Templatic morphology as an emergent property: Roots and functional heads in Hebrew*

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Abstract

Modern Hebrew exhibits a non-concatenative morphology of consonantal "roots" and melodic "templates" that is typical of Semitic languages. Even though this kind of non-concatenative morphology is well known, it is only partly understood. In particular, theories differ in what counts as a morpheme: the root, the template, both, or neither. Accordingly, theories differ as to what representations learners must posit and what processes generate the eventual surface forms. In this paper I present a theory of morphology and allomorphy that combines lexical roots with syntactic functional heads, improving on previous analyses of root-and-pattern morphology. Verbal templates are here argued to emerge from the combination of syntactic elements, constrained by the general phonology of the language, rather than from some inherent difference between Semitic morphology and that of other languages. This way of generating morphological structure fleshes out a theory of morphophonological alternations that are non-adjacent on the surface but are local underlyingly; with these tools it is possible to identify where lexical exceptionality shows its effects and how it is reined in by the grammar. The Semitic root is thus analogous to lexical roots in other languages, storing idiosyncratic phonological and semantic information but respecting the syntactic structure in which it is embedded.

1 Introduction

Morphological and phonological systems are often conceived of in linear terms: the concatenation of one morpheme to another, or the assimilation of a feature from one segment to an adjacent one, play a central role in describing the structures generated by the grammar of a language. Against this backdrop, cases of non-concatenative morphology in Semitic languages make notable reference to non-adjacent interactions. A common approach in the analysis of these languages is to revise basic assumptions of what morphemes are like, introducing non-linear morphophonological elements. The current paper argues that such a revision is not necessary, once the correct structural and lexical specifications are defined. A novel analysis of the verbal system of Modern Hebrew demonstrates that correctly combining lexical roots and syntactic heads is able to derive the non-concatenative effects of the language, making accurate predictions about allomorphic interactions within the phonological word. The result is a theory

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of morphosyntax and morphophonology that is as applicable to concatenative languages as it is to non-concatenative ones.

According to the traditional view of Semitic non-concatenative morphology, a word such as Arabic *takattab* 'got written' is made up of the consonantal "root" √ktb and a melodic verbal "template" (alternatively called Pattern, Measure, Form, *wazn* or *binyan*). This idea was famously formalized by McCarthy (1979, 1981), who divided the Semitic verb into three "planes" or "tiers": the CV skeleton (slots for consonant and vowels), the root (consonants) and the melody (individual vowels and inflectional information). For example, *takattab* was analyzed as in (1a), with a default verbal vowel *-a-* (McCarthy 1981:392). By including the vocalism on a separate tier, McCarthy's theory allowed vowels to be manipulated independently of the roots or the skeleton. In (1b), the melody *u-a-i* was taken to derive the active participle (McCarthy 1981:401). This theory allowed for an elegant separation of three morphological elements on three phonological tiers.

(1) a. *takattab*: b. *mutakaatib*:

Yet the nature of the CV skeleton and the melody has never been fully understood. The differences between templates are not purely phonological; rather, each template is associated with certain semantics – alternations in argument structure.

In the years since, different approaches have attempted to tackle different aspects of the system. Whereas McCarthy (1981) assumed that roots and templates interleave according to the CV skeleton, work in Prosodic Morphology (McCarthy and Prince 1990a,b) attempted to derive the phonological effects from general prosodic principles. However, focusing on the phonology left the underlying syntax and semantics of the templates untreated. Furthermore, this line of work concentrated on nouns, where there is little argument structure to correlate with morphophonology. In an attempt to better understand the morphosyntax, Arad (2005) proposed that templates are morphemic instantiations of the syntactic head Voice. This proposal still had to stipulate alternations between templates in the syntax, and did not present a phonological implementation. A different assumption was made by what I call the *stem-based approach* (Bat-El 1994, 2002, 2008; Ussishkin 2005). This theory assumes that there is no morphemic consonantal root at the base of the derivation. Instead, forms are derived from one another via output-output correspondence, with markedness regulating the phonological system as a whole. On that view the consonantal root is epiphenomenal, a "residue". As discussed in detail in Sect. 5, that theory has no account of the syntactic behavior of templates, nor does it make the right predictions in the phonology. And in a different line of work, Shlonsky (1989) hypothesized that affixes are "picked up" by head movement of the verb through the clausal spine, echoing similar claims about European languages (Pollock 1989).

Even though a number of different proposals exist, then, none manages to tie together the syntactic, semantic and phonological aspects of the verbal system. The existing work does leave us in prime position to ask what the morphosyntax behind the different forms is, and how it translates into templatic *effects*. My answers to these questions lead me to make the following assumptions. Like in McCarthy (1981), I too believe that the consonantal root lies at the core of the Semitic lexicon. Unlike in his theory, I do not postulate independent CV skeletons and do not accord the prosody morphemic status. Instead, following the seminal work of Doron (2003), I decompose the templates into functional heads. Building on the ideas of Arad (2005), I develop a theory of Voice which is the locus of argument structure alternations as well as phonological exponence. The templates or skeletons are now a by-product of how functional heads are processed and regulated by the phonology of the language. In the current paper, the term "template" is used in a descriptive sense, referring to morphophonological patterns such as

"CaCaCCaC" without treating them as morphological primitives. There is no skeleton CVCVCCVC yielding *takattab* as in (1a), for example: there would be a prefix *ta-*, a number of vowels spelling out Voice, gemination spelling out an additional head, and the organization of these segments will proceed in a way that satisfies the phonology without making reference to prosodic primitives.

