeals in a non-standard variety of Hebrew. An OT account of the language's prohibition against a sequence of a non-low vowel immediately preceding a coda pharyngeal was provided.

After presenting the data and generalizations, I outlined the strategies used to avoid the disallowed sequences. It was shown that SMH considers multiple factors with regard to this prohibition, such as syllabic position, stress and lexical category.

Since nouns and verbs show different behaviour with respect to the processes under examination, different co-phonologies were proposed in order to analyze them separately. It was also shown that in SMH, verbs exhibit a greater resistance to vowel lowering than nouns.

4 Grammatical Paradigm Uniformity

This chapter is a slightly modified version of the paper that was published as:

Pariente, Itsik. 2012. Grammatical paradigm uniformity. *Morphology* 22: 485–514.

Abstract

This paper develops a formal model of correspondence between words that share a Morphological Structure but do not share a lexeme. The empirical data used to advocate for this relation is explored using an analysis of nouns and verbs containing /a/ as a Root Vowel in General Modern Hebrew in positions where the corresponding form in Sephardic Modern Hebrew has a voiced pharyngeal. The emergence of Root Vowels reveals mora-related generalizations: Root Vowels emerge only if their parallel paradigmatic consonant (consonant that occupies the same prosodic position in other roots of the same Morphological Structure) is in coda position, i.e. if it is moraic. The theory presented in this paper employs Output-to-Output constraints in order to account for surface phenomena which cannot be explained by standard Paradigm Uniformity theory.

4.1 Introduction

This paper develops a formal model of paradigmatic relations between words not sharing a lexeme. This idea was first introduced by Burzio (1998), following whom it is argued that similarity relations between words that do not share a lexeme can also be a factor in the morphology–phonology interface. The main idea is that words with the same Morphological Structure (MS) are subject to certain similarity demands. A case study on the manifestation of Root Vowels

(RVs) in Modern Hebrew will be discussed to support these paradigmatic relations.

4.1.1 The problem

RVs do not appear at the surface level in all forms. The data given below lists both the environments in which RVs emerge and those in which they do not. The forms containing RVs are compared to other forms in the language which have the same Morphological Structure, i.e. the same conjugation (Vocalic Pattern and Prosodic Structure and derivational affixes of the conjugation if they exist), the same affixes, the same gender, number and person, and for verbs also the same tense. The forms in comparison do not have a RV, but rather a consonant in the same prosodic position. If a RV does not emerge in a specific environment, a different word of the same lexeme, which does contain a manifested RV, is given in the table in order to illustrate that the alternation is synchronic, which means that these lexemes did not lose the RV completely but that it is present in the Underlying Representation (UR).

Roots in Modern Hebrew usually consist of three consonants in a fixed order. In RV forms, a vowel occupies one of the positions of these consonants, i.e. instead of the regular triconsonantal root CCC, a RV form has one of the following structures: VCC, CVC or CCV. While the consonants in these structures always appear on the surface, the vowel may appear or not. The alternation in the manifestation/omission of the RV is argued to mirror the moraic structure of triconsonantal verbs.

In the examples in Table 4.1, a RV is parallel to a final consonant in triconsonantal forms. Since the final consonant in the triconsonantal forms is in coda position, it is moraic. In these cases, the RV appears on the surface to mirror the moraic structure of the triconsonantal form:

Table 4.1. RVs emerge at word final position

UR	Surface Form	Gloss	A form with the same morphological structure and a consonant at the same prosodic position of the RV	Gloss
ʃavu**a**	ʃa.vú.**a**	week	ta.pú**z**	orange
liʃmo**a**	liʃ.mó.**a**	to hear	liʃ.mó**ʁ**	to guard
titpare**a**	tit.pa.ré.**a**	she will misbehave	tit.ka.dé**m**	she will advance

The generalization in Table 4.1 has one exception; if the RV is preceded by *a,* it will not manifest. This behavior is assumed to be the result of an OCP effect:

Table 4.2. RVs do not emerge at word final position when they are preceded by /a/

UR	Surface Form	Gloss	Form with same morphol. structure and consonant at the same prosodic position of RV	Gloss	Form of the same lexeme with a manifested RV	Gloss
nasa**a**	na.sá	he drove	la.má**d**	he studied	no.sé.**a**	he is driving
jiʃma**a**	jiʃ.má	he will hear	jil.má**d**	he will study	ʃo.mé.**a**	he is hearing
mikta**a**	mik.tá	section	mig.dá**l**	tower	ko.té.**a**	he is cutting

In the examples in Table 4.3, a RV is parallel to an initial consonant in triconsonantal forms. Since the initial consonant in the triconsonantal forms is in onset position, it is not moraic. In these cases, the RV does not appear on the surface to mirror the moraic structure of the triconsonantal forms.

Table 4.3. Word-initial RVs do not emerge

UR	Surface Form	Gloss	Form with the same morphol. structure and a consonant at the same prosodic position of the RV	Gloss	Form of the same lexeme with a manifested RV	Gloss
aamad	a.mád	he stood up	**j**a.ʃáv	he set down	ne.**e**.mád[25]	he stood up
aoneg	ó.neg	pleasure	**k**ó.deʃ	holiness	ta.**a**.núg	pleasure
aeved	é.ved	slave	**j**é.led	boy	he.**e**.víd	he employed

Word-medial RVs create vowel hiatus consisting of the RV and a preceding/following vocalic pattern vowel. The manifestation of the RV is again predictable according to the moraicity of its parallel consonant in the triconsonantal form; if the consonant that is parallel to the RV in other forms with the same Morphological Structure is in coda position (i.e. moraic), the RV

[25] The quality of the RVs will be discussed in section 4.4.2.

will emerge, see Table 4.4. If the parallel consonant is in onset position (i.e. non-moraic), the RV will not emerge, see Table 4.5.

Table 4.4. Word-initial RVs emerge when their parallel segment in other forms with the same morphological structure is in coda position

UR	Surface Form	Gloss	A form with the same morph. structure and a consonant at the same prosodic position of the RV	Gloss
hi**a**vid	he.**e**.víd	he employed	hi**ʃ**.tík	he silenced
ni**a**mad	ne.**e**.mád	he stood up	ni**ʁ**.dám	he fell asleep
ji**a**mod	ja.**a**.mód	he will stand up	ji**g**.nóv	he will steal
mi**a**mad	ma.**a**.mád	status	mi**g**.dál	tower

Table 4.5. Word-medial RVs do not emerge when their parallel segment in other forms with the same morphological structure is in onset position

UR	Surface Form	Gloss	Form with same morph. structure and consonant at same prosodic position of RV	Gloss	Form of same lexeme with manifested RV	Gloss
pa**a**am	pa.ám	he/it throbbed	ʃa.**m**áʁ	he guarded	pa.**a**.món	bell
ni**a**er	ni.ér	he shook	di.**b**éʁ	he talked	hit.na.**a**.ʁút	shaking oneself
jitpa**a**el	jit.pa.él	he will be impressed	jit.ka.**t**év	he will correspond	hit.pa.**a**.lút	impression

The correspondence relations are one-to-one relations between segments of the triconsonantal forms and of RV forms. That is to say that in triconsonantal forms such as *katáv* every segment is compared to its parallel segment in the same prosodic position; first root segment, first Vocalic Pattern vowel, second root segment, second Vocalic Pattern, and so on. For example, the triconsonantal verb in *dibéʁ* is compared in (4) with RV verb of the same Morphological Structure *ʃigeá* with a final manifested RV and *niéʁ* with a medial un-manifested RV:

(4.1)
```
ʃ i g é a
| | | | |
d i b é ʁ
| | | | |
n i   é ʁ
```

The data in Tables 4.1–4.5 reveals a remarkable generalization: RVs emerge only when their parallel segment in other forms with the same Morphological Structure is in coda position (though a higher ranked constraint can prevent RV from emerging (Table 4.2)). I argue that in fact RVs emerge when their parallel segment in other forms with the same Morphological Structure is *moraic*.

4.2 Brief relevant language background

4.2.1 The emergence of Root Vowels in Modern Hebrew

RVs emerged from historical pharyngeals which do not have a phonemic status in Modern Hebrew. At the time of the revival of Hebrew, pharyngeals were not adopted by the (originally European) revivers of the language or by the native speakers that followed them. That is, historical *ħ* emerged as *(a)x* and historical *ʕ* emerged as *a*.

Following Faust (2005) I do not assume underlying pharyngeals in the grammar of the language. Pharyngeals never appeared at the surface of General Modern Hebrew (as opposed to Sephardic Modern Hebrew); so, assuming they exist at the lexical level poses the question of how they are learned by children.[26]

For an analysis using underlying pharyngeals (and even geminates) that are never realized at the phonetic level, see Bar-Lev (1977). Bar-Lev's analysis is greatly influenced by the phonology of Tiberian Hebrew, imposing its phonological structures and inventory on General Modern Hebrew to account for opaque phenomena in the language. However, as Bat-El (2006) points out:

> Modern Hebrew was not transmitted but rather (at best) revived […] Modern Hebrew adopted the morphological paradigms of Tiberian

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[26] A similar idea of historical pharyngeal becoming RVs synchronically can be found in Prunet (1996). Prunet argues that in Gurage (Semitic) the historical *ħ* became *a* in some roots.

> Hebrew, including the morpho-phonological alternations. However, it did not adopt the phonology of Tiberian Hebrew. (Bat-El 2006: 7)

Pharyngeals were not surface-true at any stage of the language, and assuming they exist at the UR level and are subsequently deleted seems improbable.

Sephardic Modern Hebrew is a dialect with surface-true pharyngeals (Pariente 2010). One can argue that both dialects have the same phonological lexicon containing pharyngeals but that in General Modern Hebrew they simply disappear at the surface level. Such a scenario would have been plausible had Sephardic Modern Hebrew been the major dialect of Hebrew; however, as Pariente (2010) points out, Sephardic Modern Hebrew is the minor dialect of Hebrew (which has only two dialects) and it is dying out.

In reality, most children acquiring General Modern Hebrew are never exposed to surface-true pharyngeals, so assuming they are somehow acquired by children appears unlikely.

4.2.2 Semitic morphology

One approach to Semitic morphology is *Root-and-Pattern* morphology (McCarthy 1979, 1981). The root usually consists of three consonants that appear in a fixed order. According to McCarthy, the conjugations, called binyanim (sg. binyan) for verbs and mishkalim (sg. mishkal) for nouns, consist of the Vocalic Pattern (the morpheme that determines the quality and the order of the conjugation vowels), the Prosodic Template, which determines the prosodic structure of the conjugation (number of syllables, syllable structure and stress), and a derivational affix, if it exists in a specific conjugation. The Prosodic Template governs the interdigitation of the root consonants and the Vocalic Pattern. The consonantal root encodes the core semantic properties, while the conjugation encodes aspect, mood, voice and other grammatical properties.

The following table overviews the verbal paradigm and some nominal conjugations of some consonantal roots. The verbs are given in the third person singular forms. Prefixes are underlined. The binyanim are abbreviated as B1, B2 and so on.

Table 4.6. Root and template paradigms

root / template	{p,g,ʃ}	{k,t,v}	{ʃ,t,k}
B1 CaCáC	*pagáʃ* 'bump into'	*katáv* 'write'	*ʃaták* 'be quiet'
B2 niCCáC	*nifgáʃ* 'meet'	*nixtáv* 'be written'	-----------------
B3 iCCíC	*ifgíʃ* 'to bring together'	*ixtív* 'dictate'	*iʃtík* 'silence'
B4 CiCéC	-----------------------	-----------------	*ʃiték* 'paralyze'
B5 itCaCéC	-----------------------	*itkatév* 'correspond'	*iʃtaték* 'become silent'
miCCáC	*mifgáʃ* 'meeting'	*mixtáv* 'letter'	-----------------
taCCíC	----------------------	*taxtív* 'dictate'	-----------------

Some elements of this approach were criticized by several later studies. For example, McCarthy and Prince (1986, 1995) in their Prosodic Morphology theory argued that the Prosodic Template can be derived by general prosodic constraints and thus not need be specified as an independent property in Semitic languages. The prosodic structure is determined by language-specific rankings of universal prosodic constraints. According to this approach, the prosodic template is *not* an arbitrary structure, but rather the result of the interaction of universal prosodic constraints.

Bat-El (1994a, 2002, 2003b) and Ussishkin (1999, 2000) offer an approach which is surface-based and eliminates the Consonantal Root completely from the grammar, using stems and words as the base for derivation. Ussishkin (2000) argues that a B1 verb (CaCaC) is the base of every verb paradigm, even if none of the verbs in a specific lexeme is conjugated in B1. Bat-El (2003b) argues for different bases in different paradigms (co-phonology). In this word-based approach to Semitic morphology, an existing word is always the base of derivation (Output-to-Output correspondence). The Vocalic Patterns can be viewed as an affix (Ussishkin 2003) or as a constraint-affix (Bat-El 2003b) that overwrites the vowels of the base (Melodic Overwriting).

(4.2) l **i** m **e** d + Vocalic Pattern {u,a} → l **u** m **a** d

This debate is outside the scope of this paper (see Shimron 2003). It is worth mentioning that each approach defines the term *lexeme* differently. In the Root & Pattern approach, a lexeme is equivalent to the Consonantal Root. In Melodic Overwriting, a lexeme is a stem or a word that is considered as the base for derivation.

To sum up, every word in Nonconcatenative Morphology has to be specified for a binyan or a mishkal in the lexicon (Bat-El 1989), i.e. /g.d.l., B4 (CiCeC)/ → [gi.dél] (Root & Pattern) or /gadál., B4{ie}/ → [gi.dél] (Melodic Overwriting). The interdigitation and the prosodic structure (stress and syllabic structure) are determined by constraint interaction.

Both approaches to Semitic Morphology yield the same outputs but assume different lexical representation of inputs. Since the current study deals with relations between output forms, any approach regarding the formation of the output (Root & Pattern or Melodic Overwriting) can be assumed.

I adopt the Root & Pattern view in this study. However, the UR in the rest of the paper will be given with interdigitation and vocalic pattern for simplicity reasons, i.e. /gadál., B4/ or /g.d.l., B4/ will be given as /gi.del/. The tableaux below demonstrate how this system works.

(4.3) Syllable structure:

/gidel/	ONSET	DEP	MAX	FINALC	*CODA
(a) gid.él	*!				**
☞ (b) gi.dél					*
(c) gi.dé			*(!)	*(!)	
(d) gi.dé.le		*(!)		*(!)	
(e) gid.lé				*!	*

(4.4) Stress:

/gidel/	TROCHEE	ALIGNR	FINALSTRESS	FTBIN
(a) [gí.del]			*!	
(b) [gi.dél]	*!			
☞ (c) gi[dél]				*

Tableaux (4.3) and (4.4) give a fragment of Hebrew grammar regarding syllable structure and stress. The phonology of the language is, of course, more complex (including, for example, morpheme position, moraicity etc.), but the mechanism is the same.

4.3 From Paradigm Uniformity to Grammatical Paradigm Uniformity

It has been observed that surface resemblance arises between words that share a paradigm (Benua 1997; Steriade 2000; McCarthy 2005 among many others). A paradigm is a network of interconnected words sharing a lexeme, but having different Morphological Structure.

To account for surface resemblance effects in morphological truncation, Benua (1997), based on McCarthy and Prince (1995), developed the Transderivational Correspondence Theory (TCT) in which inflected forms can be forced to resemble simplex forms via Output-to-Output constraints. In this theory the simplex form serves as the *base* that complex forms are required to resemble.

Another theory of paradigmatic relations between words was developed around the same time by Kenstowicz (1996). This theory, called Uniform Exponence (UE), deals with paradigms which are not built on a single morphological simplex base. In this theory, Output-to-Output constraints militate for minimizing the difference between the members of a paradigm. Since no base is identified (or can be identified), the constraints are symmetric in the sense that they demand similarity from all members equally. UE demands to minimize the difference between the realizations of the same lexical item in all its appearances within a paradigm.

McCarthy (2005) developed a model of Paradigm Uniformity called Optimal Paradigms (OP). In OP, candidates consist of entire inflectional paradigms, and constraints are symmetric with no privileged base. (Other studies on paradigmatic relations with similar ideas can be found in Steriade 1999, 2000)

In a series of studies Burzio (1994, 1998, 2002a, b, 2005a, b) argued for a radical surface approach to morphology. His approach reduces morphology to Output-Output Faithfulness constraints. Burzio proposes a mechanism of “Representational Entailment Hypothesis” (REH). REH demands that the more two words overlap structurally, the more similar they should be. Words are taken to be connected (as in a paradigm) only via Output-to-Output constraints and no mutual Underlying Representation is assumed to exist. The theory proposed by Burzio regulates relations between different allomorphs of the same lexeme (for a similar idea, see Steriade’s Lexical Conservatism 1999).

