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

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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.

Keywords Stress, Syncope, Epenthesis, Duke of York Gambit, Hebrew

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, 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 §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.

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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 two overviews the necessary language facts and background, section three gives the relevant data and generalizations. Section four analyzes stress and syncope and establishes a ranking, section five deals with morphologically sensitive syncope. Section six deals with cases of complete blocking of syncope. Section seven examines earlier approaches to syncope and syncope and epenthesis co-occurrence in MH. Section eight examines alternative approaches to syncope and syncope and epenthesis co-occurrence in MH, and section nine concludes the study.

2 Relevant language background
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 2003 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 specific language ranking of universal prosodic constraints and

determines the syllabic structure of the verb. Stems are formed by the interdigitation of the root consonants[1] 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 (2003):

(1) MH Binyanim

	Past	Future
B1	C**a**.C**á**C	F**i**C.C**á**C/ F**i**C.C**ó**C
B2	n**i**C.C**á**C	F**i**.C**a**.C**é**C
B3	h**i**C.C**í**C	F**a**C.C**í**C
B4	C**i**.C**é**C	F**e**.C**a**C**é**C
B5	h**it**.C**a**C.**é**C	F**it**.C**a**C.**é**C
B6	h**u**C.C**á**C	F**u**C.C**á**C
B7	C**u**C**á**C	F**e**.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 (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 1st.sg. ,j- identifies 3rd.masc.sg. and 3rd.pl. ,t-* identifies all 2nd. and 3rd. fem.sg. *n- identifies 1st.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):

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[1] 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.

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(2) 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 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.

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 subjects 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 identified 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).

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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 trochaic analysis is superior to binary analysis on the bases of stress shift and loanword adaptation, 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.[2]

(4) Stress related constraints
TROCH (Prince & Smolensky 1993/2004; McCarthy & Prince 1993)
Feet are left-headed.

FOOTBINARITY (FTBIN) (Prince 1980; Prince & Smolensky 1993/2004)
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 TROCH is un-dominated in MH and must outrank FTBIN. I include TROCH 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 TROCH is never dominated by other constraints).

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[2] To my knowledge a dual foot structure was proposed for only Yidinʸ (Dixon 1977), Guahibo (Kondo 2001) and Wargamay (Houghton 2014).

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(5) Stress and foot structure in MH verbs

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

In tableau (5) 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

TROCH above FTBIN.

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 (6a) or if it consists of a prefix and a stem (6b) (prefixes are

underlined).

(6a) Ultimate stress in bare stems
lamád 'he studied'
dibér 'he spoke'
ʃikér 'he lied'
ʃamár 'he guarded'

(6b) 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) (7), and

ultimate if the suffix is of the form V. This stress shift to V suffixes triggers syncope of

the penultimate vowel (8).

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(7) Penultimate stress in verbs with a CV suffix
/n̲ivhal-tem/→ n̲ivháltem 'you_{PLURAL} were spooked'
/h̲itxaten-tem/→ h̲itxatántem 'you_{PLURAL} got married'
/ʃiker-nu/→ ʃikárnu 'we lied'
/ʃamar-ti/→ ʃamárti 'I guarded'

(8) 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'
/h̲itxat**e**n-u/→ h̲itxatnú '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) (9).

 (9) No stress shift and no syncope in verbs with penultimate high vowel
/h̲imʃ**i**x-a/ →h̲imʃíxa 'she continued'
/h̲iʃm**i**d-u/→ h̲iʃmídu 'they destroyed'
/h̲iʃm**i**n-u/→ h̲iʃmínu 'they gained weight'
/h̲ikd**i**m-a/→ h̲ikdíma '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 un-suffixed and suffixed forms. 'Stress shift' indicates stress falling on an added suffix and not on the last syllable of the stem as in the un-suffixed form. Stress shift does not imply any Output-to-Output relations between the output form of the un-suffixed form and the output of a suffixed form.

(10) Stress shift

/lamad /		/lamad -a/
↓		↓
IO		IO
lamád	stress shift ⟶	lamdá

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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-σ_1 prevents the deletion of the first vowel.