As a consequence of this approach, Semitic differs from other language families not in having unique kinds of morphemes but in generalizations about what the phonology of individual elements is like: a root is triconsonantal, for example, and a functional head might be spelled out as a prefix and an infix. Under this view, the syntax is rigid but lexical roots provide the locus of exceptionality, both in the semantics and in the phonology. The emerging picture is one in which the syntax generates structure which is then interpreted at the interfaces as long as it satisfies idiosyncratic requirements of individual roots.

The data in this paper are drawn from the seven verbal templates of Modern Hebrew, allowing us to make a direct comparison with competing theories of non-concatenative morphology. Support for my own view is given by going beyond citation forms, considering all parts of the morphological system across tenses, agreement features, templates and root classes. The current analysis also predicts where linear intervention effects arise, as certain structural configurations do not allow for allomorphic interactions between elements. Previous accounts overgenerate forms across different tense features and are not able to account for the syntactic and semantic characteristics of different templates. In terms of competing hypotheses, the paper claims that Semitic morphology requires recourse to a morphemic root and a number of functional heads, whose composition with the root derives the templatic effects both in the syntax-semantics and in the phonology. In terms of appeal beyond Semitic, the current study thus demonstrates that a cyclic, syntax-based approach to morphology with rigid locality constraints is well suited not only to languages with concatenative morphology but to templatic morphology of the Semitic kind as well.

The paper is organized as follows. Section 2 introduces the basics of the Hebrew verbal system, outlining what is constant and what varies from root to root and from template to template. Section 3 develops a theory of the Hebrew verb in Distributed Morphology (Halle and Marantz 1993). Here the templatic effects will emerge as the result of spelling out functional heads which themselves are necessary for the syntactic work done by each template. Section 4 tests the predictions made by this theory for cases of intervention between affixes. Sections 5 and 6 compare this account with the stem-based approach and with a recent root-based approach. Section 7 concludes with a number of topics for further research, including surface forms, underlying representations, and how these might be learned.

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2 Roots, templates and alternations

Modern Hebrew makes use of seven distinct morphophonological verbal forms in which a given root may or may not be instantiated. The argument structure alternations can be straightforward, as in (2), or more opaque, as in (3). Very few roots instantiate all seven templates, and many appear only in two or three; I begin here with a subset of four verbal templates out of the seven. X, Y and Z are placeholders for the root consonants. The non-syllabic diacritic Y̯ marks a consonant which does not spirantize, an issue that is explored further in Sect. 3.3. The template *heXYiZ* usually appears in the literature as *hi̱XYiZ*, with the first vowel an /i/, reflecting older usage; nothing hinges on this distinction.

(2) Some forms for $\sqrt{\text{ktb}}$, generally associated with writing.

	Template	Verb	Gloss	Note
a.	*XaYaZ*	katav	‘wrote’	unmarked/transitive
b.	*niXYaZ*	nixtav	‘was written’	anticausative of *XaYaZ* (2a)
c.	*heXYiZ*	hextiv	‘dictated’	causative of *XaYaZ* (2a)
d.	*huXYaZ*	huxtav	‘was dictated’	passive of *heXYiZ* (2c)

(3) Some forms for $\sqrt{\text{pk̯d}}$, generally associated with surveying or commanding.

	Template	Verb	Gloss	Note
a.	*XaYaZ*	pakad	‘ordered’	
b.	*niXYaZ*	nifkad	‘was absent’	not an anticausative of *XaYaZ* (3a)
c.	*heXYiZ*	hefkid	‘deposited’	not a causative of *XaYaZ* (3a)
d.	*huXYaZ*	hufkad	‘was deposited’	always a passive of *heXYiZ* (3c)

It can already be seen that there are some regularities and some irregularities to the system. Roots usually have one overarching semantic field but the relation between forms is not necessarily transparent: *writing* and *dictating* are similar, but *ordering* and *depositing* much less so. Similarly with respect to the templates, some participate in predictable argument structure alternations (*huXYaZ* is always a passivized version of *heXYiZ*) but at other times the semantic contribution of a given template is much harder to pin down (Doron 2003; Arad 2005).

In order to understand how these forms are generated we will need to distinguish between what is lexically specified (crucially depends on the root) and what must be the same across the paradigm (underspecified and can be filled in by the grammar). I begin by examining the Hebrew data more closely.

2.1 Hebrew preliminaries

The consonantal inventory of Modern Hebrew is given in Table 1, where the highlighted segments are those that undergo spirantization to their fricative counterparts. Segments in parentheses are either limited to loanwords (ʧ, ʤ, ʒ) or are slowly disappearing (ʔ, h).[1] I transcribe /ɡ/ as “g”, /χ/ as “x” and /ʁ/ as “r”. Syncopated vowels are marked in this paper with angled brackets, *hal<a>xá* = [halxá]. Acute accents are used to mark stress.

	Labial	Dental	Alveloar	Palato-alveolar	Palatal	Velar	Uvular	Glottal
Stop	p b	t d				k g		(ʔ)
Nasal	m	n						
Fricative	f v		s z	ʃ (ʒ)			χ ʁ	(h)
Affricate			ts	(ʧ) (ʤ)				
Approximant	w	l			j	w		

Table 1: The consonantal inventory of Modern Hebrew. Spirantizing segments are highlighted, marginal segments are in parentheses.

A process of spirantization causes the stops /p/, /b/ and /k/ to undergo lenition to [f], [v] and [x] following a vowel. The examples in (4a–c) show a few regular verbs in *XaYaZ* and their future forms. The examples in (4d–f) demonstrate a number of roots with spirantizing stops. Underlying /k̯/ never spirantizes to [x], unlike /k/.