None of the approaches mentioned above can account for the alternation of RVs given in Tables 4.1–4.5 due to the simple fact that the manifestation of RVs is not lexeme-dependent, and no generalizations can be drawn by regarding only a lexemic paradigm. All the theories mentioned above explain phonological opacity by imposing similarity demands to other members of a paradigm that share the same lexeme. However, the data in Tables 4.1–4.5 shows that RV manifestation is not consistent throughout a lexemic paradigm, but rather it is regulated by similarity to other words with the same Morphological Structure regardless of the lexemic paradigm.

The correspondence relations developed in this study are in line with Burzio (1994, 1998, 2002a, b, 2005a, b). Burzio studies similarity relations within the domain of verbal conjugations in Italian. In a detailed analysis he shows that output forms are subject to "Multiple Correspondence" relations. Some of these correspondence relations are lexemic in nature; however, some of them are correspondence relations between forms of the same Morphological Structure (Italian participles) and even between words sharing a suffix.

Following Burzio's scheme of Multiple Correspondence, this study illustrates how such a mechanism of paradigmatic relation imposes similarity over lexemic paradigms. This notion is developed in more detail in the next section.

4.3.1 The proposal

4.3.1.1 The grammatical paradigm

This paper argues for correspondence relations between words sharing a *Morphological Structure* (Halle and Marantz 1993). Forms which share a Morphological Structure have the same feature value in all *Grammatical Categories.* Grammatical Categories refers to the set of all possible values of a Morpho-Syntactic Feature (Bybee 1985; Crystal 1985; Hopper 1992; Iscrulescu 2006). For example, the feature *Gender* is represented in inflected forms by the Grammatical Category {female, male}. In addition to the Grammatical Categories Person, Number and Gender, in Semitic morphology the morpho-syntactic system contains the Grammatical Category *conjugation {binyan (B1, B2, B3, B4, B5) or mishkal}*. All forms sharing a Morphological Structure (same value for all Grammatical Categories) construct the Grammatical Paradigm (G-

Paradigm). For example, all forms sharing the Grammatical Categories values: Conjugation {B1}, Person {3rd}, Tense {past}, Gender {male} and Number {singular} compose a G-Paradigm.

Forms inflected in B1 3rd.past.masc.sg. are subject to Output-to-Output constraints militating that they all have the same shape (prosodic structure, number of syllables and the value and order of the vocalic template vowels) as the base.

4.3.1.2 The base

Grammatical Paradigm Uniformity is an asymmetric theory, and Grammatical Paradigm Uniformity constraints demand similarity of a base to all other output forms, but not vice versa. However, verbs (and indeed words) employ multiple shapes for each G-Paradigm. I argue that the base is the most frequent shape in the paradigm. The most frequent shape contains a triconsonantal form (Chomsky 1957: 122 among many others). In the case of 3rd.masc.sg.past. of B1, triconsonantal forms of verbs have the shape *ka.táv* 'write', *ʃa.máʁ* 'guard', *ʁa.ʃám* 'write' etc. All these forms are identical to one another aside from the root consonants. Since the root (lexeme) is irrelevant to the G-Paradigm, we can mark it with a capital C. For example, the base of 3rd.masc.sg.past. of B1 is C_1a.C_2áC_3. Forms that deviate from this shape like *baxá* 'wept' violate a Grammatical Paradigm Uniformity constraint, in this case *baxá* fails to fill the position of the third consonant of the root.

Why Output-to-Output constraints and not templatic constraints? At this point some terminology needs to be clarified. I have formulated the base in templatic terms such as C_1a.C_2áC_3; however, this formulation is used for simplicity reasons only. Grammatical Paradigm Uniformity does not assume that words are subject to identity demands to a template, but rather to identity demands to the shape of other frequent members of the G-Paradigm. For example, the irregular verb *ʃatá* 'drink' does not violate any constraints demanding it will be identical in its shape to C_1a.C_2áC_3, but it violates some Output-to-Output constraints demanding it will be identical in its shape to the frequent regular verbs in the G-Paradigm (*katáv*, *ʃamár* etc.), which are constructed in this shape.

This approach does not make any reference to templates as arbitrary structures, but rather it coincides with the idea that the structure of the template is governed by general and language-specific constraints that relate to prosodic units (Prosodic Morphology; McCarthy and Prince 1986, 1995; for Hebrew see Ussishkin 2000; Adam 2002; Bat-El 2003b).

This approach raises the question of how the base is exactly represented in the grammar of speakers. One approach is to assume that it is represented as a general scheme such as C_1a.C_2áC_3 with no specification of the root consonants. This form resembles a template; however, it is fully specified for prosodic structure (syllable structure, stress etc.). Since prosodic structure is a surface property, this form cannot be regarded as identical to binyan or mishkal or any other sort of template which is lexically specified. This form has to be considered as an output form since its structure is predictable and can be accounted for by the grammar of the language. Every G-Paradigm has such a base. If C_1a.C_2áC_3 is the base of 3rd.masc.sg.past. of B1, C_1aC_2.C_3á is the base for 3rd.fem.sg.past. of B1 (*kat.vá, ʃam.ʁá* etc.). The base is created by adding the feminine suffix *–á* to the masculine form and syncope of the second vowel (*katáv-a → katvá)*. The derivation of 3rd.fem.sg.past. of B1 can be accounted for by the grammar of the language as well and thus does not need to be specified in the lexicon.

To summarize, a base is not a template (or conjugation). It is an output form which is composed of the conjugation with unspecified root consonants and morphological structure (tense, gender, etc.)

Another possibility of representing the base in the grammar is to assume that speakers simply choose a specific triconsonantal verb as a base for RV (and potentially other sub-paradigms), for example $k_1a.t_2áv_3$ for 3rd.masc.sg.past. of B1.

The editor suggests yet a third possibility along the lines of the REH: there is no UR at all, but rather all 3rd.masc.sg.past. of B1 compose a paradigm. In this paradigm the largest group of verb consists of the triconsonantal verbs. This largest group influences the smaller groups of verbs (RV verbs and other irregular verbs). As the editor points out this is a version of the "real verb" possibility with all real verbs as the base.

At this point both ways (scheme or a real verb(s)) seem plausible and which one is the correct one will be left as a matter for further study. For simplicity reasons I will use a real verb as the base when comparing a RV to a triconsonantal root.

4.3.1.3 The constraints

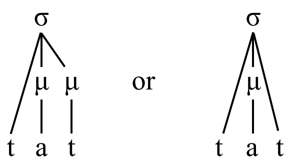
Identity to the base is regulated by Output-to-Output constraints. These constraints are asymmetric, and can relate only to prosodic structure, number of syllables and the value and order of the templatic vowels. These constraints do not regulate the quality of the root consonants (or RVs in this study), since these constraints do not relate to the lexeme, but only to the shape of words.

4.4 Moraic structure in Hebrew

The current analysis assumes the representation of segments linked to a timing tier. In X-slot theory (Levin 1985), every segment is linked to the syllable via X-slots. The X's are time units and lack information about the nature of the segment (vowel or consonant) as opposed to CV theory (Clements and Keyser 1983).

As phonological theory evolved, most phonologists abandoned the X-slot theory in favor of Moraic theory (Hyman 1985; Itô 1986), since Moraic theory makes more accurate predictions regarding weight-related phenomena. Hebrew is a quantity-insensitive language, so most of the analyses of it dismiss the presence of moras in the phonology of the language (though see Landau 1997 for a different view). However, Moraic theory proves most adequate in the analysis of Hebrew RV-related processes, because it differentiates between non-moraic segments and moraic segments. Onsets are presumed universally non-moraic (Hyman 1985; Hayes 1989 among many others, though see Topintzi 2006), nuclei are always moraic, and codas can be either moraic or weightless.

(4.5) Moraic representation:



The emergence of RVs reveals mora-related generalizations: a RV emerges only if its parallel paradigmatic consonant is in coda position, i.e. if it is moraic. In other words, RVs will never appear when their parallel paradigmatic segment is in onset position.

An important point to mention is that codas and vowels are parsed differently in the language; while they are both moraic, a vowel will always create a syllable, but a moraic coda will be parsed as part of the syllable whose nucleus is the preceding vowel. This fact means that every emergence of a RV necessarily violates a Grammatical Paradigm Uniformity constraint militating for corresponding segments to have the same syllabic value. However, since the impact of such a constraint is never noticeable, I assume it is ranked low in the language, and I will not include it in the tableaux.

A less formal notion of Grammatical Paradigm Uniformity is argued by Faust (2005) to analyze RV verbs in Hebrew (though in his terminology it is regarded as regular Paradigm Uniformity). The current analysis is based on Faust's observation that the manifestation of RVs cannot be explained by Paradigm Uniformity constraints that connect words sharing a lexeme, and that another type of constraints that connect words that do not share a lexeme is needed.

The current analysis differs from Faust's analysis in a few crucial points:

(a) The scope of the paradigmatic relations. As in Faust, this study assumes that RV-forms are subject to constraints militating for similarity to triconsonantal forms with the same Morphological Structure (Faust's analysis deals only with the verbal system and triconsonantal verbs are called "whole verbs" in his terminology). In addition, Faust assumes that the past form is the base for the future form, so the future form is also subject to similarity demands to the past form. Furthermore, regular Paradigm Uniformity constraints are also employed in Faust's study. Finally, only the base is assumed to have a UR and all inflected forms are created by inflection of the base form.

The current analysis does not employ any Paradigm Uniformity constraints, nor does it employ any past/future relations. It is not to say that such relations do not exist (Paradigm Uniformity constraints certainly exist, see Bat-El 2008), but rather the analysis does not require such relations. All phenomena are explained in means of IO and Grammatical Paradigm Uniformity constraints.

(4.6) Constraint scheme:

dibéʁ	dibáʁti
(3^{rd}.sg.mas.past.)	(1^{st}.sg.fem/mas.past.)
↓ GPU	↓ GPU
ʃigéa	ʃigáti
(3^{rd}.sg.mas.past.)	(1^{st}.sg.fem/mas.past.)
↑ IO	↑ IO
/ʃigea/	/ʃigea-ti/

(b) The motivation for the alternation. Faust analyzes verbs as iambic and binary. The motivation for the manifestation or the non-manifestation of the RVs is foot size and alignment. Such an analysis can deal with margin RV (i.e. initial and final) but not with medial RVs. In the current analysis I argue that moraicity and prosodic structure of a trochaic system explain the alternation better. Moraicity indeed explains all the alternations in the manifestation of RVs, margin and medial.

4.4.1 OT analysis: moraic structure without weight sensitivity

As mentioned above, the manifestation of RV depends on the moraic structure of the corresponding segment in the G-Paradigm. The constraint in (4.7) encodes this similarity demand.

(4.7) IDENTMORAICSTRUCTURE^{GPU} (IDμ^{GPU}):

Let A be a segment in S_1 and B be a segment S_2. If A and B are in a correspondence relationship, then B must have the same moraic structure as A.
(S_1 = base. S_2 = any output form sharing the G-Paradigm of the base).

The theoretical assumptions given above make the analysis extremely simple. By ranking IDμ^{GPU} above MAX we get the right outcome for most forms in the language.

(4.8) Initial RV[27]:

/**a**omed/ base: **k**o.tév	IDμ^{GPU}	MAX
a) **a**$^{\mu}$.o.méd	*!	
☞ b) o.méd		*

In tableau (4.8) the UR contains *a* at the beginning of the word. In the faithful candidate (a) it emerges and so it violates the high-ranking constraint IDμ^{GPU}, since its corresponding segment is in onset position. The emergence of the vowel creates a mismatch in the moraic structure between the two segments. The winning candidate (b) omits the UR *a*, violating MAX but satisfying IDμ^{GPU}.

(4.9) Word-medial RV that is parallel to a moraic segment in the paradigm:

/niamad/ base: ni**x**$^{\mu}$.táv	IDμ^{GPU}	MAX
a) ni.mád		*!
☞ b) ne.**e**$^{\mu}$.mád		

In tableau (4.9) the UR contains *a* in the middle of the word in a position that is occupied by a coda segment in the G-Paradigm. In the faithful candidate (b) it emerges creating a mora and satisfying both IDμ^{GPU} and MAX. Candidate (a) omits the UR *a*, thus violating MAX and being ruled out.

(4.10) Word-medial RV that is parallel to a non-moraic segment in the paradigm:

/niaeʁ/ base: si.**p**éʁ	IDμ^{GPU}	MAX
a) ni.**a**$^{\mu}$.éʁ	*!	
☞ b) ni.éʁ		*

In tableau (4.10) the UR contains *a* in the middle of the word in a position that is occupied by an onset in other forms in the G-Paradigm. In the faithful candidate

[27] Throughout the analysis, I will not present candidates that change a RV into a consonant (*aomed → joméd). Such candidates can be ruled out by IDENT[consonantal]. Since such a solution is never employed by the language, I leave it out for simplicity.

(a) it emerges creating a mora and violating the high-ranking constraint IDμ^{GPU}. Candidate (b) omits the UR *a*, thus satisfying IDμ^{GPU}, so it wins, although it violates MAX.

(4.11) Word-final RV:

/ʃavu**a**/ base: ta.pú**z**^{μ}	IDμ^{GPU}	MAX
a) ʃa.vú		*!
☞ b) ʃa.vú.**a**^{μ}		
☛ c) ʃa.vu.**á**^{μ}		

By the ranking given so far, candidates (b) and (c) in (4.11), which preserve the UR *a*, are more optimal than candidate (a), which omits the UR *a*. Candidates (b) and (c) are both optimal under this ranking. The actual form in the language exhibits penultimate stress; however, the default stress in Hebrew is final, which would make candidate (c) the better choice.

In candidate (c), *ʃa.vu.**á**^{μ}*, the last radical of the root (RV) serves as the stress-bearing unit. I argue that such a situation violates a Grammatical Paradigm Uniformity constraint, which demands that stress will fall at the same vowel throughout the G-Paradigm (in this case; the final vowel of the vocalic pattern):

(4.12) IDENTSTRESS^{GPU} (IDSTRSS^{GPU}):

Let A be a vowel in S_1 and B be a vowel S_2. If A and B are in a correspondence relationship, then if A is stressed B is stressed and if A is unstressed B is unstressed.
(S_1 = the base. S_2 = any output form sharing the G-Paradigm of the base).

IDSTRSS^{GPU} must outrank the constraint responsible for final stress in Hebrew i.e. FINALSTRESS. ALIGNR(Ft, PrWd) rules out any candidate that satisfies IDSTRSS^{GPU} but creates a non-aligned foot.

(4.13) FINALSTRESS:

The final syllable in the prosodic word is stressed.

(4.14) ALIGNR(Ft, PrWd):

The right edge of the foot aligns with the right edge of the prosodic word.

(4.15) Word-final RV with stress constraints:

/ʃavu**a**/ base: ta.pú**z**$^{\mu}$	IDSTRSS^{GPU}	ALIGNR (Ft, PrWd)	IDμ^{GPU}	MAX	FINAL STRESS
a) ʃa[vú]				*!	
☞ b) ʃa[vú.**a**$^{\mu}$]					*
c) ʃa.vu[**á**$^{\mu}$]	*!				
d) ʃa[vu.**á**$^{\mu}$]	*!				
e) ʃa[vú]**a**$^{\mu}$		*!			*

The ranking employed in (4.15) predicts that forms with final RV will manifest it as an unstressed vowel. This ranking fails in explaining forms with a final RV that is preceded by another *a* as shown in (4.16):

(4.16) Word-final position *a* that is preceded by another *a*:

/nasaa/ base: ka.tá**v**$^{\mu}$	IDSTRSS^{GPU}	ALIGNR (Ft, PrWd)	IDμ^{GPU}	MAX	FINAL STRESS
☞ a) na[sá]				*!	
☛ b) na[sá.**a**$^{\mu}$]					*
c) na.sa[**á**$^{\mu}$]	*!				
d) na[sá]**a**$^{\mu}$		*!			*

By the ranking given so far, candidate (b), which preserves the UR *a*, is more well-formed than the actual form in the language (a), which omits the UR *a*. In candidate (b) na[sá.**a**$^{\mu}$] the stress pattern is faithful to the base, i.e. the last syllable of the vocalic pattern serves as the stress-bearing unit, thus it must be parsed as a binary trochaic foot. I argue that this form is ruled out by OCP$_{foot}$[V$_i$V$_i$].