(11) PARSE-2 (Kager 1994)
One of two adjacent stress units (μ, σ) must be parsed by a foot (syllables in MH).

(12) MAX-σ_1 (Beckman 1998)
Any element appearing in the first syllable in the output has a correspondent in the input.

(13) V suffixed form

/katav-a/	MAX-σ_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-σ_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. 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 situated (i.e. a non-initial vowel that belongs

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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.

(14) Stress shift to ultimate syllable and penultimate vowel change to *e*
/t̠ixt**o**v-u/ → tixt**e**vú 'you$_{PLURAL}$ will write'
/t̠igd**a**l-i/→ tigd**e**lí 'you$_{FEM.SG.}$ will grow'
/n̠ird**a**m-a/→ nird**e**má 'she fell asleep'
/h̠uʃm**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 (15), the ranking established so far cannot account for this phenomenon straightforwardly.

(15) B(1) future tense

/tixtov-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

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three consonant clusters are not allowed in the verbal system.[3] This means that

*COMPLEXONSET and *COMPLEXCODA (Prince & Smolensky 1993/2004) are un-

dominated in the system as shown in (16).

(16) B(1) future tense revised

/tixtov-u/	*COMPLEX ONSET	*COMPLEX CODA	PARSE-2	RIGHTMOST	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.

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 (*tixtvú*). If *COMPLEXONSET and *COMPLEXCODA are

ranked above PARSE-2, the output will contain two unparsed syllables (*tix.to[vú]*). If

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[3] Three consonants clusters are observed by Bat-El (1994) 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 consonants clusters, however, are never the result of syncope in the language.

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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.

5.1 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 (14), the two unparsed syllables are stem syllables (*t̠ix.to[vú]→t̠ix.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:

(17) 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, insuring epenthesis will occur at the same locus of deletion.

(18) CONTIGUITY (Prince & McCarthy 1995)
Elements adjacent in the input must be adjacent in the output.

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(19) B(1) future tense final

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

In tableau (19) 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.

5.2 Stem Sensitivity vs. Derived Environment Effect.

Syncope fails to occur in B5 un-suffixed form. In the verbs given in (20), the two unparsed syllables are the prefix and a stem syllable (*hit.ka[tév]*). The output of such verbs contains two unparsed syllables, yet no vowel is deleted:

(20) B5 *lack of syncope in un-suffixed forms*
hitk**a**tév 'he corresponded' (not *hitk**e**tév)
hitl**o**tséts 'he joked' (not *hitl**e**tséts)

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jiʃtadél 'he will try' (not *jiʃtedél)
hizdakén 'he aged' (not *hizdekén)

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):

(21) B5 un-suffixed verbs

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

In tableau (21) 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 *COMPLEXCODA. However, it is not the optimal candidate since it violates MAX and DEP.

Since syncope fails to occur in un-suffixed 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 analysis will render a stem sensitivity constraint (PARSE-2[STEM]) unnecessary.

If syncope does not take place in un-derived verbs, there is no need to assume that syncope is sensitive to the morphological structure of the verb. In the verbs given in (20),

two unparsed syllables (*hit.ka[tév]*) are allowed in simplex forms,[4] 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:

(22) B5 *lack of syncope in suffixed forms*
/hitkatev-tem/ → hitkatávtem 'you_PLURAL corresponded' (not *hitketávtem)
/hitlotsets-nu/ → hitlotsátsnu 'we joked' (not *hitletsátsnu)
/hiʃtadel-ta/→ hiʃtadálta 'you_MASC.SG tried' (not *hiʃtedálta)
/hizdaken-t/ →hizdakánt 'you you_FEM.SG aged' (not *hizdekánt)

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:

(23) MAX-$\sigma_{1[STEM]}$
Any output element appearing in first syllable in the stem has a correspondent in the input.