[1] The /h/ is still pronounced by some older speakers and certain sociolinguistic groups, often marginalized ones (Schwarzwald 1981; Gafter 2014).

(4) Spirantization and tense alternations:

	Root		Past 3SG.M	Future 3SG.M
a.	‘light’	√dlk̯	dalak	ji-dlok (*ji-zlok)
b.	‘steal’	√gnv	ganav	ji-gnov (*ji-ɣnov)
c.	‘pull’	√mʃx	maʃax	ji-mʃox (*ji-vʃox)
d.	‘meet’	√**p**gʃ	**p**agaʃ	ji-**f**goʃ
e.	‘write’	√**k**t**b**	**k**ata**v**	ji-**x**to**v**
f.	‘cancel’	√**b**tl	**b**itel	je-**v**atel

This process will be returned to in Sect. 3.3. We will now see how the standard picture in (4) is marred by the rest of the language: first roots, then templates.

2.2 Lexical exceptionality in root classes

In order to understand the allomorphic alternations of Hebrew, we must first distinguish between lexical and structural factors. The verbal morphophonology of Hebrew is fairly uniform once a template is specified: most roots enter into a predictable alternation in a given template. For example, the “simple” template *XaYaZ* forms past tense 3SG.M verbs as *XaYaZ* and future ones as *jiXYoZ*. Some examples were seen in (4a–c) and a few more are given in (5). This section discusses lexical exceptions: roots which disrupt the regularity of paradigms like (5). Some roots can alter the vowels of the verbal stem and even elide segments in ways which are often systematic, but not entirely so.

(5) Some regular roots in *XaYaZ*:

	Root		Past 3SG.M *XaYaZ*	Future 3SG.M *jiXYoZ*
a.	‘write’	√ktb	katav	jixtov
b.	‘wash’	√ʃtf	ʃataf	jiʃtof
c.	‘break’	√ʃbr	ʃavar	jiʃbor

Semitic roots are traditionally classified into different classes defined by their hypothesized underlying consonantal representations: /j/-final √XYj, /ʔ/-final √XYʔ, /n/-initial √nYZ, geminated/spread √XYY, and so on. In this sense, root classes are similar to the conjugation classes of many European languages (although the analogy is not complete). In each class, the forms of verbs in some tenses may be different than in regular roots such as those in (5). Within a given template and tense, these differences mostly include changes to the *stem vowels* which slot between and around the root consonants. A recent formalization of the division to classes can be found in Faust (2016).

(6) Some irregular roots in *XaYaZ* by root class with predictable alternations:

Class		Root		Past 3SG.M		Future 3SG.M	
/j/-final √XYj	a.	‘happen’	√k̯rj	kara	(*karaj)	jikre	(*jikroj)
	b.	‘want’	√rtsj	ratsa	(*ratsaj)	jirtse	(*jirtsoj)
	c.	‘buy’	√k̯nj	kana	(*kanaj)	jikne	(*jiknoj)
/ʔ/-final √XYʔ	d.	‘freeze’	√k̯pʔ	kafa	(*kafaʔ)	jikpa	(*jikpoʔ)
	e.	‘read’	√k̯rʔ	kara	(*karaʔ)	jikra	(*jikroʔ)
/w/-medial √XwZ	f.	‘reside’	√gwr	gar	(*gawar)	jagur	(*jigwor)
	g.	‘get up’	√k̯wm	kam	(*kawam)	jakum	(*jikwom)

Later on, in Sect. 7.1, I will revisit the question of whether it is accurate to speak of underlying consonants or whether we should only discuss surface forms. For the meantime, certain underlying consonants can be seen in other forms. For example, the action nominal of *XaYaZ* is in the pattern *XYiZa*. The root-final /j/ of √k̯nj from (6c) and the /ʔ/ of √k̯pʔ from (6d) do not surface in the past or future but do surface in the action nominal, (7). Modern usage often omits the glottal stop, as noted earlier.

(7) Hypothesized root consonants appear in other forms instantiating the same root:

	Root	Past 3SG.M	Action nominal
a.	√ʃbr	ʃavar	ʃvira ‘breaking’
b.	√knj	kana	knija ‘buying’
c.	√kpʔ	kafa	kfiʔa ‘freezing’

Some classes do not show predictable alternations like those in (6), as can be seen from the idiosyncratic forms in (8). There are also root-specific exceptions, (9).

(8) Some /n/-initial roots in *XaYaZ*, √nYZ, without predictable alternations:

Class			Root	Past 3SG.M	Future 3SG.M	
/n/-initial √nYZ	a.	‘fall’	√npl	nafal	jipol	(*jinpol)
	b.	‘give’	√ntn	natan	jiten	(*jinton)
	c.	‘avenge’	√nkm	nakam	jinkom	
	b.	‘drip’	√nzl	nazal	jizol/jinzol/jizal	

(9) Other idiosyncratic exceptions in *XaYaZ*:

Class			Root	Past 3SG.M	Future 3SG.M	
Various exceptions	a.	‘lie down’	√ʃkb	ʃaxav	jiʃkav	(*jiʃkov)
	b.	‘wear’	√lbʃ	lavaʃ	jilbaʃ	(*jilboʃ)
	c.	‘learn’	√lmd	lamad	jilmad	(*jilmod)
	d.	‘whisper’	√lxʃ	laxaʃ	jilxaʃ	(*jilxoʃ)
	e.	‘take’	√lkx	lakax	jikax	(*jilkox)
	f.	‘travel’	√nsa	nasa	jisa, jinsa	(*jinso)
	g.	‘ride’	√rkb	raxav	jirkav	(*jirkov)

It is difficult to estimate what proportion verbs such as those in (6)–(9) make up of the entire language since the existing corpora do not have the fine-grained annotation which would make such a search immediately straightforward. Yet these forms are frequent and at least some root classes show productive alternations in nonce words (Moore-Cantwell 2013; Asherov and Bat-El 2016).