(4.17) OCP$_{foot}$[V$_i$V$_i$]:[28]
Identical vowels are forbidden within the domain of a foot.

[28] This constraint cannot be true for words like *táam* and *náaʁ*. Such words belong to a large number of native nouns that are disyllabic, with the accent falling on the first syllable. However, most of their plurals have the form CCaC + the plural suffix *-ím*/*-ót* with final accent. Traditionally they are known as the “Segolates”. This group of nouns is analyzed by invoking extrametricality in Bat-El (1993). Bolozky (1995) and Becker (2003) characterize its plural form as templatic. Following Bat-El (1993) I assume that the last syllable is extrametrical, so the footing is [tá]{am}. This footing does not violate OCP$_{foot}$[V$_i$V$_i$].

(4.18) Word final position a that is preceded by another a with OCP$_{foot}$[V$_i$V$_i$]:

/nasaa/ base: ka.tá**v**$^{\mu}$	ID STRSS^{GPU}	ALIGNR (Ft, PrWd)	OCP$_{foot}$ [V$_i$V$_i$]	IDμ^{GPU}	MAX	FINAL STRESS
☞ a) na[sá]					*	
b) na[sá.**a**$^{\mu}$]			*!			*
c) na.sa[**á**$^{\mu}$]	*!					
d) na[sá]**a**$^{\mu}$		*!				*

4.4.1.1 Suffixed forms

In the verb system, vowel-initial suffixes attract stress whereas consonant-initial suffixes do not. The analysis is shown to work for both cases:

(4.19) Evaluation of verbs with vowel initial suffixes:

/ʃamaa-u/ base: lam.**d**ú	ID STRSS^{GPU}	ALIGNR (Ft, PrWd)	OCP$_{foot}$ [V$_i$V$_i$]	IDμ^{GPU}	MAX	FINAL STRESS
a) ʃa.m**a**$^{\mu}$[ú]				*!		
☞ b) ʃa[mú]					*	

In tableau (4.19) the UR is *ʃamaa-ú* with *a* (RV) and *-u*. The faithful candidate (a) contains the UR *a*, and thus violates IDμ^{GPU}. At this point it is important to notice that in the regular paradigm the second *a* of the stem is deleted (**lam**a**-dú* → *lamdú*). This syncope is argued by Bat-El (2008) to emerge due to the impact of the OO constraint DEP$_{\sigma}$ (‘A derived form has the same number of syllables as its base’). The winning candidate (b) omits the UR *a*, creating a violation of MAX, but satisfying IDμ^{GPU}.

(4.20) Evaluation of verbs with consonant-initial suffixes:

/ʃamaa-ti/ base: ka[tá**v**$^{\mu}$.ti]	ID STRSS^{GPU}	ALIGNR (Ft, PrWd)	OCP$_{foot}$ [V$_i$V$_i$]	IDμ^{GPU}	MAX	FINAL STRESS
☞ a) ʃa[má.ti]				*	*	*
b) ʃa.ma[**á**$^{\mu}$.ti]	*!					*
c) ʃa[má.**a**$^{\mu}$]ti		*(!)	*(!)			*

In tableau (4.20) the UR is *ʃamaa-ti* with RV *a*. The faithful candidates (b) and (c) contain the UR *a* satisfying IDμ^{GPU}; however, candidate (b) violates IDSTRSS^{GPU} and candidate (c) violates OCP$_{foot}$[V$_i$V$_i$] and they are both ruled out. In the winning candidate (a) the RV *a* is omitted, satisfying the high ranked constraints IDSTRSS^{GPU} and OCP$_{foot}$[V_iV_i] though violating IDμ^{GPU} and MAX.

The final ranking is given in (4.21).

(4.21) The ranking:

$$
\begin{array}{ccc}
\text{IDSTRSS}^{GPU} & \text{OCP}_{foot}[a] & \text{ALIGNR} \\
\searrow & \downarrow & \swarrow \\
 & \text{ID}\mu^{GPU} & \\
 & | & \\
 & \text{MAX} & \\
 & | & \\
 & \text{FINALSTRESS} &
\end{array}
$$

4.4.1.2 Exception: the future form of B2

The analysis given above has one exception; in the future form of B2, the sequence *ea* becomes *a* (and does not stay *ea*).

(4.22)	iʃam**á**	'he will be heard' (UR jiʃam**ea**)	cf. ikanés 'he will enter'
	ikan**á**	'he will surrender' (UR jikan**ea**)	cf. ikanés 'he will enter'

A possible solution is mentioned in Faust (2005), following Dor (1995). If we assume that the *e* in the regular paradigm is epenthetic, i.e. /ji-gamʁ/ → jigam**é**ʁ, then a root with a final RV will not require this vowel: /ji-ʃam**a**/ → jiʃam**á**. This solution raises two problems: (a) as Faust mentions, speakers will have to deduce the structure of the regular paradigm from the sub-paradigm of the irregular RV roots. The regular paradigm gives no phonological cue that this vowel is epenthetic. (b) In the regular paradigm this vowel is stressed (*jigaméʁ*) whereas in Hebrew epenthetic vowels are never stressed.

The second solution given by Faust formulates a special constraint for B2 future. I agree with Faust that the above-mentioned two solutions are inadequate and a better explanation is yet to be proposed.

4.4.2 The quality of Root Vowels

Another issue to be dealt with is the quality of the vowels in the vowel sequences created by the adjacency of a RV and a following/preceding vowel. As shown in (4.23), *ia* sequence changes to *ee* in the verb system (a) and to *aa* in the noun system (b). If the cluster of vowels is within a foot, it does not change (c).

(4.23) Vowel sequences:

a.	n**ee**[mád]	'he stood up' (UR n**ia**mad)	cf. niʁdám	'he fell asleep'
b.	m**aa**[mád]	'status' (UR m**ia**mad)	cf. migdál	'tower'
c.	ʃa[vú.a]	'week' (UR ʃavua)	cf. ta[púz]	'orange'
	hiʃ[pí.a]	'he influenced' (UR hiʃpia)	cf. hixtív	'he dictated'

I argue that in Hebrew a sequence of two vowels of non-identical height is forbidden. Using Local Conjunction (LC) (Smolensky 1995), a combination of the height demands for the features [+high] and [+low] can be formalized as a single constraint. In LC two constraints can be combined; a combined constraint is violated only by candidates that violate both combining constraints. The combined constraint is ranked above its combining constraints. The relevant constraints to be combined in this case are the IDENT height constraints IDENT[high] and IDENT[low] into IDENT[high]&IDENT[low]. The other relevant constraints are AGREE[high] and AGREE[low] (as formulated in Baković 2000).

(4.24) IDENT[high]&IDENT[low]:
Corresponding segments have the same value of the features [high] and [low].

(4.25) AGREE[high]: Adjacent vowels must agree in the feature [high].

(4.26) AGREE[low]: Adjacent vowels must agree in the feature [low].

(4.27) Verb system evaluation:

/n**ia**mad/	AGREE [high]	AGREE [low]	IDENT[high] &IDENT[low]	IDENT [high]	IDENT [low]
☞ a) n**ee**mád				*	*
b) n**ea**mád		*!		*	
c) n**ie**mád	*!				*
d) n**ia**mád	*(!)	*(!)			
e) n**aa**mád			*!	*	*
f) n**ii**mád			*!	*	*

Tableau (4.27) demonstrates this ranking: all candidates containing a sequence of two vowels that differ in the value of [high] and [low] (b, c and d) are ruled out by AGREE[high] or AGREE[low]. Candidates changing the UR value of [high] and [low] in the same locus (i.e. the same vowel) are ruled out by IDENT[high]&IDENT[low] (e changes the affix vowel from +high to -high and from –low to +low, and f changes the RV from -high to +high and from +low to –low). The winning candidate (a) changes the value of [high] in the first vowel and the value of [low] in the second vowel, thus violating IDENT[high] and IDENT[low] but not the combined constraint IDENT[high]&IDENT[low], since the violations are not in the same locus.

In the noun system the output also contains two identical vowels, e.g. ***maa**mád*, although both vowels are *a* and not *e*. I argue that the identical quality of both vowels is due to the impact of AGREE height constraints which demand identity between adjacent vowels regarding height. However, the quality of the RV does not change in the noun system. This demand of faithfulness of height to a RV can be encoded in the positional faithfulness constraint in (4.28) (Beckman 1998). This constraint is indexed for nouns (McCarthy and Prince 1995; Pater 2000).

(4.28) IDENTROOT[low]$_{nouns}$:
A root segment and its output correspondent must have identical specifications for the feature [low].

This constraint must outrank IDENT[high]&IDENT[low] as shown in tableau (4.29).

(4.29) Noun system evaluation:[29]

/m**ia**mad/	AGREE [high]	AGREE [low]	IDENT ROOT [low]$_{nouns}$	IDENT[high] &IDENT[low]	IDENT [high]	IDENT [low]
a) m**ee**mád			*!		*	*
b) m**ea**mád		*!			*	
c) m**ie**mád	*(!)		*(!)			*
d) m**ia**mád	*(!)	*(!)				
☞ e) m**aa**mád				*	*	*
f) m**ii**mád			!	*	*	*

[29] Nouns are more faithful than verbs, in accordance with Smith's (1997) observations.

In tableau (4.29) all candidates containing a sequence of two vowels that differ in the value of [high] and [low] (b, c and d) are ruled out by AGREE[high] or AGREE[low]. Candidates (a) and (f) change the value of [low] (+low to –low) in the second vowel (a RV), thus violating IDENTROOT[low]$_{nouns}$ and being ruled out. The winning candidate (e) does not change the RV values for [low], thus not violating IDENTROOT[low]$_{nouns}$.

As shown in (4.23), if the vowel sequence contains a stressed vowel, the vowels do not agree in the values of [high/low]. I argue that this is the result of IDENTITY[high/low]$_{Foot}$ which are undominated and militate against changing the height values of vowels within a foot.

(4.30) IDENTITY[high]$_{Foot}$:
Correspondent segments contained in a prosodic head must be identical for high.

(4.31) IDENTITY[low]$_{Foot}$:
Correspondent segments contained in a prosodic head must be identical for low.

(4.32) Vowel cluster within a foot:

/ʃavua/	IDENT [high]$_{Foot}$	IDENT [low]$_{Foot}$	OCP$_{foot}$ [V_iV_i]	AGREE [high]	AGREE [low]	IDENTROOT [low]$_{nouns}$	IDENT [high] &IDENT [low]	IDENT [high]	IDENT [low]
a) ʃa[vú.u]	*(!)	*(!)	*(!)			*	*	*	*
☞ b) ʃa[vú.a]				*	*				
c) ʃa[vá.a]	*(!)	*(!)	*(!)				*	*	*
d) ʃa[vú.e]		*!		*		*			*
e) ʃa[vó.a]	*!				*			*	

At this point any reader familiar with the structure of Hebrew will notice that this analysis cannot account for numerous instances of existing non-identical vowel sequences in the language, for example, the forms *ni[ér]* ‘he will shake’ in B4 and *jitpa[él]* ‘he will be impressed’ in B5. The lack of agreement between the vowels in the sequence in these instances cannot be attributed to OCP$_{foot}$[V_iV_i], since the first vowel does not belong to the foot. The data reveals that agreement is forced on some binyanim and mishkalim, but not on others. For example, in the verb system agreement is active in B1, B2 and B3, but never in B4 and B5. The explanation of these different behaviors can be found in the work of Bat-El (2003b), who argues that Vocalic Patterns (VP) are to be viewed as constraints, and "An input has to be specified for the binyan required in the output, and the specification on the VP constraint has to match this requirement" (ibid. p.10). For example, the VP of B4 is {ie}, as in the regular verb ***niʃék*** 'he kissed'. Any change in the vowel's quality will violate the B4 VP constraint.

Using examples from denominative verbs Bat-El shows that VP constraints are violable (as any OT constraints). The data from Hebrew exhibits an interesting generalization: *agreement affects only RVs and affix vowels, but not VP vowels*. Agreement effects take place only in B2 and B3. In these binyanim an infix is added before the VP; *ni-* in B2 and *hi-* in B3. The vowels affected by AGREE are never part of the VP; they are always part of the infix or the root. This behavior suggests that all VP constraints are ranked above the agreement constraints. Tableau (4.33) demonstrates this ranking using B4. B4{ie} must outrank the agreement constraint. (Remember that the RV is omitted in the surface).

(4.33) B4 evaluation:

/niaer/	B4{ie}	OCP$_{foot}$ [V_iV_i]	AGREE [high]	AGREE [low]	IDENTROOT [low]$_{nouns}$	IDENT [high] &IDENT [low]	IDENT [high]	IDENT [low]
a) ne[eʁ]	*!						*	
☞ b) ni[eʁ]			*					
c) ni[iʁ]	*!							*

The vocalic patterns of past tense Hebrew verbs are given in Table 4.7.

Table 4.7. Vocalic Patterns

B1	CaCaC VP{aa}
B2	ni-CCaC {a}
B3	hi-CCiC {i}
B4	CiCeC {ie}
B5	hit-CaCeC {ae}

This list of vocalic patterns is different than the one presented in Bolozky and Schwarzwald (1992) and Bat-El (2003b), who consider all vocalic patterns as disyllabic and thus consider only the consonant as a prefix in B2 and B3.

Table 4.8. Vocalic Patterns (Bolozky and Schwarzwald 1992; Bat-El 2003b)

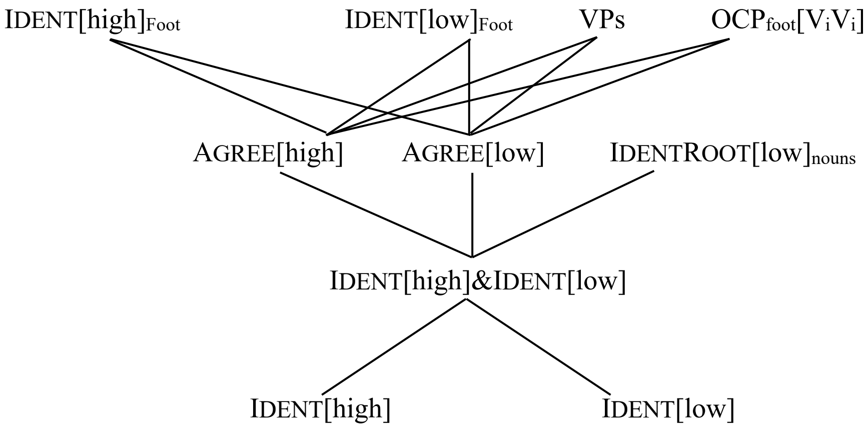
B1	CaCaC VP{aa}
B2	n-iCCaC {ia}
B3	h-iCCiC {ii}
B4	CiCeC {ie}
B5	hit-CaCeC {ae}

However, as was shown above, the division offered in this paper captures the different behavior of the Vocalic Patterns on the one hand and the prefix vowels on the other hand, with regard to agreement restrictions.[30]

[30] This system however produces stems that are not disyllabic. This is of no consequences since the structure of verbs is still mostly disyllabic, composed of VP vowels in B1 and B4 and of a prefix vowel and a VP vowel in B2 and B3.

As mentioned above, only RVs and affix vowels are affected by agreement. RVs are always *a*; however, the values of affix vowels are also restricted in the language. Affix vowels are always *i* or *a*. This means that vowel sequences affected by agreement are *ia* and *aa* (the latter is, of course, already in agreement).[31]

(4.34) Ranking of vowel quality constraints:



[31] A list of the most frequent affixed mishkalim is given in the following table of affixed mishkalim in Modern Hebrew:

Mishkal	**Example**	**Gloss**	**Example**	**Gloss**
maCCéC	mavʁég	screwdriver	maʃpéx	funnel
maCCeCá	makdexá	drill (tool)	mat͡slemá	camera
miCCáC	miʃtáʁ	regime	mivt͡sáʁ	fortress
miCCaCá	milxamá	war	miʃtaʁá	police
tiCCóCet	tiʁgólet	drill	tixtóvet	correspondence
taCCíC	taʁgíl	exercise	taxtív	dictate
taCCúC	taʃlúm	payment	tamʁúʁ	road sign
taCCuCá	tavʁuʔá	sanitation	taxbuʁá	transport
miCCéCet	mivʁéʃet	brush	mizxélet	sled
ʔaCCaCá	ʔazkaʁá	alarm	ʔavxaná	diagnosis
miCCóC	mit͡sbóʁ	accumulation	mizmóʁ	psalm

4.4.2.1 Exception: the future form of B1

In the future form of B1, the sequence *ia* becomes *aa* (and not *ee*):

(4.35) j**aa**mód 'he will stand up' (UR j**ia**mod) cf. iʃmóʁ 'he will guard'
j**aa**zóv 'he will leave' (UR j**ia**zov)

The historical reason for this behavior is that the original vowel was *a* and at some point *a*'s in unstressed syllables became *i*. This did not happen before a pharyngeal. The alternation was adopted in Modern Hebrew even though the pharyngeal was not (see §4.2.1).