(24) MAX-$\sigma_{1[STEM]}$ analysis

/ hitkatev-tem/	*COMPLEX[5]	MAX-$\sigma_{1[STEM]}$	PARSE-2	MAX	DEP
☞ (a) hit.ka[táv.tem]			*		
(b) hit.ke[táv.tem]		*!	*	*	*
(c) hitk[táv.tem]	*!			*	
(c) hit[ktáv.tem]	*!			*	

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[4] 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] For simplicity *COMPLEXONSET and *COMPLEXCODA are collapsed into one *COMPLEX constraint from this point.

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This analysis can explain the lack of B5 syncope successfully without the use of PARSE-2[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[STEM]) or in the MAX constraint (MAX-$\sigma_{1[STEM]}$).

Furthermore, PARSE-2[STEM] analysis is superior to MAX-$\sigma_{1[STEM]}$ with regard to Duke of York gambit relations. As shown in tableau (25), MAX-$\sigma_{1[STEM]}$ analysis will prefer the faithful candidate. Since PARSE-2 is indifferent to the nature of the unparsed syllables, both candidate with two unparsed syllables (a) and (b) are equally bad. MAX-$\sigma_{1[STEM]}$ is also neutral in regard to syncope since the second vowel of the stem is deleted. The choice between of the optimal candidate is determined by the lower ranking constraints.

(25) B(1) future tense in MAX-$\sigma_{1[STEM]}$ analysis

/tixtov-u/	*COMPLEX	MAX-$\sigma_{1[STEM]}$	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).

6 Blocking syncope

6.1 B3 lack of syncope

B3 exhibits two interesting and unique characteristics: stress never shifts and syncope never occurs. Table (26) provides the full past paradigm of B3 for example.

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(26) Past paradigm of B3

Base	Suffixed forms
hiCCíC 3rd.sg.masc	
	hiCCáC-ti 1st.sg.masc/fem
	hiCCáC-ta 2nd.sg.masc
	hiCCáC-t 2nd.sg.fem
	hiCCáC-nu 1st.pl.masc/fem
	hiCCáC-tem 2nd.pl.masc/fem
	hiCCíC-a 3rd.sg.fem
	hiCCíC-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 in (9) is repeated again in (27). Such analysis is provided in (29).

(27) No stress shift and no syncope in verbs with penultimate high vowel
/himʃix-a/ →himʃíxa 'she continued'
/hiʃmid-u/→ hiʃmídu 'they destroyed'
/hiʃmin-u/→ hiʃmínu 'they gained weight'
/hikdim-a/→ hikdíma 'she was early'

(28) MAX$_{[+high]}$
Every occurrence of a feature specification [+high] in the input has a correspondent in the output.

(29) B(3) MAX$_{[+high]}$ analysis

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

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The ranking established so far accounts for the fix stress in such verbs. MAX[+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[STEM] above RIGHTMOST.

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 in (7) is repeated in (30).

(30) Penultimate stress in verbs with a CV suffix
/nivhal-tem/→ niváltem 'youPLURAL were spooked'
/hitxaten-tem/→ hitxatántem 'youPLURAL got married'
/ʃiker-nu/→ ʃikarnú 'we lied'
/ʃamar-ti/→ ʃamárti 'I guarded'

The current analysis cannot account for this fact:

(31) CV(C) suffixed form

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

   In tableau (31), 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 a final stress so it does not violate RIGHTMOST.

According to the ranking given so far, candidate (c) is the optimal candidate.

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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:

(32) 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 (32) 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 to any morphological category.

(33) 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 (33), 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.

7. Previous analyses

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

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Uniformity constraint DEPσ, 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 of the output form of their simplex counterparts, i.e. suffixed verbs have no input form.

(34) DEPσ (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:

(35) V suffixed form (Bat-El 2008) (simplified)

zaʁak-a	*COMPLEX	DEPσ	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 DEPσ to derive syncope.

It is not clear how such analysis will deal with vowel alternations of the kind *tixtóv-i → tixteví* (analyzed in the present study as deletion and simultaneous epenthesis). Bat-El does not discuss such cases, yet it seems that DEPσ cannot account for this alternation as it demands only identity of number of syllables regardless of vowel quality/properties.

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 than 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.