Similar effects arise in other templates, for instance in *XiYeZ* in (10).

(10) A regular and irregular root in *XiYeZ*:

Class			Root	Past 3SG.M	Future 3SG.M
Regular √XYZ	a.	‘complicate’	√sbx	sibex	jesabex
Doubled √XYY	b.	‘spin’	√svv	sovev	jesovev

In all these cases, the alternations are due to idiosyncratic requirements of specific lexical items (roots) and are not the result of predictable, phonologically-conditioned processes (Faust 2012). For example, future *jikne* ‘will buy’ is derived from √knj in *XaYaZ*, as can be gleaned from nominal forms such as *knija* ‘buying’. The regular form would have been **jiknoj*, (6a–c). The process giving *jikne* instead is relativized to √XYj, not a general rule which turns /oj/ into [e], (11).

(11) No general rule of Hebrew */oj/ → [e]:

a.	/ojev/	‘enemy’	→	[o.jev]	(*eev)
b.	/avoj/	‘woe! (interjection)’	→	[a.voj]	(*ave)
c.	/oj/	‘oi! (interjection)’	→	[oj]	(*e)

To summarize the first set of examples, the stem vowels may be conditioned by the root. One immediate question is to what extent lexical exceptionality is maintained across templates and when do templates ignore lexical idiosyncrasies. In order to approach this topic we will need a theory of how the verbal forms are derived.

2.3 Alternations by template

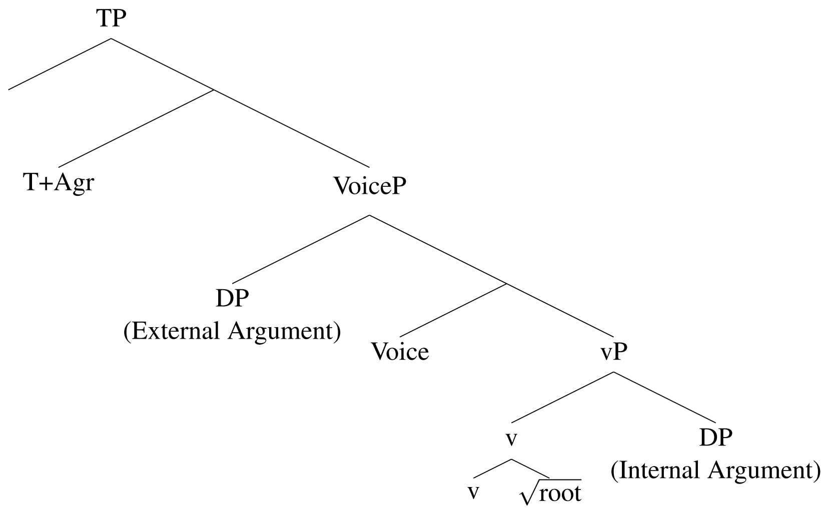
This paper implements a version of Distributed Morphology (Halle and Marantz 1993) in which abstract roots and functional syntactic heads are part of the syntactic derivation; there is no separate morphological component to the grammar (Embick 2015). The syntactic structure is derived as is commonly assumed, phase by phase (Chomsky 1995, 2001), and sent off for interpretation at the interfaces with the phonology and the semantics. Upon interpretation in the phonological component (Spell-Out), abstract morphemes are replaced with phonologically contentful Vocabulary Items (VIs) via a process of Vocabulary Insertion.

We are interested in the difference between roots and functional morphemes as a way of getting at the loci of idiosyncrasy and systematicity in the grammar. The root is an acategorial morpheme: the English verb *walk*, for example, consists under these assumptions of a root $\sqrt{\text{WALK}}$ adjoined to a verbalizing categorizer, little v. There are three such categorizers: a, n, and v, which serve to categorize roots as adjectives, nouns or verbs (Marantz 2001; Arad 2003, 2005; Wood and Marantz 2017). I make no distinction between the Semitic consonantal root and the abstract root of Distributed Morphology since I take the two to be one and the same. This is a main point of contention in the debate between the syntactic, root-based approach and the lexicalist, stem-based approach of Sect. 5 (Aronoff 1994; Bat-El 1994; Ussishkin 2005): on the stem-based approach there are no roots, be they abstract or consonantal.

2.3.1 Morphosyntactic preliminaries

The functional head v introduces an event variable and categorizes a root as a verb. The internal argument (object) is the complement of v. A higher functional head, Voice, introduces the external argument (Kratzer 1996; Pylkkänen 2008; Marantz 2013b). T is the locus of tense and agreement features, post-syntactically yielding two exponents, T and Agr. A basic structure is given in (12).

(12) Basic structure of a TP:



In order to derive the full range of templates in Hebrew, a few variants of these heads are also necessary. In general, morphemes affecting transitivity are variants of Voice (Doron 2013), as proposed for a range of languages including English (Bruening 2014), French (Labelle 2008), German (Schäfer 2008; Alexiadou et al. 2015), Greek (Alexiadou and Doron 2012; Spathas et al. 2015) and Icelandic (Wood 2015).

I assume that Voice has a syntactic feature [±D], which either requires or prohibits a DP from merging in its specifier (Kastner 2016, 2017). As a result, Voice can be instantiated in three different ways, (13): [+D], [–D] or underspecified for [±D] (see Harbour 2011 for similar logic applied to person features). [±D] is basically an EPP feature, as per Chomsky (1995) who recast the EPP as a privative

[D] feature on T.