Faust (2005) argues that the prefix is actually *jV*, i.e. the vowel is not specified for height or backness in the lexicon. The resulting *aa* sequence is achieved by agreement to the RV. To explain why the prefix vowel is *i* in regular (triconsonantal) roots and not the default epenthetic vowel *e* (***ji****ʃmóʁ* not **jeʃmóʁ)*, Faust assumes it is influenced by the glide. This outcome is predicted under the ranking given in (4.36):

(4.36) B1 future:

/j**V**-**a**mod/		OCP_{foot} $[V_iV_i]$	AGREE [high]	AGREE [low]	IDENTROOT $[\text{low}]_{\text{nouns}}$	IDENT [high] &IDENT [low]	IDENT [high]	IDENT [low]
	a) j**ia**[mód]		*!	*				
☞	b) j**aa**[mód]							
	c) j**ee**[mód]							*!
	d) j**ii**[mód]					*!	*	*

Candidate (a) violates agreement and is ruled out. All other candidates satisfy agreement; however, candidate (b) is the optimal one since it does not violate any identity constraint.

This analysis is problematic for two reasons:

1. All other prefixes have *i* as their vowel (***ti****ʃmóʁ*, ***ni****ʃmóʁ* etc.). This *i* has to be lexical and not represented as just *V* in the UR. Were this vowel just *V* in the lexicon, it would not surface as *i*, since these prefixes do not begin with a glide.

The expected vowel would be the default vowel in Hebrew *e*. Faust indeed assumes that only the 3^{rd}.masc.sg. prefix has no vowel specification and all other prefixes are specified for *i* in the UR (*ti-, ni*). However, such a division between the 3^{rd}.masc.sg. prefix and all other prefixes raises the question of why only this prefix is unspecified for the vowel quality, while all others are fully specified? Furthermore, in all other binyanim the 3^{rd}.masc.sg. prefix is also fully specified, e.g. B2 *je-* B3 *ja-* B4 *je-* (We cannot assume these vowels not to be fully specified, since hadn't they been, they would have surfaced as *i* due to the glide according to Faust's analysis). Again, such a division between the 3^{rd}.masc.sg. prefix in B1 and the 3^{rd}.masc.sg. prefix in all other binyanim seems arbitrary.

2. A more serious problem is that this analysis assumes that speakers (and children acquiring the verbal system of Hebrew) have to deduce that the structure of the 3^{rd}.masc.sg. prefix of B1 is *jV-* from irregular verbs (RVs verbs), while there is no phonological cue in the regular paradigm that suggests that this vowel has no value specification.

It seems that speakers have to learn that 3^{rd}.masc.sg. of B1 acts differently than other verb paradigms and actually acts like the noun system. This behavior may suggest that the difference between verbs and nouns is collapsing in the language.

4.5 What happened to historical *ħ* in Modern Hebrew?

This section deals with the manifestation of the unvoiced pharyngeal in Modern Hebrew. As mention in section 4.2.1, Hebrew has no pharyngeal in its consonant inventory. The unvoiced pharyngeal *ħ* emerged as *x* or *ax* on the surface. I assume that the grammar of Hebrew differentiates between *x* that emerged from the shift *ħ* → *x* and *x* that did not.

The following shifts occurred during the history of Hebrew[32]:

(4.37) The historical development of dorsal fricatives

Tiberian Hebrew ħ ⟶ ax
Tiberian Hebrew K ⟶ K[33]

[32] For the sake of simplicity, I skip intermediate stages in the history of the language.

[33] Capital K represents an archiphoneme: [x] post-vocalically and [k] elsewhere.

Velar fricatives have two origins in Modern Hebrew. This is of course a historical observation that bears no significance to a synchronic analysis of the language. However, the two phonemes act differently synchronically as well: the consonant that emerged from a pharyngeal always surfaces as the fricative *x* and this consonant is sometimes preceded by the vowel *a*; the consonant that emerged from /K/ never surfaces as [ax] and is subject to post-vocalic spirantization (alternates between *k* and *x* – see Adam 2002). These phonological cues help a learner of Hebrew to establish two distinct phonemes: *the historical* ħ *that became* /ax/ *and the historical* K *that stayed* /K/.

4.5.1 Generalizations

a. *ax* that is parallel to a moraic consonant in the G-Paradigm

[ax] in word-final position if the preceding vowel is not [a]:

Table 4.9. [ax] in word-final position where the preceding vowel is not [a]

UR	Surface Form	Gloss	A form with the same MS and a consonant at the same prosodic position of the RV	Gloss
ʃati**ax**	ʃa.tí.**ax**	carpet	ʃa.tí**l**	seedling
hivti**ax**	hiv.tí.**ax**	he promised	hi.txí**l**	he began
himli**ax**	him.lí.**ax**	he salted	hit.xí**l**	he began

If the preceding vowel is *a*, only the consonant will emerge:

Table 4.10. [ax] in word-final position where the preceding vowel is [a]

UR	Surface Form	Gloss	A form with same MS and consonant at same prosodic position of RV	Gloss	A form of the same lexeme with manifested RV	Gloss
laka**ax**	la.ká**x**	he took	la.má**d**	he studied	lo.ké.**ax**	he takes
miʃta**ax**	miʃ.tá**x**	surface	mig.dá**l**	tower	hiʃ.tí.ax	he flattened

If a vowel appears before the *ax*, coalescence occurs:

Noun system: *i* + *ax* coalesce to *a* and *a* + *ax* coalesce to *a*:

Table 4.11. Noun system coalescence

UR	Surface Form	Gloss	A form with same MS and consonant at the same prosodic position of *ax*	Gloss
mi**ax**nak	m**ax**.nák	suffocation	m**ig**.dál	tower
mi**ax**laka	m**ax**.la.ká	department	m**iʃ**.ta.ʁá	police
ma**ax**beʁet	m**ax**.bé.ʁet	notebook	'm**ik**.tér.et	pipe

Verb system: *i* + *ax* coalesce to *e* (in B2 and B3):

Table 4.12. Coalescence

UR	Surface Form	Gloss	A form with same MS and consonant at the same prosodic position of *ax*	Gloss
n**iax**nak	n**ex**[nák]	he choked	n**ig**[máʁ]	it was finished
h**iax**lit	h**ex**.lít	he decided	h**ig**.díl	he enlarged

b. ax that is parallel to a non-moraic consonant in the G-Paradigm will appear as x

Table 4.13. Word-initial

UR	Surface Form	Gloss	A form with the same MS and a consonant at the same prosodic position of *ax*	Gloss
axaveʁ	**x**a.véʁ	friend	**g**a.déʁ	fence
axaʃav	**x**a.ʃáv	he thought	**l**a.mád	he studied

Table 4.14. Word-medial

UR	Surface Form	Gloss	A form with the same MS and a consonant at the same prosodic position of *ax*	Gloss
hat**ax**ala	hat.**x**a.lá	beginning	haʃ.**p**a.lá	humiliation
ma**ax**aʁ	ma.**x**áʁ	tomorrow	na.**h**áʁ	river
ni**ax**em	ni.**x**ém	he comforted	ki.**b**él	he received

4.5.2 Analysis

4.5.2.1 B2 and B3 coalescence

As mentioned above, when the *ax* phoneme is preceded by a vowel and this sequence is not in a foot (i.e. in B2 and B3), coalescence occurs. The pattern of the coalescence is as follows: ia→ e.

In features we can formulate the pattern as V_1[+high–low]V_2[–high+low] → $V_{1,2}$[–high–low]. Since coalescence takes place, the anti-coalescence constraint UNIFORMITY (McCarthy and Prince 1995) must be violated.

(4.38) UNIFORMITY:
No output segment has multiple correspondents in the input.

I argue that manifesting both the consonant and the vowel of the *ax* phoneme violates a one-to-one correspondence constraint. This GPU constraint militates against additional segments in forms with *ax*:

(4.39) ONETOONE^{GPU}:
Every segment of S_1 has one correspondent segment in S_2 and every segment of S_2 has one correspondent segment in S_1.
(S_1 = base, S_2 = any output form sharing the G-Paradigm of the base)

(4.40) Verb system coalescence:

/niaxnak/ base: ni**l**$^{\mu}$mád	AGREE [high]	AGREE [low]	MAX	ONETOONE^{GPU}	IDENT [high] &IDENT [low]	UNIFORMITY	IDENT [high]	IDENT [low]
a) ni.**a**$^{\mu}$**x**$^{\mu}$[nák]	*!	*		*				
☞ b) ne$^{\mu}_{1,2}$x$^{\mu}$[nák]						*	*	*
c) ni$^{\mu}_{1,2}$x$^{\mu}$ [nák]					*!	*	*	*
d) na$^{\mu}_{1,2}$x$^{\mu}$ [nák]					*!	*	*	*
e) ni**x**$^{\mu}$[nák]			*!					
f) n**a**$^{\mu}$**x**$^{\mu}$[nák]			*!					
g) ne.**e**$^{\mu}$[nák]			*!				*	*
h) ne.**e**$^{\mu}$**x**$^{\mu}$ [nák]				*!			*	*

In tableau (4.40), the UR contains the phoneme *ax* in the prosodic position that is occupied by a root consonant in the GP. Candidate (a) is the faithful candidate which does not delete or change any segment of this phoneme, it thus violates the agreement constraints. Candidates (e), (f) and (g) delete the vowel of the *ax* phoneme, the suffix vowel or the root consonant respectively, so they are ruled out by MAX. Candidates (b), (c) and (d) fuse the prefix vowel and the RV. IDENT[high]&IDENT[low] is the combined constraint that militates against changing both the high and the low values of a vowel. Candidate (c) changes the RV from *a* to *i*, thus violating this constraint (+low to –low and –high to +high), and candidate (d) changes the prefix vowel from *i* to *a* (–low to +low and +high to –high), thus violates IDENT[high]&IDENT[low] as well. Candidate (h) changes the prefix vowel from *i* to *e* and the RV from *a* to *e*. These changes do not violate IDENT[high]& IDENT[low]. However, this form has two segments (*ax*) in a prosodic position that has only one segment in the triconsonantal form. Such a situation violates ONETOONE^{GPU}. The winning candidate (b) changes the RV from *a* to *e* (+low to –low) and the prefix vowel from *i* to *e* (+high to –high), but it does not change both values in the same vowel, so it does not violate the combined constraint IDENT[high]&IDENT[low]. It does violate the uniformity constraint (as all the coalescence candidates do) which is ranked low.

In the noun system, the sequence *i+a* becomes *a*. I argue that this coalescence is due to the ranking of the positional faithfulness constraint IDENTROOT[low]$_{nouns}$ over IDENT[high]&IDENT[low].

(4.41) Noun system coalescence:

miaxnak/ base: mi**g**$^{\mu}$dál	AGREE [high]	AGREE [low]	MAX	ONETOONE^{GPU}	IDENT ROOT [low]$_{nouns}$	IDENT [high] &IDENT [low]	UNIFORMITY	IDENT [high]	IDENT [low]
a) mi.**a**$^{\mu}$**x**$^{\mu}$[nák]	*!	*		*					
b) me$^{\mu}_{1,2}$x$^{\mu}$[nák]					*!		*	*	*
c) mi$^{\mu}_{1,2}$x$^{\mu}$ [nák]					*!	*	*	*	*
☞ d) ma$^{\mu}_{1,2}$x$^{\mu}$ [nák]						*	*	*	*
e) mi**x**$^{\mu}$[nák]			*!						
f) m**a**$^{\mu}$**x**$^{\mu}$[nák]			*!						
g) me.**e**$^{\mu}$[nák]			*!		*			*	*
h) me.**e**$^{\mu}$**x**$^{\mu}$ [nák]				*!	*			*	*

4.5.2.2 *ax* within a foot

When the *ax* phoneme is in word-final position, it is realized as *ax* and not as just *x*. However, the ranking so far predicts that the optimal candidate is the candidate that fuses the stressed vowel and the RV:

(4.42) Evaluation of forms with final *ax*:

/tapuax/ base: kadúʁ$^{\mu}$	AGREE [high]	AGREE [low]	MAX	ONETOONE^{GPU}	IDENT ROOT [low]$_{nouns}$	IDENT [high] &IDENT [low]	UNIFORMITY	IDENT [high]	IDENT [low]
☞ a) ta[pú.**a**$^{\mu}$**x**$^{\mu}$]	*	*!		*					
b) ta[pú**x**$^{\mu}$]			*!						
c) ta[pú.**a**$^{\mu}$]	*	*!	*						
☛ d) ta[pó$_{1,2}$**x**$^{\mu}$]					*		*	*	*

I argue that FTBN prevents coalescence within a foot, as shown in (4.43).

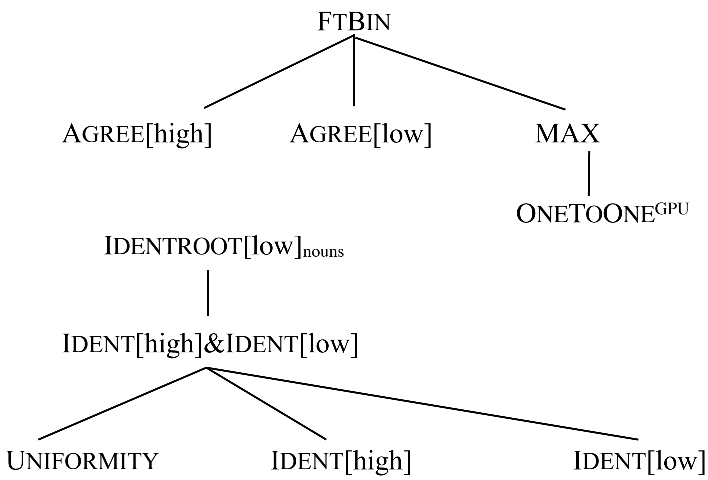
(4.43) Evaluation of forms with final *ax*:

/tapuax/ base: kadúʁ$^{\mu}$	FTBN	AGREE [high]	AGREE [low]	MAX	ONETOONE^{GPU}	IDENT ROOT [low]$_{nouns}$	IDENT [high] &IDENT [low]	UNIFORMITY	IDENT [high]	IDENT [low]
☞ a) ta[pú.**a**$^{\mu}$**x**$^{\mu}$]		*	*		*					
b) ta[pú**x**$^{\mu}$]	*!			*						
c) ta[pú.**a**$^{\mu}$]		*	*	*!						
d) ta[pó$_{1,2}$**x**$^{\mu}$]	*!					*		*	*	*

In tableau (4.43) candidate (a) realizes the vowel and the consonant of the UR *ax*. Candidate (c) realizes only the consonant of the UR *ax* and is ruled out by MAX. Candidate (b) and (d) create a unary foot and are ruled out by FTBN.

Candidate (a) is the optimal candidate though it has two segments (*a* and *x*) that are parallel to one segment of the triconsonantal form (namely, the final consonant).

(4.44) Final ranking:



4.6 Discussion and conclusions

4.6.1 What is the motivation for Grammatical Paradigm Uniformity relations?

Any word must contain a lexeme and a set of grammatical features that convey "functional" meanings, such as Tense, Number, Gender etc. (Spencer 2000). These features can be expressed by inflection (I do not address the division made by Booij (1994; 1996 among others) between contextual inflection and inherent inflection). Not every language may realize every feature or realize all features in a given word. Analogical relations between words sharing a lexeme have received much treatment in linguistic theory; however, apart from a few studies (notably Burzio 1998), the claim for analogical relations between words sharing grammatical features was not strongly advocated.

The relation between words sharing a lexeme is quite straightforward: the same lexeme appears throughout the inflectional paradigm such as the English *drink, drinks, drinking* or *eat, eats, eating* paradigms. Such relations can explain under- and over-application phenomena in related words. The reason for such relations seems straightforward as well: the more similar words belonging to a lexemic paradigm are, the more transparent their connection to the base is (Bybee 1988). The data given in this study demonstrate that an opaque phonological alternation can be accounted for by relating to forms with the same morphological structure. Such an observation makes a reference to grammatical paradigms; a notion well-known and studied in linguistic literature (Stump 1993 for example), and motivated by other independent reasons (see Jackendoff 1997; Spencer 1997). The proposal here is that similarity demands exist within grammatical paradigms and not just within the lexemic paradigms. What is the motivation for such similarity relations? *The greater the phonological invariance of members of a grammatical paradigm, the more transparent their morphological structure is.* It seems that the purpose of Paradigm Uniformity and Grammatical Paradigm Uniformity is to utilize phonological structure as indication for morphological/lexical structure.