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

(37) 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 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

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syllabic and prosodic structure, ONSET cannot play a role in the selection of the winning candidate.

(38) 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:

(39) Faithful candidate wins

/tixtov-u/	MAX	DEP
☜(a) ([tix.tóv])u		
☞ (b) ([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 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." (ibid. p. 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 is the exact

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nature of phonological leveling/stratum in the language. 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.

8. Alternatives

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 (40) and (41).

(40) Classic OT evaluation
/Input/ → GEN → Candidates → EVAL → [output]

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(41) HS evaluations
/Input/ → GEN → Candidates → EVAL → [output$_0$] → /Input/ → GEN → Candidates → EVAL → [output$_1$] … [input$_n$] = [output$_n$]

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 (42):

(42) Stress assignment

/tixtov-u/	TROCH	RIGHTMOST	FTBIN
☞ (a) tix.to[vú]			*
(b) tix[tó.vu]		*!	

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As expected, the optimal output has a final stress in a unary foot. The output is taken as the input of the syncope stage. (43).

(43) Syncope

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

In the second evaluation (43), the output of the first evaluation (42) is taken as the input (*tix.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.

(44) Epenthesis

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

In the last evaluation (44), the output(s) of the second evaluation (43) are taken as the input. Candidate (a) is the faithful candidate; it does not insert any vowel, but it contains complex margin and is ruled out by COMPLEXONSET/CODA. Candidates (b) and (c) insert a vowel to avoid complex margin. Candidate (c) is ruled out though by CONTIGUITY.

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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[STEM] constraint. However HS **has** to employ the PARSE-2[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 (*tix.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 (1968) SPE, assuming deletion precedes epenthesis (i.e. deletion feeds epenthesis):

(45) Rule ordering of syncope and epenthesis in MH
UR: /tixtov-u/

Syncope: tixtvu

Epenthesis: tixtevu

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" (ibid. 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

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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.

8.2. Reduction

A completely different point of view of the vowel alternation given in (14) 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)[6]. 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 in the surface (so a three consonant cluster cannot occur), syncope and not reduction occurs, e.g. *joxál-u → joxlú* ('they will eat') and not **joxelú*.

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[6] 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 *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.

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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_{M.SG}', 'small_{M.PL}') vs. l**a**ván l**e**vaním ('white_{M.SG}', 'white_{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[STEM] as the optimal candidate contains two unparsed stem vowels as shown in (46):

(46) Stress assignment

/tixtov-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, and 2004) defines vowel reduction as neutralization of phonemic vowels in unstressed positions. She identifies two types of vowel reduction:

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(a) Moderate Reduction that 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 that 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.

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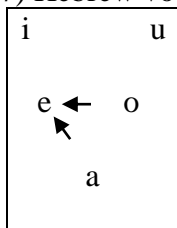
The crucial question is in what sense is the vowel *e* reduced? Reduction is a process of decreasing sonority of unstressed vowels (Kenstowicz 1994, Crosswhite 2000). This observation is encoded in the following fixed constraint hierarchy suggested by Kenstowicz 1994:

(48) *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.

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A reduction analysis can still be argued 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/round 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/round 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) pints out: "…Tiberian Hebrew schwa corresponds in Modern Hebrew to *e* after a sonorant and between identical consonants, and Ø elsewhere." (ibid. p39).

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 'beard'. MH, on the other hand, does permit complex consonants but lacks schwa in its vowel inventory. This state of affairs leads to TH reduction to emerge (I would say "leads to TH reduction emerging as…") as syncope in MH: zakán 'beard', zkaním 'beard'. However, if such syncope yields a consonant cluster

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which is illicit in MH, i.e. violating the sonority sequencing principle, *e* is inserted

between these consonants (na**h**ár 'river', n**e**harót 'rivers').

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" (ibid. 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

that 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" (ibid. p.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.

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If Duke of York relations are rare, Syllabic Duke of York relations seem to be nonexistent in the literature, as Norton (2003, 191) notes: "Duke of York interactions between syncope and epenthesis applying at the same site are to my knowledge unattested". 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 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.

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