(13) Three variants of Voice:

			DP in Spec,VoiceP	Semantics
a.	$\text{Voice}_{\{D\}}$	(active)	Required	$\lambda x \lambda e.\text{Cause}(x,e)$
b.	$\text{Voice}_{\varnothing}$	(non-active)	Prohibited	$\lambda P_{<s,t>}.P$
c.	Voice	(underspecified)	Underspecified	Underspecified

The tripartite classification of Voice heads need not be overt in all languages, but I will suggest that the three variants have distinct exponents in Hebrew. The generative possibilities of this system are such that verbs derived using using $\text{Voice}_{\{D\}}$ will be unergative or transitive, (14a). Conversely, verbs derived using $\text{Voice}_{\varnothing}$ will be unaccusative, since no external argument may be merged, (15a). Finally, verbs derived using unmarked Voice will be underspecified in this regard, (14b), (15b).

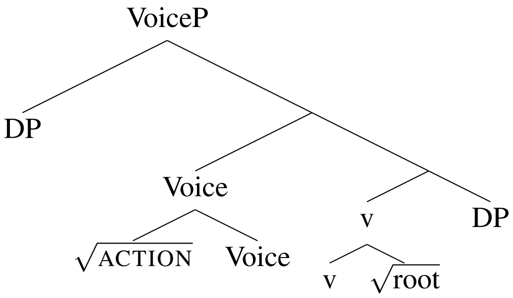
(14) a. Transitive *heXYiZ* ($\text{Voice}_{\{D\}}$)
ha-agronomit ***hegdil-a*** *et ha-jevul*
the-agronomist increased-F.SG ACC the-crop
'The agronomist increased the crops.' (After Doron 2003:27)

b. Unaccusative *XaYaZ* (Voice)
ha-jevul ***gadal*** *pi eser*
the-crops grew times ten
'The crops grew tenfold.'

(15) a. Unaccusative *niXYaZ* ($\text{Voice}_{\varnothing}$)
ha-ʃa'ar ***niftax***
the-gate opened
'The gate opened.'

b. Transitive *XaYaZ* (Voice)
josi ***patax*** *et ha-ʃa'ar*
Yossi opened ACC the-gate
'Yossi opened the gate.'

In Sect. 3.3.2 I extend the system by assuming an additional element $\sqrt{\text{ACTION}}$ which may adjoin to Voice as in (16), enforcing an agentive reading of the verb. This element has been argued to be a root by Kastner (2017), although it is not crucial for present purposes whether it should be treated as a root or a functional head. Its main function, as is shown later on, is to entail that the external argument is an Agent, rather than an inanimate Cause, though individual roots might entail agentive readings even without $\sqrt{\text{ACTION}}$ (as with English *assassinate*).

(16)


The different "flavors" of Voice thus have predictable syntactic and semantic behavior; the rest of this article develops the theory behind their phonological behavior and how it interacts with idiosyncratic information in the root. Table 2 summarizes the contribution of the different morphemes that will be used in this paper, resulting in the seven verbal templates of Hebrew (and will be repeated in Sect. 4.5 as a summary). Empty cells are underspecified and "EA" stands for obligatory external argument. For full justification see Kastner (2016); the seven templates can be seen under the column marked "Phonology".

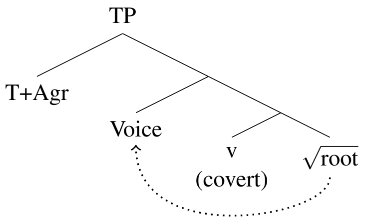
	Heads		Syntax	Semantics	Phonology	Sect.
	Voice				*XaYaZ*	3
	Voice	√ACTION		**Agentive**	*XiY̭eZ*	3.3.2
Pass	Voice	√ACTION	*Passive*	**Agentive**	*XuY̭aZ*	4.3
	Voice$_{\{D\}}$		EA		*he-XYiZ*	3.1.2
Pass	Voice$_{\{D\}}$		*Passive*		*hu-XYaZ*	4.3
	Voice$_{\emptyset}$		No EA		*ni-XYaZ*	4.5
	Voice$_{\emptyset}$	√ACTION	No EA	**Agentive**	*hit-XaY̭eZ*	4.5

Table 2: The requirements of functional heads in the Hebrew verb.

2.3.2 Morphophonological preliminaries

Let us see how this system works by analyzing an alternation such as *katav* 'wrote' ∼ *jixtov* 'will write' in *XaYaZ*. A simplified structure is given in (17), leaving out the internal and external arguments. To recap, little v is a categorizing head, verbalizing an acategorial root. Voice is the standard head that introduces an external argument. The dotted arrow should be read as "conditions allomorphy on".

(17) Simplified structure of a TP:



On my analysis, little v is phonologically null in Hebrew (by hypothesis). Hebrew stem vowels originate on Voice. Contextual allomorphy of Voice is conditioned by the identity of the root. The two, Voice and the root, are in a local relationship after Spell-Out since v is covert (phonologically silent): the sequence is linearized as Voice-v-√root, at which point covert elements like v are removed ("Pruning", Embick 2010). Since Voice and √root are now linearly adjacent, the latter can condition allomorphy on the former. In Sect. 4 I explain further how this theory of allomorphy requires linear adjacency between the allomorphic trigger and target.