The consequence of this hypothesis is that words may be subject to similarity demands in two dimensions: lexical and grammatical. Constraints militating for identity within a lexemic paradigm will relate only to forms with the same lexeme and ignore forms that do not share the same lexeme.

Constraints militating for identity within a grammatical paradigm will relate only to forms with the same morphological structure and ignore forms that do not share the same morphological structure.

4.6.2 Root Vowels and Richness of the Base

RVs in Modern Hebrew emerged from historical pharyngeals. This fact explains why only the low vowel *a* can be a RV. Phonetic studies on pharyngeals (Delattre 1971, Perkell 1971 among others) show that low vowels involve some pharyngeal constriction, with concomitant acoustic similarities between the vowel *a* and the pharyngeals (high F_1).

However, from a synchronic point of view it is not clear why only *a* appears as a RV. Richness of the Base (Prince and Smolensky 1993) holds that any vowel can appear in the UR. The state of affairs as it is in Hebrew does not contradict Richness of the Base, but is actually more restrictive than what Richness of the Base predicts.

A possible explanation can be found in the special history of the language. Modern Hebrew was revived at the end of the 19^{th} century, i.e. it has been a live language for just over 100 years, a very short time in the life of a language. It is possible that other RVs will emerge in the language in a later stage. In other words, even though *a* is the only RV attested in the language, RVs are part of the grammar of Hebrew speakers. Other vowels as RV do not appear in Hebrew due to historical reasons and not due to any grammatical reason.

A potential *o* as a RV can be found in B4 and B5 reduplicated verbs (Bat-El 2003b). In these verbs the first vowel of the stem is *o*: *x**o**kek* 'he made a law' in B4, and *hitk**o**nen* 'he got ready' in B5. Bat-El analyzes these verbs as having a marginal Vocalic Pattern {oe} (and not regular B4{ie} and B5{ae}). A lot of these verbs are denominative. However, theoretically these verbs can be analyzed as having the RV *o*. This claim is supported by the fact that denominative verbs with *o* are created in this way (Bat-El 1994a, 2003b, Ussishkin 2000): *ʁóm* ('height') → *ʁomém* ('he uplift, raised'), *kód* ('code') → *kodéd* ('he encoded'). It is not clear why only *o* is transmitted to verbs, why only in reduplicated verbs, why it occupies the position of the first vowel of the vocalic pattern (in regular verbs) and why only in B4 and B5. Nevertheless, it may be the case that Hebrew is changing towards allowing other vowels to be RV.

4.6.3 Conclusion

This paper examined the synchronic status of historical pharyngeals in Modern Hebrew. It was argued that pharyngeals do not have any phonemic standing in the system of the language, thus a more transparent account of the surface phenomena is needed. Such an analysis was laid down by using a new theoretical notion: Grammatical Paradigm Uniformity. Grammatical Paradigm Uniformity is an Output-to-Output theory which organizes similarity relations between words that share the same Morphological Structure but do not share a lexeme.

It was argued that the historical voiced pharyngeal ʕ was recovered as the vowel *a* and that the historical unvoiced pharyngeal *ħ* was recovered as *ax*. On the surface, however, the historical voiced pharyngeal can appear as *a* or as nothing, and the *ax* phoneme can appear as *ax* or as *x*. It was argued that the interaction of Grammatical Paradigm Uniformity constraints and regular phonological constraints is responsible for these different behaviors.

5 Stress, Syncope, Epenthesis and the Duke of York Gambit in the Verbal System of Modern Hebrew*

This chapter is a slightly modified version of the paper that was published as:

Pariente, Itsik. 2017. Stress, Syncope, Epenthesis and the Duke of York Gambit in the Modern Hebrew Verb System. *Lingua* 196: 39–54.

Abstract

This study focuses on data from the verbal system of Modern Hebrew. A full analysis of stress and syncope is given. In Hebrew verbs, some but not all unstressed vowels are subject to deletion. The study identifies the conditions for this deletion and its limitations. It also describes cases in which syncope creates an illicit three-consonant cluster that is broken by epenthesis. In these forms, stress shifts to the ultimate syllable and the penultimate vowel changes to *e*: tixt**ó**v-i → tixt**e**ví. It is argued that this seemingly serial interaction between phonological processes can be adequately analyzed within a parallel model of phonology, i.e. the non-derivational version of Optimality Theory.

5.1 Introduction

This paper investigates the complex interactions between stress, syncope and epenthesis in the verbal system of Modern Hebrew (MH). The verbal system of MH is rich in inflectional suffixes. When some suffixes are added to a verb,

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* This paper is dedicated to my teacher, colleague and friend, Shmuel Bolozky, upon his retirement from the department of Judaic and Near Eastern Studies at UMass. I hope this paper meets the standard of excellence he showed throughout his academic career. The usual disclaimers apply.

stress may shift to the suffix and syncope may occur (e.g. gad**á**l-a → gadlá) (Bat-El 2008; Laks, Cohen and Azulay-Amar 2016). Some verbs also exhibit vowel alternation in suffixed forms (tixt**ó**v-u → tixt**e**vú). Within parallel Optimality Theory (OT) (Prince and Smolensky 1993/2004), such an alternation can be viewed as vowel reduction to *e* (see §5.8.2) or as simultaneous syncope and epenthesis. Within Derivational OT, for example Harmonic Serialism (HS) (McCarthy 2008b), such an alternation can also be viewed as syncope followed by epenthesis.

The purpose of this paper is to show that a simultaneous syncope and epenthesis analysis is superior to other analyses. The paper also provides an analysis for cases in which syncope is blocked altogether.

This paper is organized as follows: section 5.2 overviews the necessary language facts and background; section 5.3 gives the relevant data and generalizations. Section 5.4 analyzes stress and syncope and establishes a ranking, section 5.5 deals with morphologically sensitive syncope. Section 5.6 deals with cases of complete blocking of syncope. Section 5.7 examines earlier approaches to syncope and syncope and epenthesis co-occurrence in MH. Section 5.8 examines alternative approaches to syncope and syncope and epenthesis co-occurrence in MH, and section 5.9 concludes the study.

5.2 Relevant language background

5.2.1 The structure of Hebrew verbs

Modern Hebrew verbs are divided into seven verbal templates. Any verb must be conjugated in one of these seven templates. Traditionally these verbal classes are termed Binyanim (singular Binyan). Every Binyan is composed of prosodic structure, vocalic pattern, and sometimes a prefix (see Bat-El 2003b for a detailed discussion).

Vocalic patterns are morphemes that are composed of vowels. The order and quality of these vowels are arbitrary although fixed. The prosodic structure of the language is derived by language-specific ranking of universal prosodic constraints and determines the syllabic structure of the verb. Stems are formed by the interdigitation of the root consonants[34] and the vocalic pattern.

The following table overviews the verbal paradigm of MH. The verbs are given in the third person masculine singular forms. Vocalic Patterns are bold. The Binyanim are abbreviated as B1, B2 etc. This list of Binyanim and the generalizations following it are adapted from Bat-El (2003b):

Table 5.1. Modern Hebrew Binyanim

	Past	Future
B1	C**a**.C**á**C	F**i**C.C**á**C / F**i**C.C**ó**C
B2	**ni**C.C**á**C	Fi.C**a**.C**é**C
B3	**hi**C.C**í**C	F**a**C.C**í**C
B4	C**i**.C**é**C	Fe.C**a**C**é**C
B5	hit.C**a**C.**é**C	Fit.C**a**C.**é**C
B6	h**u**C.C**á**C	F**u**C.C**á**C
B7	C**u**C**á**C	Fe.C**u**C**á**C

All Vocalic Patterns are disyllabic. *n-* identifies B2 verbs in the Past. *h-* identifies B3 verbs in the Past. A prefix identifies all verbs in the Future (indicated by F in Table 5.1). All prefixes occupy the first onset of the verb, except for B3, B5 and B7, in which a prefix forms a separate syllable. (*ʔ-* identifies 1^{st}.sg. ,*j-* identifies 3^{rd}.masc.sg. and 3^{rd}.pl., *t-* identifies all 2^{nd}. and 3^{rd}. fem.sg., *n-* identifies 1^{st}.pl.).

B6 and B7 do not exist in Bat-El's analysis, as she views them as the result of Melodic Overwriting (see also Ussishkin 2000, 2003) of B3 and B4 respectively. Melodic Overwriting is a process that changes the vowels of the base to create a new verb (in this case, a passive verb is created by overwriting the vowels of its active correspondent):

(5.1) l **i** m **e** d + Vocalic Pattern {u,a} → l **u** m **a** d

Participles are not discussed in this study. In MH participles can serve as present tense verbs (moxéʁ 'he is selling'), as nouns (moxéʁ 'salesman'), or as

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[34] The term "root consonant" simply refers to the consonant of the root, and should not be confused with the notion "Consonantal Root". Whether Semitic roots are composed of only consonants (Consonantal Root) or whether stems and words are the base for derivation, are questions that are outside the scope of this study.

adjectives (mehamém 'stunning'). In a detailed study on the phonological behavior of syncope in nouns, adjectives, participles and verbs, Bat-El (2008) shows that MH groups words phonologically into three groups: (i) nouns, (ii) adjectives and participles, and (iii) verbs. This study focuses on MH verbs. Since MH exhibits different co-phonologies for verbs and for participles, the latter will not be addressed.

5.2.2 Stress

In the last few decades, the stress system of MH has been the subject of a number of debates. While most scholars agree that MH is a quantity-insensitive language with a default final stress, the existence of secondary stress and the foot structure of the language are still subject for discussion.

Secondary stress is discussed in most of the generative literature about stress in MH, beginning with Bolozky (1982), where it is described as appearing on every other syllable to the left of the primary stress. However, Becker (2002) finds no acoustic evidence for secondary stress either by pitch or by vowel length. In (3), for example, he identifies only one point of high pitch and one (phonetically) long vowel:

(3) hagamadoní:m 'the little dwarfs'

I will adopt Becker's view in this study, since to my knowledge it is the only study to use acoustic measurements (see Pariente and Bolozky (2014) for a similar analysis of Hebrew nouns).

Two suggestions have been made to analyze the foot structure of the language. Bolozky (1982) and Graf and Ussishkin (2003) claim that the MH stress system consists of binary strong feet (enclosed in square brackets), either trochaic or iambic (*ʃa*[*már.ti*], [*la.káx*]). Becker (2003) on the other hand, suggests that MH stress consists of trochaic feet, either binary or degenerate (*ʃa*[*már.ti*], *la*[*káx*]).

Following Pariente and Bolozky (2014) who show that the trochaic analysis is superior to the binary analysis on the basis of stress shift and loanword adaptation, the trochaic analysis is preferred here. Furthermore, according to Hayes (1995) the main function of foot structure is to generate alternating rhythmic patterns. Having two types of feet in one system renders this function ineffective.[35]

(5.2) Stress related constraints:

TROCHEE (Prince and Smolensky 1993; McCarthy and Prince 1993): Feet are left-headed.

FOOTBINARITY (FTBIN) (Prince 1980; Prince and Smolensky 1993): Feet must be binary under syllabic or moraic analysis.

RIGHTMOST (ALIGN (PRWD, R, HEAD-FT, R)) (Cohen and McCarthy 1994): The right edge of every prosodic word is aligned with the right edge of some head foot.

I assume that feet are always trochaic in the language (binary or unary). This means that TROCHEE is undominated in MH and must outrank FTBIN. I include TROCHEE in the first tableau to demonstrate its interaction with other stress-related constraints; however, it will be dropped from following tableaux for the sake of simplicity (as I assume that all feet in the language are trochaic and TROCHEE is never dominated by other constraints).

(5.3) Stress and foot structure in MH verbs:

/katav/	TROCHEE	RIGHTMOST	FTBIN
☞ (a) ka[táv]			*
(b) [ka.táv]	*!		
(c) [ká.tav]		*!	

In tableau (5.3) candidate (c) has a non-final stress, so it is ruled out by RIGHTMOST. Candidates (a) and (b) both have a final stress, but a different foot structure: binary iamb (b) and unary (a). Candidate (a) is chosen over (b) due to the ranking of TROCHEE above FTBIN.

[35] To my knowledge, a dual foot structure was proposed only for Yidiny (Dixon 1977), Guahibo (Kondo 2001) and Wargamay (Houghton 2013).

5.3 Data and generalizations

Stress in the verbal system of Modern Hebrew falls on the last syllable if the verb consists of a bare stem (5.4) or if it consists of a prefix and a stem (5.5) (prefixes are underlined).

(5.4) Ultimate stress in bare stems:

lamád	‘he studied’
dibér	‘he spoke’
ʃikér	‘he lied’
ʃamár	‘he guarded’

(5.5) Ultimate stress in affixed verbs:

nivhál	‘he was spooked’
hitpalél	‘he prayed’
himʃíx	‘he continued’
huglá	‘he was exiled’

If the verb is suffixed, stress is penultimate if the suffix is of the form CV(C) (5.6), and ultimate if the suffix is of the form V. This stress shift to V suffixes triggers syncope of the penultimate vowel (5.7).

(5.6) Penultimate stress in verbs with a CV(C) suffix:

/nivhal-tem/	→	[nivháltem]	‘you$_{\text{PLURAL}}$ were spooked’
/hitxaten-tem/	→	[hitxatántem]	‘you$_{\text{PLURAL}}$ got married’
/ʃiker-nu/	→	[ʃikárnu]	‘we lied’
/ʃamar-ti/	→	[ʃamárti]	‘I guarded’

(5.7) Stress shift and syncope in verbs with a V suffix:

/l**a**mad-a/	→	[lamdá]	‘she studied’
/dib**e**r-a/	→	[dibrá]	‘she spoke’
/lak**a**x-u/	→	[lakxú]	‘they took’
/hitxat**e**n-u/	→	[hitxatnú]	‘they got married’

If the penultimate vowel is a high vowel, stress does not shift to the ultimate vowel (the suffix) and syncope fails to occur (this situation occurs only in B3) (5.8).

(5.8) No stress shift and no syncope in verbs with penultimate high vowel:

/h̲imʃ**i**x-a/	→	[h̲imʃ**í**xa]	‘she continued’
/h̲iʃm**i**d-u/	→	[h̲iʃm**í**du]	‘they destroyed’
/h̲iʃm**i**n-u/	→	[h̲iʃm**í**nu]	‘they gained weight’
/h̲ikd**i**m-a/	→	[h̲ikd**í**ma]	‘she was early’

The use of the term “stress shift” in this study should be explained at this point. I use the term “stress shift” in a descriptive way to indicate a difference in stress position between unsuffixed and suffixed forms. “Stress shift” indicates stress falling on an added suffix and not on the last syllable of the stem as in the unsuffixed form. Stress shift does not imply any Output-to-Output relations between the output form of the unsuffixed form and the output of a suffixed form.

(5.9) Stress shift:

$$\begin{array}{ccc} \text{/lamad /} & & \text{/lamad-a/} \\ \downarrow & & \downarrow \\ \text{IO} & \longrightarrow & \text{IO} \\ \text{[lamád]} & \text{stress shift} & \text{[lamdá]} \end{array}$$

5.4 Deriving syncope

Syncope occurs only when stress shifts to a suffix that begins with a vowel. If the suffix begins with a consonant, stress does not shift and syncope does not occur. I argue that syncope is the result of the ranking of PARSE-2 above MAX. I also argue that the positional faithfulness constraint MAX-V_1 prevents the deletion of the first vowel.

(5.10) PARSE-2 (Kager 1994):

One of two adjacent stress units (μ, σ) must be parsed by a foot (syllables in MH).

(5.11) MAX-V_1 (inspired by Beckman 1998’s MAX-σ_1):

The first vowel in the input has a correspondent in the output.

(5.12) V suffixed form:

/katav-a/		MAX-V_1	PARSE-2	RIGHTMOST	MAX
	(a) ka[tá.va]			*!	
	(b) ka.ta[vá]		*!		
☞	(c) kat[vá]				*
	(d) kta[vá]	*!			*

Due to the ranking of PARSE-2 and RIGHTMOST above MAX, any candidate which has a non-final stress (a) or two unparsed syllables (b) is disqualified. The optimal candidate has to have a final stress and delete a vowel in order to avoid a sequence of two unparsed syllables. MAX-V_1 prevents the deletion of the first vowel (d), yet is indifferent about the deletion of any other vowel. The optimal candidate (c) deletes the second vowel, violating MAX but not violating any of the higher ranked constraints.