Following ideas first made explicit by McCarthy (1981), I assume that the stem vowels are spelled out as unmarked *a-a* in the past tense of *XaYaZ*. In the future only one vowel is inserted, *o*. Vocabulary Insertion proceeds "inside-out" from the most deeply embedded element, typically the root (Bobaljik 2000, 2012; Marantz 2013a). Vocabulary Items (lexical entries) are given in (18). Past and future forms are derived from the root. The stem-based approach contrasted in Sect. 5 would generate these verbs differently, deriving the future form from the past tense form.

(18) Vocabulary Items for:
√XYZ *katav* 'wrote' ∼ *jixtov* 'will write'
√XYj *kara* 'happened' ∼ *jikre* 'will happen'
√XYʔ *kafa* 'froze' ∼ *jikpa* 'will freeze'.

a. √XYZ ↔ *XYZ*
b. √XYj ↔ *XYe* / T[Fut] ___
c. √XYʔ ↔ *XYa* / T[Fut] ___
d. v ↔ (covert)

e. $\text{Voice} \leftrightarrow \begin{cases} a{,}a & \text{/ T[Past] \_\_\_} \\ o & \text{/ T[Fut] \_\_\_} \\ \text{(covert)} & \text{/ T[Fut] \_\_\_} \ \sqrt{\text{XYj}} \\ \text{(covert)} & \text{/ T[Fut] \_\_\_} \ \sqrt{\text{XY?}} \\ \ldots \end{cases}$

f. T[3SG Fut] ↔ *ji*

The notation used here for the identity of roots is meant as an index to a store of phonological information. Notation like "$\sqrt{\text{ktb}}$ ↔ *ktb*" will be used as shorthand for extrapolating (18) upon lexical insertion: "$\sqrt{\text{XYZ}}$ ↔ *XYZ*, where X=k, Y=t, Z=b". Then, $\sqrt{\text{XYj}}$ roots could be analyzed as roots whose underlying representation is *XY* plus a vocalic diacritic, as *XYi*, or as $\sqrt{\text{\#123}}$ with an abstract pointer to the relevant underlying representations. The latter option is the most likely, since some root suppletion exists in Hebrew, as in (19). The existence of two phonological forms for the same root indicates that its content is more likely to consist of a pointer than one of the two actual forms (Harley 2014a,b; Faust 2014, 2016), with content inserted "late".

(19) *amar* 'said' ∼ *jagid* 'will say'

In what follows I combine these kinds of Vocabulary Items in an Optimality Theoretic grammar (Prince and Smolensky 1993/2004). In essence, the stem vowels are treated as contextually conditioned segments hosted on the Voice head. That is to say, the vowels can be seen either as a spell-out of Voice or as a spell-out of a Theme head adjoined to Voice post-syntactically, as in Oltra Massuet (1999) and Embick (2010). At this point I see no difference emerging between the two possibilities and will treat the vowels as exponents of Voice for simplicity. The upshot of this configuration is that the root can determine the choice of theme vowels. I next explain how tense and agreement information interact with the root, deriving the templatic effects explicitly.

---

3 Concatenating the non-concatenative

Let us see a simple case of spirantization in action before we begin inflecting the verbs and deriving templates. The linearized structure is T[Past]-Voice-v-$\sqrt{\text{spr}}$.

(20) *safár* 'counted':

a. Voice ↔ *a,a* / T[Past] ___

b. v ↔ (covert)

c. $\sqrt{\text{spr}}$ ↔ *spr*

For the phonological component of the grammar, a subset of the constraints used by Temkin Martínez (2010) in her treatment of Hebrew will be adopted:

(21) a. ***V-STOP**: Postvocalic stops are prohibited.
Assign a violation mark for every stop preceded by a vowel.

b. **IDENT(CONT)**: Input-output correspondents are identical in [cont].
Assign a violation mark for every segment in the input whose output correspondent differs in its value for [cont].

To these I add:

(22) a. ***COMPLEX** (Prince and Smolensky 1993/2004; Bat-El 2008):
No complex clusters.
Assign a violation mark for every consonant followed by another consonant in syllable

onset, nucleus or coda, *[...CC...]$_\sigma$.

b. **STRESS-TO-WEIGHT PRINCIPLE (SWP)** (Prince 1990:358):
If stressed, then heavy.
Assign a violation mark for every monomoraic stressed syllable, *CV́]$_\sigma$.

I assume that Hebrew feet are iambic in verbs; for in-depth discussions of the intricacies of Hebrew stress, especially in the nominal domain, see Graf and Ussishkin (2002), Becker (2003), Bat-El (1993, 2008) and Ussishkin (2005).

Lexical items are concatenated **cyclically**, according to the structure: outer elements are linearized to the left. The tableau in (23) shows two processes applying at once: postvocalic spirantization, (23b–c), and insertion of the stem vowels. The overall rarity of coda clusters in Hebrew is accounted for by *COMPLEX, here ruling out (23a); I set aside clusters licensed by sonority rises.

(23) [T[Past] [Voice [v $\sqrt{\text{spr}}$]]] 'counted':

	a,a-spr	*COMPLEX	*V-STOP	SWP	ID(CONT)
	a. aaspr	*!			
☞	b. safár				*
	c. sapár		*!		
	d. safrá			*!	*

When /p/ does not follow a vowel it is produced faithfully as [p], as in *mis**p**ar* 'number'. This derivation shows how the underlying /p/ is spirantized as [f] in *safar*.

Next, in Section 3.1 I go beyond the citation form (3rd person masculine singular past tense) and show how agreement morphology is captured in this system, extending the discussion to additional templates. Section 3.2 reintroduces root exceptionality, deriving the correct forms across roots, tenses, templates and agreement features. Section 3.3 reintroduces spirantization.

3.1 Tense and agreement

This section fleshes out how in the same template, different combinations of stem vowels arise depending on tense and agreement. In anticipation of some confounding issues, I will first of all explain the cyclic "inside-out" derivation and the process of syncope.

3.1.1 Affixes, syncope and cycles

Systematic interactions of stress and syncope are prevalent in Semitic (Kiparsky 2000, 2012; Wolf 2011; Wallace 2013). Here I illustrate the basics of syncope in Hebrew within the current framework in the service of two goals: to extend the empirical coverage beyond that of existing accounts (Graf and Ussishkin 2002; Bat-El 2008), and to isolate the effects of phonology when discussing the effects of morphosyntax.

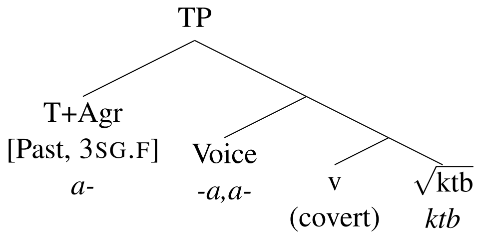
Descriptively speaking, some Hebrew affixes bear stress; when they attach to the stem, its previously stressed vowel syncopates. See the 3SG.F, 3PL.M and 3PL.F forms in (24).

(24) Past tense *a,á* for *katáv* 'wrote':

	XaYaZ $\sqrt{\text{ktb}}$	
	SG	PL
1	katáv-ti	katáv-nu
2M	katáv-ta	katáv-tem
2F	katáv-t	katáv-tem
3M	katáv	kat<á>v-ú
3F	kat<á>v-á	kat<á>v-ú

The structure for *katvá* 'she wrote' is as in (25). Vocabulary Insertion and phonological calculation apply incrementally.

(25) *katvá* 'she wrote':



Again, note that Spell-out proceeds **cyclically** (Bobaljik 2000; McCarthy 2007, 2008a,b; Wolf 2008): first Voice and v combine with √ktb to give *katáv*, and only then does the agreement suffix *-a* attach in an additional cycle (VoiceP is a phase). Covert v is ignored throughout this article: since it is phonologically contentless, it does not violate formal constraints and its combination with the root is glossed over.

(26) T[Past, 3SG.F]-Voice-√ktb, *katvá* 'she wrote'

a. √ktb ↔ *ktb*

b. Voice ↔ *a,a* / T[Past] ___

c. *a,a-ktb*

d. At this point the phonology would yield:
⇒ *katáv*. See (23) for a similar derivation.

e. T[Past, 3SG.F]-*katáv*

f. 3SG.F ↔ *á* / Past ___

g. *á-katáv*

h. Phonology yields:
⇒ *katvá*. See (27) for the derivation.

This framework is similar to Optimality Theory with Optimal Interleaving (Wolf 2008) in that morphemes are inserted and evaluated sequentially. However, unlike OT-OI, there is no need for PRECEDENCE constraints to help regulate the phonology of different morphemes: the order is read directly off the tree, inviolably inside-out. The theories are similar in assuming spell-out from the root outwards (Wolf 2008:160) and in rejecting whole-phase spell-out (Wolf 2008:418). In contrast, though, my cycles proceed according to the syntactic structure which also feeds semantic interpretation (see Sande and Jenks 2017 for a similar approach).

The tableau in (27) illustrates how syncope arises when a stressed stem vowel "loses" its stress to a stressed affix. I adopt the standard constraints **ONSET**, **ALLFTRT** and **MAX** (Prince and Smolensky 1993/2004) from the the analysis of Hebrew stress in Graf and Ussishkin (2002), as well as their ranking; we will see that ALLFTRT often enforces a disyllabic output, (27a–b). **REALIZEMORPHEME** (Rose 1997; Kurisu 2001) ensures that morphemes have a realization in the output, ruling out (27d).

(27) [T[3SG.F] *katáv*] 'she wrote':

	$á_{3SG.F}$ + katáv	ONSET	RM	CONTIG	ALIGN-WD	ALLFTRT	*V-STOP	SWP	MAX
	a. (ka)(ta.vá)				*	*!		*	
☞	b. (kat.vá)				*			*	*
	c. (ka.táv)a	*!							
	d. (ka.táv)		*!						*

Two more constraints will be necessary for additional cases of cyclicity later on. The first implements the cyclic assumption that material from a later cycle cannot overwrite material from a form cycle, comparable to "bracket erasure" of Lexical Phonology and related theories (e.g. Kiparsky 1982). The assumption that a stem from a previous cycle may not be overwritten is implemented here as a general correspondence constraint **CONTIG** (McCarthy and Prince 1995). This constraint is dominated by the highly-ranked *COMPLEX, which is why the templatic vowels can be inserted between the root consonants in the first place.

(28) **CONTIG** (McCarthy and Prince 1995:123): "No Intrusion" (O-CONTIG).
The portion of the Output standing in correspondence forms a contiguous string.

The second is a constraint regulating stress placement. In their detailed study of stress in Hebrew, Graf and Ussishkin (2002) formulate a number of generalizations tying stress to the footing possibilities of affixes and assume the existence of highly-ranked **ALIGN-WD**. This constraint aligns the right edge of a stem (as in *katav*) with the right edge of the prosodic word and forces affixes to be extraoutputmetrical, as in (27c).

A form whose suffix is consonant-initial like *katáv-ti* is derived in similar fashion: the footing [(ka.táv)ti] is preferred to [ka(tav.tí)] since the latter violates ALIGN-WD; see Graf and Ussishkin (2002:263).[2]

This discussion served to illustrate how the regular phonology can proceed without recourse to any Semitic-specific constraints. With this interlude for syncope out of the way we return to the main phenomenon: templatic effects in the morphophonology across morphosyntactic features.