5.5 Duke of York Gambit cases

An intriguing phenomenon about MH syncope is that it is not blocked by phonotactic constraints. If all conditions for syncope are met (i.e. a non-initial vowel that belongs to a pair of syllables which are not parsed by a foot), syncope will take place. For example, in the 2nd.pl.masc/fem, the 2nd.sg.fem forms and the 3rd.pl.masc/fem in the future tense of B1, stress shifts to the ultimate syllable and the penultimate vowel changes to *e*: tixt**e**vú, tixt**e**ví and jixt**e**vú, respectively.

(5.13) Stress shift to ultimate syllable and penultimate vowel change to *e*:

/t̲ixt**o**v-u/	→	[tixt**e**vú]	‘you$_{\text{PLURAL}}$ will write’
/t̲igd**a**l-i/	→	[tigd**e**lí]	‘you$_{\text{FEM.SG.}}$ will grow’
/n̲ird**a**m-a/	→	[nird**e**má]	‘she fell asleep’
/h̲uʃm**a**d-a/	→	[huʃm**e**dá]	‘she was destroyed’

The interaction of syncope and epenthesis in MH can be viewed as a sub-case of Duke of York Gambit relations (Pullum 1976). Duke of York Gambit derivations are the interaction of two phonological processes with opposing results, ordered in a manner that the second undoes the outcome of the first, i.e. A → B → A. In MH, epenthesis reinstates the syllabic structure prior to syncope: CCVC → CCC → CCVC. It will therefore be referred to as a Syllabic Duke of York Gambit.

As shown in (5.14), the ranking established so far cannot account for this phenomenon straightforwardly.

(5.14) B1 future tense:

/t̲ixtov-u/	PARSE-2	RIGHTMOST	MAX	DEP
(a) tix.to[vú]	*!			
☜ (b) tixt[vú]			*	
☞ (c) tix.te[vú]	*!		*	*

Under the current analysis, the optimal candidate is the one that deletes a vowel and thus does not violate PARSE-2. Candidate (b) violates only the lowest ranking constraint MAX and is chosen, despite creating a three-consonant cluster. This outcome is wrong, since three-consonant clusters are not allowed in the verbal system.[36] This means that *COMPLEXONSET and *COMPLEXCODA (Prince and Smolensky 1993/2004) are undominated in the system, as shown in (5.15).

(5.15) B1 future tense revised:

/t̲ixtov-u/	*COMPLEX ONSET	*COMPLEX CODA	PARSE-2	RIGHT-MOST	MAX	DEP
☜ (a) tix.to[vú]			*			
(b) tix[tvú]	*!				*	
(c) tixt[vú]		*!				
☞ (d) tix.te[vú]			*		*	*!

Under the revised analysis, the optimal candidate is the faithful candidate. Candidates (b) and (c) create a three-consonant cluster, so they are disqualified by *COMPLEXONSET and *COMPLEXCODA respectively. Candidates (a) and (d) have the same syllabic form. Neither of them violates any syllable structure constraints; however, candidate (d) is less economic since it deletes and inserts a vowel at the same locus, violating MAX and DEP.

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[36] Three-consonants clusters are observed by Bat-El (1994a) in denominal verbs of loanwords, e.g. *sinxren* 'he synchronized'. Such clusters are viewed as the result of faithfulness to the base (Output-to-Output relations – see also Ussishkin 1999). Three-consonant clusters, however, are never the result of syncope in the language.

At this point I would like to sharpen the paradox. Since any verb containing more than two syllables and a final stress violates PARSE-2, syncope takes place. If this syncope creates a three-consonant cluster, three possible outcomes can emerge: if PARSE-2 is ranked above *COMPLEXONSET and/or *COMPLEXCODA, the output will have a three-consonant cluster (*ti**xtv**ú*). If *COMPLEXONSET and *COMPLEXCODA are ranked above PARSE-2, the output will contain two unparsed syllables (*tix.to[vú]*). If PARSE-2, *COMPLEXONSET and *COMPLEXCODA are ranked above RIGHTMOST, the output will have a non-final stress (*tix[tó.vu]*).

Under no ranking of the current analysis can an output undergo deletion and epenthesis at the same locus. Since all candidates are evaluated simultaneously, deletion of a vowel that creates an illicit cluster in the language will be avoided and not repaired by epenthesis. Such a process will always be less economic than simply not deleting the vowel.

5.5.1 Morphologically sensitive syncope analysis

I argue that this paradox can be solved by refinement of only one constraint presented in the current analysis. A closer examination of the data reveals that syncope takes place only when two **stem** syllables are unparsed. In the verbs given in (5.13), the two unparsed syllables are stem syllables (*t̲ix.to[vú]→t̲ix.te[vú]*).

In order to capture this generalization, an analysis must specify the domain of stem in the parsing constraint, i.e. refine the PARSE-2 constraint to militate against two stem-adjacent unparsed syllables:

(5.16) PARSE-2$_{[STEM]}$:

One of two adjacent stress units belonging to a stem must be parsed by a foot.

The constraint CONTIGUITY prevents epenthesis from occurring between two input-adjacent consonants, ensuring epenthesis will occur at the same locus of deletion.

(5.17) CONTIGUITY (Prince and McCarthy 1995):

Elements adjacent in the input must be adjacent in the output.

(5.18) B1 future tense final:

/t̲ixtov-u/	*COMPL ONSET	*COMPL CODA	PARSE-2[STEM]	CONTI-GUITY	RIGHT-MOST	MAX	DEP
(a) tix.to[vú]			*!				
(b) tix[tvú]	*!					*	
(c) tixt[vú]		*!					
(d) ti.xet[vú]				*!		*	*
☞ (e) tix.te[vú]						*	*

In tableau (5.18) candidate (a) preserves the original stem vowel *o* and is ruled out by PARSE-2[STEM] since it has two unparsed stem syllables. Candidates (b) and (c) delete the original stem vowel *o*, creating an illicit three consonant cluster and are disqualified by *COMPLEXONSET and *COMPLEXCODA respectively. Candidates (d) and (e) do not violate PARSE-2[STEM], since they delete the original vowel and employ the default epenthetic vowel *e* to avoid an illicit consonant cluster. Candidate (e) is the optimal candidate, since it inserts a vowel in a position which does not break input adjacent elements, thus not violating CONTIGUITY (as opposed to candidate (d)).

This is not an ad-hoc solution; in fact, changing the PARSE constraint to be sensitive to the morphological structure of a verb makes the correct prediction that a sequence of two unparsed syllables in which only one syllable is a stem syllable, will not undergo syncope. Such a case is given in the next section.

5.5.2 Stem sensitivity vs. Derived-Environment Effect

Syncope fails to occur in B5 unsuffixed forms. In the verbs given in (5.19), the two unparsed syllables are the prefix and a stem syllable (*<u>hit</u>.ka[tév]*). The output of such verbs contains two unparsed syllables, yet no vowel is deleted:

(5.19) B5 lack of syncope in un-suffixed forms:

hitk**a**tév	'he corresponded'	(not *hitk**e**tév)
hitl**o**t͡sét͡s	'he joked'	(not *hitl**e**t͡sét͡s)
jiʃt**a**dél	'he will try'	(not *jiʃt**e**dél)
hizd**a**kén	'he aged'	(not *hizd**e**kén)

The lack of syncope can be explained by the morphological structure of these verbs: even though these verbs exhibit two adjacent unparsed syllables, only one of them is a stem syllable. Such state of affairs does not trigger syncope (prefixes are underlined):

(5.20) B5 unsuffixed verbs:

/hit-katev/	*COMPLEX ONSET	*COMPLEX CODA	PARSE-2 [STEM]	RIGHT-MOST	MAX	DEP
☞ (a) hit.ka[tév]						
(b) hit[ktév]	*!				*	
(c) hitk[tév]		*!			*	
(d) hit.ke[tév]					*!	*

In tableau (5.20) candidate (a) preserves the original stem vowel *a* but it does not violate PARSE-2[STEM], since only one unparsed syllable is a stem syllable. Candidates (b) and (c) delete the original stem vowel creating an illicit three consonant cluster and are disqualified by *COMPLEXONSET and *COMPLEXCODA respectively. Candidate (d) deletes the original vowel and employs the default epenthetic vowel *e* to avoid a violation of *COMPLEXONSET and *COMPLEX-CODA. However, it is not the optimal candidate, since it violates MAX and DEP.

Since syncope fails to occur in unsuffixed forms, it might be analyzed as derived-environment effect (only B5 is relevant, since it has a whole syllable as a suffix, creating a three-syllable verb with two unparsed syllables). Such an analysis will render a stem sensitivity constraint (PARSE-2[STEM]) unnecessary.

If syncope does not take place in underived verbs, there is no need to assume that syncope is sensitive to the morphological structure of the verb. In the verbs given in (5.19), two unparsed syllables (*hit.ka[tév]*) are allowed in simplex forms,[37] so syncope does not apply since the environment triggering syncope is not present in these verbs, and not because of the morphological structure of these verbs.

It is true that syncope occurs only in derived verbs; however, this analysis cannot be correct since syncope fails to occur in B5 derived forms as well:

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[37] Simplex with regard to inflection suffixed. For the sake of simplicity I do not regard the Binyan prefix(es) as creating a derived environment.

(5.21) B5 lack of syncope in suffixed forms:

/hitk**a**tev-tem/	→ hitk**a**távtem	‘you$_{\text{PLURAL}}$ corresponded’	(not *hitk**e**távtem)
/hitl**o**tsets-nu/	→ hitl**o**tsátsnu	‘we joked’	(not *hitl**e**tsátsnu)
/hiʃt**a**del-ta/	→ hiʃt**a**dálta	‘you$_{\text{MASC.SG}}$ tried’	(not *hiʃt**e**dálta)
/hizd**a**ken-t/	→ hizd**a**kánt	‘you$_{\text{FEM.SG}}$ aged’	(not *hizd**e**kánt)

A possible remedy of this analysis is to assume that syncope is indeed a derived-environment effect, but the first vowel of a stem cannot be deleted (in addition to the restriction on the deletion of the first vowel of the output). Such a restriction will prevent syncope of the second vowel of B5 verbs (the first syllable of the stem), without employing stem sensitivity in the parsing constraint:

(5.22) DEP-$\sigma_{1[\text{STEM}]}$:

Any output element appearing in the first syllable of the stem has a correspondent in the input.

(5.23) DEP-$\sigma_{1[\text{STEM}]}$ analysis:

/hit-k**a**tev-tem/	*COMPLEX	DEP-$\sigma_{1[\text{STEM}]}$	PARSE-2	MAX	DEP
☞ (a) hit.k**a**[táv.tem]			*		
(b) hit.k**e**[táv.tem]		*!	*	*	*
(c) hitk[táv.tem]	*!			*	
(d) hit[ktáv.tem]	*!			*	

This analysis can explain the lack of B5 syncope successfully without the use of PARSE-2$_{[\text{STEM}]}$. However, I argue that it is not superior to the stem-sensitive syncope analysis given in §5.1, since both analyses make reference to morphological structure either in the parse constraint (PARSE-2$_{[\text{STEM}]}$) or in the DEP constraint (DEP-$\sigma_{1[\text{STEM}]}$).

Furthermore, PARSE-2$_{[\text{STEM}]}$ analysis is superior to DEP-$\sigma_{1[\text{STEM}]}$ with regard to Duke of York gambit relations. As shown in tableau (5.24), MAX-$\sigma_{1[\text{STEM}]}$ analysis will prefer the faithful candidate. Since PARSE-2 is indifferent to the nature of the unparsed syllables, both candidates with two unparsed syllables (a) and (b) are equally bad.

DEP-$\sigma_{1[\text{STEM}]}$ is also neutral in regard to syncope since the second vowel of the stem is deleted. The choice for the optimal candidate is determined by the lower-ranking constraints.

(5.24) B1 future tense in MAX-$\sigma_{1[STEM]}$ analysis:

/t̲ixtov-u/	*COMPLEX	DEP-$\sigma_{1[STEM]}$	PARSE-2	MAX	DEP
☜ (a) tix.to[vú]			*		
☞ (b) tix.te[vú]			*	*(!)	*(!)
(c) tix[tvú]	*!			*	
(d) tixt[vú]	*!			*	

Candidate (a) is chosen since it does not violate MAX and DEP.

5.6 Blocking syncope

5.6.1 B3 lack of syncope

B3 exhibits two interesting and unique characteristics: stress never shifts, and syncope never occurs. The full past paradigm of B3 in Table 5.2 is an example.

Table 5.2. Past paradigm of B3

Base	Suffixed forms
hiCC**í**C 3rd.sg.masc	hiCC**á**C-ti 1st.sg.masc/fem
	hiCC**á**C-ta 2nd.sg.masc
	hiCC**á**C-t 2nd.sg.fem
	hiCC**á**C-nu 1st.pl.masc/fem
	hiCC**á**C-tem 2nd.pl.masc/fem
	hiCC**í**C-a 3rd.sg.fem
	hiCC**í**C-u 3rd.pl.masc/fem

Following Graf and Ussishkin (2003), I assume that high vowels are impervious to deletion (as observed by Gouskova 2003 for other languages). Indeed, only non-high vowels are subject to syncope in the language (Bat-El 2008). The data from (5.8) is repeated again in (5.25). An analysis with the constraint MAX[+high] as defined in (5.26) is provided in (5.27).

(5.25) No stress shift and no syncope in verbs with penultimate high vowel:

/h̲imʃ**i**x-a/	→	[h̲imʃ**í**xa]	'she continued'
/h̲iʃm**i**d-u/	→	[h̲iʃm**í**du]	'they destroyed'
/h̲iʃm**i**n-u/	→	[h̲iʃm**í**nu]	'they gained weight'
/h̲ikd**i**m-a/	→	[h̲ikd**í**ma]	'she was early'

(5.26) MAX[+high]:

Every occurrence of a feature specification [+high] in the input has a correspondent in the output.

(5.27) B3 MAX[+high] analysis:

/hixtiv-u/	MAX [+high]	*COMPL ONSET	*COMPL CODA	PARSE-2$_{\text{[STEM]}}$	RIGHT-MOST	MAX	DEP
☞ (a) hix[tí.vu]					*		
(b) hix.ti[vú]				*!			
(c) hix[tvú]	*!	*				*	
(d) hixt[vú]	*!		*			*	
(e) hix.te[vú]	*!					*	*

The ranking established so far accounts for the fixed stress in such verbs. MAX$_{\text{[+high]}}$ disqualifies any candidate that deletes a high vowel ((c), (d) and (e)). Stress does not shift to the final syllable, due to the ranking of PARSE-2$_{\text{[STEM]}}$ above RIGHTMOST.

5.6.2 Verbs with CV(C) suffixes

As mentioned above, stress shift and syncope do not occur in verbs with CV(C) type suffixes. The data from (5.6) is repeated in (5.28).

(5.28) Penultimate stress in verbs with a CV suffix:

/nivhal-tem/	→	[nivháltem]	‘you$_{\text{PLURAL}}$ were spooked’
/hitxaten-tem/	→	[hitxatántem]	‘you$_{\text{PLURAL}}$ got married’
/ʃiker-nu/	→	[ʃikárnu]	‘we lied’
/ʃamar-ti/	→	[ʃamárti]	‘I guarded’

The current analysis cannot account for this fact:

(5.29) CV(C) suffixed form:

/katav-ti/	PARSE-2$_{\text{[STEM]}}$	RIGHT MOST	MAX	DEP
☞ (a) ka[táv.ti]		*!		
(b) ka.tav[tí]	*!			
☜ (c) ka.tev[tí]			*	*

In tableau (5.29), candidates (a) and (b) preserve the original stem vowel *a*, while candidate (c) deletes the original stem vowel and inserts the default epenthetic vowel *e*. Candidate (b) violates PARSE-$2_{[STEM]}$, since it has two unparsed stem vowels, and candidate (a) violates RIGHTMOST since it has a non-final stress. The optimal candidate (c) eliminates the stem vowel, and replaces it with an epenthetic vowel; thus it does not violate PARSE-$2_{[STEM]}$. It also has final stress, so it does not violate RIGHTMOST. According to the ranking given so far, candidate (c) is the optimal candidate.

This outcome is incorrect; the actual form in the language has penultimate stress. I argue that in MH verbs every foot must contain at least one stem element (consonants or vowels), i.e. a foot cannot contain only affixes. I formulate the following constraint to account for this prohibition:

(5.30) FOOT≠AFFIX:
Assign a violation mark for every foot containing only affix elements.

This constraint is in line with Prince and Smolensky's (1993/2004) constraint family MCat≈PrWd: "A member of the morphological category MCat correspond[s] to a PrWd". The constraint in (5.30) is less restricting, however, since it demands a lack of identity between feet (prosodic category) and affixes (morphological category), and not full identity between any prosodic category and any morphological category.

(5.31) CV(C) suffixed form revised:

/katav-ti/	PARSE-$2_{[STEM]}$	FOOT≠ AFFIX	RIGHT MOST	MAX	DEP
☞ (a) ka[táv.ti]			*		
(b) ka.tav[tí]	*!	*			
(c) ka.tev[tí]		*!		*	*

As shown in tableau (5.31), FOOT≠AFFIX eliminates candidate (c), since the foot has no stem elements. The winning candidate (a) has a penultimate stress as the head of a binary trochaic foot.

5.7 Previous analyses

5.7.1 Bat-El (2008)

In a detailed study on the phonological behavior of syncope in nouns, adjectives, participles and verbs, Bat-El (2008) argues that suffixed words are subject to a

Paradigm Uniformity constraint DEP$_{\sigma}$, which demands that all suffixed words will have the same number of syllables as the bare stem they are derived from. Bat-El also argues that suffixed verbs are built from the output form of their simplex counterparts, i.e. suffixed verbs have no input form.

(5.32) DEP$_{\sigma}$ (Bat-El 2008):
A derived form has the same number of syllables as its base.

Bat-El's analysis also argues that *COMPLEX determines which vowel will be deleted:

(5.33) V suffixed form (Bat-El 2008) (simplified):

zaʁak-a	*COMPLEX	DEP$_{\sigma}$	MAX^{OO}
(a) zaʁaká		*!	
(b) zʁaká	*!		*
☞ (c) zaʁká			*

The major difference of this study from Bat-El's analysis is that syncope is derived from purely phonological constraints, whereas Bat-El's analysis employs the Output-to-Output constraint DEP$_{\sigma}$ to derive syncope.

It is not clear how such an analysis will deal with vowel alternations of the kind *tixt**ó**v-i* → *tixt**e**ví* (analyzed in the present study as deletion and simultaneous epenthesis). Bat-El does not discuss such cases, yet it seems that DEP$_{\sigma}$ cannot account for this alternation, as it demands only identity of number of syllables regardless of vowel quality/properties.

5.7.2 Graf and Ussishkin (2003)

Another study that deals with stress and syncope (though not epenthesis) in MH is Graf and Ussishkin (2003). Graf and Ussishkin's analysis is radically different from the one proposed here. One major difference is the utilization of secondary stress in the language. As mentioned before, no acoustic evidence for secondary stress is found in the language (Becker 2002). Another difference is the so-called emergent foot structure hypothesis, in which foot structure emerges as the result of interaction between constraints on prosodic structure, while foot form constraints per se do not play a role in the metrical system, i.e. foot assignment is independent of stress assignment.

The principal difference between the current analysis and Graf and Ussishkin's analysis lies in the motivation for syncope. According to Graf and Ussishkin, syncope is derived from the ranking ONSET >> ALIGN-WD >> PARSE-σ. Parentheses mark the edges of the PrWd.

(5.34) ALIGN-WD (Cohn and McCarthy, 1994: 33; Selkirk, 1995):
The right edge of every stem coincides with the right edge of some PrWd.

(5.35) Syncope (Graf and Ussishkin 2003) (simplified):

dibar-a	ONSET	ALIGN-WD	PARSE-σ
(a) ([dibár])a	*!		*
☞ (b) ([dibrá])		*	

According to this analysis, syncope occurs in order to avoid a violation of ONSET. All feet in the language must be disyllabic according to Graf and Ussishkin. Since prosodic words must be aligned to the right edge of the stem due to ALIGN-WD; the winning candidate deletes the second vowel of the stem in order to be disyllabic and not violate ONSET.

Such an analysis cannot, however, account for cases of Syllabic Duke of York Gambit. There seems to be no advantage in deleting a vowel and inserting another one in its place, since both possibilities - not deleting (tix.to.vú), and deleting and inserting (tix.te.vú) - have the same syllabic and prosodic structure. If both forms have the same syllabic and prosodic structure, ONSET cannot play a role in the selection of the winning candidate.

(5.36) Syllabic Duke of York in the line of Graf and Ussishkin (2003):

/tixtov-u/	*COMPLEX	ONSET	ALIGN-WD	PARSE-σ
☞ (a) ([tix.tóv])u		*		*
(b) ([tixtvú])	*!		*	
☞ (c) ([tixtév])u		*		*

In such a scenario the faithful candidate is more economic than any candidate that deletes and inserts a vowel in the same locus for no apparent reason:

(5.37) Faithful candidate wins:

/tixtov-u/	MAX	DEP
☜ (a) ([tix.tóv])u		
☞ (c) ([tixtév])u	*!	*

While it seems that Graf and Ussishkin are aware of this problem, the only reference to it is a footnote which claims that epenthesis is post-lexical, without giving any evidence for such an analysis:

> In contrast to *sagrá* the form *nísgerá* (3.sg.fem.), derived from *nisgár* (3.sg.masc.), does not lose its final vowel. In fact, it seems as if the vowel [a] was reduced to [e] in this specific environment. However, we claim that in this form too, the final vowel is not parsed when a V-initial suffix is attached, in order to fulfill the demand for a disyllabic form. The result is the form **nisgrá*, which cannot be syllabified in Hebrew: Hebrew does not allow a sequence of three consonants in a row. In order to break the inadmissible sequence, the vowel [e], which we claim to be the phonological epenthetic vowel in MH, is inserted between the consonants, presumably on the post-lexical level. (Graf and Ussishkin 2003: 261)

Since this footnote is the only mention of vowel alternation, it is not clear to what model of post-lexical phonology Graf and Ussishkin are referring, or what the exact nature of phonological leveling/stratum in the language is. The present study does not make any distinction between lexical and post-lexical processes in the language, as all alternations are analyzed at the same (lexical) phonological level.

5.8 Alternatives

5.8.1 Harmonic Serialism

The most intriguing issue of the present study is that syncope occurs even if its application creates a three-consonant cluster which is broken by epenthesis.

This phenomenon can also be accounted for by any derivational model of OT à la McCarthy's (2000, 2008a, b) Harmonic Serialism (HS). HS is a derivational approach to Optimality Theory. In classic OT a (potentially) infinite set of candidates produced by GEN is evaluated only once, which means that several operations can apply to the input in the mapping to the output. The optimal candidate is evaluated by EVAL and the most harmonic candidate by the language-specific ranking is chosen, regardless of the number of operations that were applied to it.

In HS, however, the number of operations that apply to the input in an evaluation is restricted to only one. Multiple operations can apply by not limiting the number of evaluations to only one. In HS the output of the first evaluation (which had only one operation applied to it) is the input of the next evaluation, and again only one operation can be applied in the mapping to the output. This output is again the input of the next evaluation, and so on. The evaluations stop only when the input is identical to the output. The differences between OT and HS are demonstrated in (5.38) and (5.39).

(5.38) Classic OT evaluation:

/input/ → GEN → Candidates → EVAL → [output]

(5.39) HS evaluations:

/input$_0$/ → GEN → Candidates → EVAL → [output$_0$] →
/input$_1$/ → GEN → Candidates → EVAL → [output$_1$] …
if [input$_n$] = [output$_n$] *then convergence*

HS is a step-by-step theory of mapping inputs to outputs with intermediate levels of representation, much like the rule-based theories that started in Chomsky and Halle (1968).

In a detailed study, McCarthy (2008b) develops a specific theory of serial interactions between stress and syncope. This theory, which proves to be very successful in the analysis of many languages, has the following characteristics:

a. **Gradualness**: GEN makes one repair per candidate. A repair can violate one basic faithfulness constraint (MAX, DEP or IDENT) at a time. Stress assignment is considered a violation of basic faithfulness.
b. **Harmonic improvement**: for every derivation, EVAL must choose an output that improves harmony under the specific constraint hierarchy.
c. **Forced serialism**: since stress and syncope violate a different set of faithfulness constraints, they must be evaluated separately.
d. **Intrinsic ordering**: the order of evaluation is metrical structure first and syncope second.

In accordance with McCarthy's theory, stress assignment is the first step in tableau (5.40):

(5.40) Stress assignment:

/t̲ixtov-u/	TROCHEE	RIGHTMOST	FTBIN
☞ (a) t̲ix.to[vú]			*
(b) t̲ix[tó.vu]		*!	

As expected, the optimal output has a final stress in a unary foot. The output is taken as the input of the syncope stage, see (5.41).

(5.41) Syncope:

t̲ix.to[vú]	PARSE-2[STEM]	*COMPLEX ONSET	*COMPLEX CODA	MAX	DEP
(a) t̲ix.to[vú]	*!				
☞ (b) t̲ix[tvú]		*		*	
☞ (c) t̲ixt[vú]			*	*	

In the second evaluation (5.41), the output of the first evaluation (5.40) is taken as the input (*t̲ix.to[vú]*). Candidate (a) is the faithful candidate; it does not delete any vowel, but it contains two unparsed stem syllables and is disqualified by PARSE-2[STEM]. Candidates (b) and (c) delete the second vowel, creating a three-consonant cluster. The difference between these two candidates is in the location of the syllable boundary: candidate (b) has a simple coda and complex onset, while candidate (c) has complex coda and a simple onset.

(5.42) Epenthesis:

t̲ix[tvú]	PARSE-2[STEM]	*COMPLEX ONSET	*COMPLEX CODA	CONTIGUITY	DEP
(a) t̲ix[tvú]		*!			
☞ (b) t̲ix.te[vú]					*
(c) t̲i.xet[vú]				*!	*
t̲ixt[tvú]					
(a) t̲ixt[tvú]			*!		
☞ (b) t̲ix.te[vú]					*
(c) t̲i.xet[vú]				*!	*

In the last evaluation (5.42), the output(s) of the second evaluation (5.41) are taken as the input. Candidate (a) is the faithful candidate; it does not insert any vowel, but it contains a complex margin and is ruled out by COMPLEXONSET/CODA. Candidates (b) and (c) insert a vowel to avoid a complex margin. Candidate (c) is ruled out though by CONTIGUITY.

Both theories (classic OT and HS) handle the MH data successfully. HS seems to have no advantage when dealing with vowel deletion and vowel insertion. OT and HS use the exact same constraints in analyzing these phenomena.

A possible advantage for HS would have been an analysis without the stem-sensitive PARSE-2$_{[\text{STEM}]}$ constraint. However, HS **has** to employ the PARSE-2$_{[\text{STEM}]}$ constraint and not the standard PARSE-2 constraint. Since the optimal candidate has two unparsed syllables (*tix.te[vú]*), it is equally bad as the faithful candidate (*ṯix.to[vú]*) with regard to PARSE-2.

In order for vowel deletion and vowel insertion to be optimal over the faithful candidate without using a stem sensitive constraint, one must “turn off” the effect of PARSE-2 before epenthesis takes place. Such a solution can be achieved by any bottom-up serial theory à la Chomsky and Halle’s (1968) SPE, assuming deletion precedes epenthesis (i.e. deletion feeds epenthesis):

(5.43) Rule ordering of syncope and epenthesis in MH:

UR:	/tixtov-u/
Syncope:	ṯixtvu
Epenthesis:	ṯixtevu
Surface:	[tixtevú]

However, HS (in its latest version at least) is not a bottom-up theory, as argued by McCarthy, Pater, and Pruitt (2016): “HS has full availability of structural operations at every step of the derivation; thus, it is not bottom-up” (p. 20).

It seems that the MH data cannot provide us with any insights in comparing the two theories. From an Occam’s razor point of view, if two (or more) theories are successful in analyzing a set of data, the simpler theory is favored. This is true for the present study, as both theories deal successfully with the data presented in this study. OT grammar, however, is by far the simpler as it employs only one evaluation in mapping inputs to outputs, whereas HS employs multiple evaluations.

That said, one phenomenon in one language is obviously not sufficient for favoring one theory over another. In fact, the comparison of the two theories is an ongoing debate in current linguistic literature (see McCarthy, Pater, and Pruitt 2016). The present study aims to add to this debate. A complete comparison of OT and HS is outside the scope of this study, as it aims to show that a seemingly serial phenomenon can be dealt with successfully within the framework of classical OT.

5.8.2 Reduction

A completely different point of view of the vowel alternation given in (5.13) is to assume that the penultimate vowel is reduced to *e* (tixt**ó**v-u → tixt**e**vú). This idea was suggested (in passing) by Bolozky (1999).[38] Such an analysis must assume that reduction takes place only when syncope would have created an illicit cluster. In other words, if syncope will not result in an illicit structure, it will take precedence over reduction. For example, in irregular verbs with only two consonants on the surface (so a three-consonant cluster cannot occur), syncope and not reduction occurs, e.g. _jox**á**l-u → joxlú_ ('they will eat') and not _*jox**e**lú_.

In fact, Bolozky (1999) lists more examples of vowel alternations (reduction to *e*) taking place, since syncope in these cases would have yielded illicit clusters: (a) Clusters which violate the sonority sequencing principle e.g. k**a**tán → ktaním ('small$_{\text{M.SG}}$', 'small$_{\text{M.PL}}$') vs. l**a**ván l**e**vaním ('white$_{\text{M.SG}}$', 'white$_{\text{M.PL}}$'). (b) Clusters that violate the OCP e.g. kat**á**v → katvá ('he wrote', 'she wrote') vs. xag**á**g xag**e**gá ('he celebrated, 'she celebrated').

In OT terminology, one can say that syncope is better than reduction, and reduction is better than keeping the original vowel. One question to be asked at this point is: what is the motivation for this reduction? Why is a candidate with reduction better than the faithful candidate? The motivation cannot be PARSE-2$_{\text{[STEM]}}$, as the optimal candidate contains two unparsed stem vowels, as shown in (5.44).

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[38] Ravid and Shlesinger (2001) provide a psycholinguistic and experimental account for the conditions of a deletion and alternation with *e*. Their study focuses on nouns and considers the *a*/*e* alternation as reduction. In a descriptive account of MH consonant clusters, Schwarzwald (2005), on the other hand, regards these vowels as epenthetic. Both studies do not explain these alternations or considering alternatives to their analyses.

(5.44) Stress assignment:

/ṯixtov-u/	*COMPLEX	PARSE-2$_{[STEM]}$	*REDUCTION
☜ (a) tix.to.vú		*	
(b) tixtvú	*!		
☞ (c) tix.te.vú		*	*!

A possible remedy for this wrong outcome is to assume that candidate (c) does not contain two unparsed stem vowels, by assuming that reduction not only changes the quality of a vowel but rather, it also eliminates its correspondence to the input. Such a solution seems arbitrary and ad hoc (in fact, lack of correspondence to the input suggests that a vowel is indeed epenthetic).

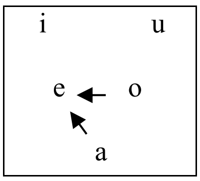
In a series of studies, Crosswhite (2000, 2001, 2004) defines vowel reduction as neutralization of phonemic vowels in unstressed positions. She identifies two types of vowel reduction:

(a) Moderate Reduction, which aims at contrast-enhancing. This kind of reduction eliminates mid vowels, or the contrasts between lower mid and higher mid vowels (Flemming 2005). By eliminating the contrast in unstressed syllables, the speaker avoids misperception of vowel quality in these positions on the one hand, and on the other hand enhances the perception of vowel quality by contrasting peripheral and non-peripheral vowel qualities only in stressed positions (Steriade 1994a, b).

(b) Extreme Reduction, which aims at increasing articulatory ease by reduction of phonetically long vowels (such as *a*) and/or salient vowel qualities in unstressed positions.

Moderate reduction does not fit the MH data, as MH changes the peripheral vowel *a* to the mid vowel *e*. MH seems to be a language that contrasts low and mid vowels under stress, but neutralizes them in unstressed positions.

(5.45) Hebrew vowel reduction:



The crucial question is: in what sense is the vowel *e* reduced? Reduction is a process of decreasing sonority of unstressed vowels (Kenstowicz 1994, Crosswhite 2000). This observation is encoded in the following fixed constraint hierarchy suggested by Kenstowicz (1994):

(5.46) *Unstressed/a >> *Unstressed/e,o >> *Unstressed/i,u >> *Unstressed/ə

Since the vowels *o* and *e* have the same sonority level it is unlikely that reduction is responsible for the alternation of *o* to *e* in the language.

A reduction analysis can still be argued for if we expand the definition of reduction to include backness/roundness neutralization. In this scenario, vowel reduction in MH neutralizes both sonority and backness/roundness of unstressed vowels, i.e. the back rounded vowel *o* is reduced to the front unrounded vowel *e* (the vowel *u* is not reduced to *i* or *e*, since high vowels are resistant to reduction in the language).

This analysis is not appealing from a typological point of view. Flemming (2005) observes that vowel reduction eliminates height contrasts. Backness or rounding contrasts (e.g. *o* → *e*) are never the **sole** target of reduction. Back rounded vowels are reduced only in languages that neutralize most or all vowels contrasts in unstressed positions. This is not the case in MH.

One reviewer pointed out that in some languages, a phonetically motivated reduction at some point in the history of the language (e.g. [a, o] > [ə]) becomes opaque in a later stage due to sound change (e.g. [ə] > [e]). This indeed seems to be the case for MH, as Bat-El (2008) points out: "Tiberian Hebrew schwa corresponds in Modern Hebrew to *e* after a sonorant and between identical consonants, and Ø elsewhere" (p. 39).

Tiberian Hebrew (TH) was much more restrictive with regard to consonant clusters than MH; complex onsets and complex codas were illicit structures in the language. TH did exhibit reduction of unstressed vowels to schwa (Gesenius 1910): *za:qá:n* 'beard', *zəqa:ní:m* 'beards'. MH, on the other hand, does permit complex consonants but lacks schwa in its vowel inventory. This state of affairs leads to TH reduction emerging as syncope in MH: *zakán* 'beard', *zkaním* 'beards'. However, if such syncope yields a consonant cluster which is illicit in MH, i.e. violating the sonority sequencing principle, *e* is inserted between these consonants (*n**a**hár* 'river', *n**e**harót* 'rivers').

5.9 Conclusion and discussion

The Duke of York Gambit has been met with much doubt since Pullum (1976) coined the phrase (e.g. Halle and Idsardi 1997, McCarthy 2003, among others). The reason for this skepticism is quite obvious: Duke of York derivations require a process B to repair a structure created by process A, instead of blocking process A in the first place. A non-economic strategy to say the least.

Indeed, much of the literature following Pullum (1976) aimed at eliminating the notion of Duke of York Gambit analyses. For example, McCarthy (2003) distinguishes between what he calls "vacuous" Duke of York derivations and "feeding" Duke of York derivations. Vacuous Duke of York derivations are derivations in which "nothing else depends on the intermediate stage" (p. 24). He later goes on to show that these derivations are nothing more than a side effect of strict serialism of rule-based theories, which can be dealt with very easily by blocking under constraint domination in OT.

Feeding Duke of York derivations are derivations in which the intermediate stage is utilized independently for another process: "That is, the rule changing A to B feeds some other rule, which applies before B changes back into A" (McCarthy 2003: 24). Such derivations are very rare and McCarthy deals with two possible examples, from Tiberian Hebrew and Bedouin Arabic, only to come to the conclusion that feeding Duke of York derivations do not exist.

If Duke of York relations are rare, Syllabic Duke of York relations seem to be nonexistent in the literature, as Norton (2003) notes: "Duke of York interactions between syncope and epenthesis applying at the same site are to my knowledge unattested" (p. 191). MH data is exactly such a feeding Duke of York case: process A (deletion) is motivated independently (by limitations on parsing), creating an environment (three-consonant cluster) for process B (epenthesis) to apply. Process B reverses the syllabic structure created by process A at the same site (locus).

Such a serial interpretation of the MH data was rejected in this study. This case of a seemingly serial interaction of a "feeding" order was argued to be best understood as a regular parallel OT process. The key observation in the analysis is that the vowel breaking the three-consonant sequences is different from the one that was deleted (*a*/*o* → *e*). Since *e* is the default epenthetic vowel in MH, it was argued that this is a case of simultaneous syncope and epenthesis.

It was also argued that an epenthetic vowel in the same position as the deleted vowel is less offensive in MH, due to the prohibition of two adjacent unparsed stem syllables.

6 Conclusion

This dissertation is composed of four papers dealing with various aspects of the phonology of Modern Hebrew. Two of these, chapter 2 (“Pharyngeal related non-lexical vowels in Sephardic Modern Hebrew” and chapter 3 (“The interaction of vowel quality and pharyngeals in Sephardic Modern Hebrew”) dealt with Sephardic Modern Hebrew, a dialect of the language that retained the two pharyngeal consonants. Chapter 4 (“Grammatical paradigm uniformity”) dealt with the standard dialect of Hebrew, which did not recover these consonants. Chapter 5 (“Stress, Syncope, Epenthesis and the Duke of York Gambit in the Verbal System of Modern Hebrew”) analyzed the interaction of stress, syncope and epenthesis in the verbal system of MH in a non-derivational model of Optimality Theory.

6.1 Further research possibilities

The relationships between the speakers of the different dialects are not dealt with in the dissertation. A future study on this topic could be a theoretical and experimental study to uncover the perception and the phonological representation of new sounds in a dialect mixture scenario (Delpit 1990, Escure 1997, Goeman 2000 among others). In such a study, data can be taken from Sephardic Modern Hebrew (SMH) speakers who encounter General Modern Hebrew speech (GMH) and vice versa. The results can be described and analyzed within a formal model in line with Escudero’s (2005) Second Language Linguistic Perception (L2LP) model but will have to be adjusted to D(ialect) 2 data. With regard to syncope in MH, a future study could deal with Syllabic Duke of York in a non-parallel model of OT. Pariente (2017) indicates that syncope is not blocked, even if it results in an illicit structure such as a sequence that violates the Sonority Sequencing Principle (SSP) or a three-consonant cluster. In these cases the vowel is deleted and an epenthetic vowel is inserted in order to break the illicit sequence (/lavan-a/ → *lvaná → [levaná] ‘white’ fm.sg.).

Within a parallel OT framework, two analyses are equally adequate: (a) the penultimate vowel is reduced to *e* (*tixtovú* → *tixtevú*); and (b) the penultimate vowel is deleted and an epenthetic vowel is simultaneously inserted in order to avoid an illicit structure. Pariente (2017) provides arguments against a reduction analysis and analyzes the alternation as simultaneous deletion and epenthesis.

A third option is to view this process as serial interaction, i.e. deletion precedes epenthesis. Such an analysis can be argued for only in a serial model of phonology, whether rule-based or constraint-based. Such analyses can be examined in a future study by comparing serial OT models such as Stratal OT and Harmonic Serialism.

Another possible study could deal with syncope as a derived-environment process. Derived-environment effects (along with opacity and paradigmatic effects) are well known among OT scholars, and changes to the original architecture were attempted in order to account for them. For example, several suggested to alter the nature of the constraints such as Anti-faithfulness (Alderete 1999, 2001), Sympathy (McCarthy 1999), Optimal Paradigms (McCarthy 2005), and Local Conjunction (Łubowicz 2002). Other suggestions increased the number of evaluations, e.g. Stratal OT (Kiparsky 2000), Candidate Chains in OT (McCarthy 2007), and Harmonic Serialism (McCarthy 2000, 2008a, b), to name a few. An examination of the MH data provided in Pariente (2017) in light of each theory could highlight the differences between these theories, and point at some advantages or disadvantages of each theory.

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Theoretical issues in Modern Hebrew phonology

Summary in English

This dissertation is composed of four papers dealing with various aspects of the phonology of Modern Hebrew. Chapter 2 ("Pharyngeal related non-lexical vowels in Sephardic Modern Hebrew") examines non-lexical vowels in Sephardic Modern Hebrew. The notion of non-lexical vowels refers to vowels that appear at the surface level, but are not present in the lexicon. The non-lexical vowels that were examined are triggered by the pharyngeal consonants. It is argued that two different kinds of epenthetic vowels can be triggered by the pharyngeal consonants.

The first kind is intrusive vowels, which do not add a syllable to the word, nor participate in phonological processes. For example, these vowels do not re-syllabify the voiced pharyngeal (/ʕ/) as onset, thus blocking vowel lowering; intrusive vowels always copy the quality of the vowel preceding them. The second kind is epenthetic vowels, which do add a syllable to the word and do participate in phonological processes, e.g. re-syllabifying the voiced pharyngeal as onsets within the foot; epenthetic vowels are always low.

Chapter 3 ("The interaction of vowel quality and pharyngeals in Sephardic Modern Hebrew") deals with Sephardic Modern Hebrew as well. This paper presents an optimality-theoretic analysis of the behavior of pharyngeals in a non-standard variety of Hebrew, e.g. the language's prohibition against a sequence of a non-low vowel immediately preceding a coda. The strategies used to avoid the disallowed sequences are described and analyzed. It is shown that Sephardic Modern Hebrew considers multiple factors regarding this prohibition, such as syllabic position, stress and lexical category. Since nouns and verbs show different behavior with respect to the processes under examination, different co-phonologies are proposed to analyze them separately. It is also

shown that in SMH, verbs exhibit a greater resistance to vowel lowering than nouns.

Chapter 4 ("Grammatical paradigm uniformity") deals with the standard dialect of Hebrew, which did not recover these consonants. It develops a formal model of paradigmatic relations between words not sharing a lexeme. The problem addressed in this paper is why Root-Vowels (RV) appear at the surface level in some environments yet not in others. The alternation in the manifestation/omission of the RV is argued to mirror the moraic structure of triconsonantal verbs. If a consonant in the triconsonantal forms is in coda position, it is moraic. In these cases, RV's corresponding to it (i.e. appearing in the same position in the same template of another root) appear on the surface to mirror the moraic structure of the triconsonantal form. If a consonant in the triconsonantal forms is in onset position, i.e. it is non-moraic, RV's corresponding to it will not appear on the surface.

This idea was first introduced by Burzio (1998), following whom it is argued that similarity relations between words that do not share a lexeme can also be a factor in the morphology–phonology interface. The main idea is that words with the same Morphological Structure are subject to certain similarity demands.

Chapter 5 ("Stress, Syncope, Epenthesis and the Duke of York Gambit in the Verbal System of Modern Hebrew") investigates the complex interactions between stress, syncope and epenthesis in the verbal system of Modern Hebrew. The verbal system of Hebrew is rich in inflectional suffixes. When some suffixes are added to a verb, stress may shift to the suffix and syncope may occur (e.g. *gadál-a* → *gadlá*) (Bat-El 2008; Laks, Cohen and Azulay-Amar 2016). Some verbs also exhibit vowel alternation in suffixed forms (*tixtóv-u* → *tixtevú*). Such an alternation can be viewed as vowel reduction to *e* or as simultaneous syncope and epenthesis. Within Derivational OT, for example Harmonic Serialism (HS) (McCarthy 2008b), such an alternation can also be viewed as syncope followed by epenthesis. The purpose of this paper is to show that a simultaneous syncope-and-epenthesis analysis is superior to other analyses, by showing that it predicts the alternation patterns more accurately.

Theoretische vraagstukken in de fonologie van het Modern Hebreeuws

Samenvatting in het Nederlands

Dit proefschrift bestaat uit vier artikelen die verschillende aspecten van de fonologie van het Modern Hebreeuws behandelen. Hoofdstuk 2 bekijkt niet-lexicale klinkers in het Sefardisch Modern Hebreeuws. Het begrip "niet-lexicale klinkers" verwijst naar klinkers die verschijnen op het oppervlakteniveau maar niet onderliggend aanwezig zijn in het lexicon. De niet-lexicale klinkers die ik onderzocht heb, zijn die die geactiveerd worden door faryngale medeklinkers. Ik betoog dat faryngale consonanten twee verschillende soorten epenthetische klinkers kunnen activeren.

De eerste soort wordt gevormd door de "inbrekende" (*intrusive*) klinkers, die geen extra syllabe aan het woord toevoegen en ook niet deelnemen aan fonologische processen. Deze klinkers maken van een voorafgaande /ʕ/ geen onset, en blokkeren daardoor niet de verlaging van de aan die /ʕ/ weer voorafgaande klinker; verder zijn de inbrekende klinkers qua kwaliteit altijd een kopie van de voorafgaande klinker. De tweede soort wordt gevormd door epenthetische (ingevoegde) klinkers, die wel een extra syllable aan het woord toevoegen en wel aan fonologische processen meedoen; ze resyllabificeren de voorafgaande stemhebbende faryngaal als onset binnen de voet. Epenthetische klinkers zijn altijd laag.

Hoofdstuk 3 doet een Optimaliteitstheoretische analyse van het gedrag van faryngalen in het Sefardisch Modern Hebreeuws, zoals het verbod op een niet-lage klinker onmiddellijk vóór een coda. Ik beschrijf en analyseer de strategieën die taalgebruikers toepassen om zulke verboden volgordes te vermijden. Ik laat zien hoe Sefardisch Modern Hebreeuws in dit verbod meerdere factoren in beschouwing neemt, zoals positie in de syllabe, klemtoon en lexicale categorie: omdat zelfstandige naamwoorden en werkwoorden verschillend gedrag vertonen met betrekking tot de bestudeerde processen, stel ik verschillende co-fonologieën voor, zodat ik ze apart kan analyseren. Ik laat zien dat werkwoorden sterker weerstand bieden tegen klinkerverlaging dan zelfstandige naamwoorden.

Hoofdstuk 4 gaat over het Hebreeuwse standaarddialect, dat in tegenstelling tot het Sefardische dialect de faryngale consonanten niet hersteld heeft. In dit hoofdstuk ontwikkel ik een formeel model van paradigmatische relaties tussen woorden die geen lexeem delen. Het vraagstuk dat ik behandel is waarom "wortelklinkers" (Root Vowels) in sommige omgevingen wel maar in andere omgevingen niet aan de oppervlakte verschijnen. Ik betoog dat de alternantie tussen het optreden dan wel wegblijven van de wortelklinker de moraïsche structuur van werkwoorden met drie medeklinkers weerspiegelt. Als een medeklinker in zo'n werkwoordssjabloon in codapositie staat, dan is hij moraïsch; in deze gevallen verschijnt een corresponderende wortelklinker (d.w.z. een klinker die op dezelfde positie in het sjabloon staat, van een andere wortel, als die medeklinker) aan de oppervlakte. Als een medeklinker in een wortel daarentegen in onset staat, dan is die medeklinker niet moraïsch, en een qua positie corresponderende klinker in een andere wortel verschijnt niet aan de oppervlakte.

Dit idee werd oorsponkelijk al geopperd door Burzio (1998), die betoogde dat gelijkenisrelaties tussen woorden die geen lexeem delen een factor kan zijn op het grensvlak tussen morfologie en fonologie. Het idee is dat van woorden met gelijke Morfologische Structuur ook geëist wordt dat ze in bepaalde andere opzichten op elkaar lijken.

Hoofdstuk 5 onderzoekt de complexe wisselwerkingen tussen klemtoon, syncope (wegval) en epenthese in het Modern Hebreeuwse werkwoordssysteem, dat in zijn vervoeging rijk is aan uitgangen. Voor sommige uitgangen geldt dat als ze achter een werkwoord geplaatst worden, de klemtoon verschuift naar deze uitgang en er een klinker wegvalt (bv. *gadál-a* → *gadlá*) (Bat-El 2008; Laks, Cohen en Azulay-Amar 2016). Sommige werkwoorden vertonen in vormen met uitgangen een klinkerwisseling (*tixtóv-u* → *tixtevú*). Zo'n wisseling kunnen we ofwel zien als klinkerreductie naar *e* ofwel als gelijktijdige syncope en epenthese. Derivationele varianten van OT, bv. Harmonic Serialism (McCarthy 2008b) zouden zo'n wisseling kunnen zien als syncope gevolgd door epenthese. Ik toon met dit artikel aan dat een analyse van gelijktijdige syncope en epenthese superieur is aan andere analyses, door te laten zien dat zo'n analyse de patronen preciezer voorspelt.

About the Author

Itsik Pariente was born in Ashkelon, Israel, on 18 January 1977. After finishing high school in 1995, he served in the Israel defense forces from 1995 to 1998. He earned a BA Linguistics and Hebrew Language (*magna cum laude*), during which he won the 2001 and 2003 Yael and Zeev Yakobbi Award from the Department of Hebrew Language.

In 2009 he was a guest lecturer at the University of Amsterdam, Dept. of Hebrew Language and Culture. He served as a Hebrew lecturer at Eötvös Loránd University, Center of Jewish Studies, Budapest, Hungary from 2009 to 2011. From 2011 to 2013 he worked as a Hebrew lecturer at Smith College and Mount Holyoke College in MA, USA. From 2013 to 2019 he served as the Diane and Guilford Glazer and Lea and Allen Orwitz Teaching Fellow in Modern Hebrew at the University of Tennessee, Knoxville, USA.