3.1.2 Beyond citation forms

We are asking how best to account for the alternations that make up the verbal system of Hebrew. So far we have seen the basics of how the root interacts with functional heads. I will now demonstrate how this theory accounts for the behavior of different agreement features, mounting an argument against independent templates.

The stem vowels in (24) above are invariant: *a,a*. But in the three templates *XiY̯eZ*, *hitXaY̯eZ* and *heXYiZ*, the past tense vowels are determined by the subject's phi-features, depending on whether the subject is 1st/2nd person or 3rd person. The paradigms in (29) use $\sqrt{\text{bʃl}}$. In *XiY̯eZ* ('cooked') and *hitXaY̯eZ* ('got cooked'), 1st/2nd person have /a/ as the second vowel and 3rd person has /e/ (though this is only visible for 3SG.M). In *heXYiZ* ('ripened'), 3rd person has /i/. Boldfaced vowels show the difference in agreement: /a/ above the line (1st and 2nd person), /e/ or /i/ below it (3rd person). There are thus different vowels for different values of T.

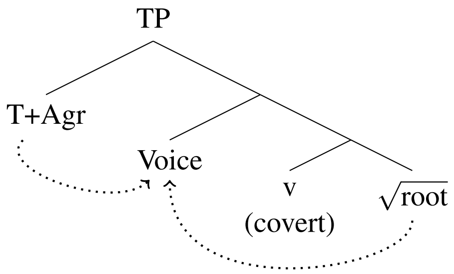
(29) Past tense, vowels alternate:

	XiY̯eZ $\sqrt{\text{bʃl}}$		*hitXaY̯eZ* $\sqrt{\text{bʃl}}$		*heXYiZ* $\sqrt{\text{bʃl}}$	
	SG	PL	SG	PL	SG	PL
1	biʃál-ti	biʃál-nu	hitbaʃál-ti	hitbaʃál-nu	hevʃál-ti	hevʃál-nu
2M	biʃál-ta	biʃál-tem	hitbaʃál-ta	hitbaʃál-tem	hevʃál-ta	hevʃál-tem
2F	biʃál-t	biʃál-tem	hitbaʃál-t	hitbaʃál-tem	hevʃál-t	hevʃál-tem
3M	biʃ**é**l	biʃ<**é**>l-ú	hitbaʃ**é**l	hitbaʃ<**é**>l-ú	hevʃ**í**l	hevʃ**í**l-u
3F	biʃ<**é**>l-á	biʃ<**é**>l-ú	hitbaʃ<**é**>l-á	hitbaʃ<**é**>l-ú	hevʃ**í**l-a	hevʃ**í**l-u

Recall that vowels are treated here as the spell-out of Voice. Since Voice is local to T+Agr, T+Agr can condition allomorphy of the vowels. This conditioning is symbolized by the higher dotted arrow in (30). As a result, different phi-feature values condition different stem vowels as in (29). The lower dotted arrow was already introduced in (17) to signal that the root can condition allomorphy (vowels) on Voice.

[2] On this particular formulation affixes must be stipulated to be outside the prosodic word. Whether this kind of assumption is necessary is an issue I will not resolve here, although it is definitely emblematic of the recurring question of which affixes are realized as prefixes and which ones are realized as suffixes. Bat-El (2008:45) proposes a similar account, assuming a constraint DEP-σ which forces disyllabicity. However, that analysis would take as input the 1SG.PL past /halax-ti/ 'I walked' and wrongly generate disyllabic **haláxt* instead of *haláxti*.

(30)



To derive a verb like *hevʃálti* 'I ripened' in *heXYiZ*, I assume that the derivation might contain the syntactic head Voice$_{\{D\}}$ which requires a DP in its specifier, as laid out in Sect. 2.3.1 (Kastner To appear). When this head is part of the syntactic structure, verbs are predicted to be either unergative (if there is no internal argument) or transitive. The head guarantees that there is an external argument; verbs in this template are productively causative. For example, *hevʃil* 'ripened' is traditionally an inchoative verb but can be used causatively as well:

(31) *hitgabrut ha-mudaut he-svivatit* ***hevʃila*** *et ha-tnaim le-pitux-o*
increase the-consciousness the-environmental **ripened** ACC the-conditions to-development-its
ʃel projekt nosaf
of project additional
'The rise in environmental consciousness set the stage for developing another project.'[3]

See Doron (2003) and Kastner (To appear) for additional discussion of the syntax and morphosemantics of *heXYiZ*. The derivation proceeds along the lines of (32)–(33).

(32) *heXYiZ*: *hevʃál-ti* 1SG.PAST ∼ *hevʃíl-a* 3SG.F.PAST

a. Voice$_{\{D\}}$ ↔ *he*, $\begin{cases} i \\ a \quad / \text{T[1st]} \_\_ \end{cases}$

b. 1SG ↔ *ti* / ___ Past

c. 3SG.F ↔ *a* / ___ Past

d. √bʃl ↔ *bʃl*

(33) a. *hevʃ**á**lti* 'I ripened': [T[Past,1SG] [Voice$_{\{D\}}$ [v √bʃl]]]
Cycle 1 (VoiceP): he-vʃál
Cycle 2 (TP): hevʃál-ti

b. *hevʃ**í**la* 'she ripened': [T[Past,3SG.F] [Voice$_{\{D\}}$ [v √bʃl]]]
Cycle 1 (VoiceP): he-vʃíl
Cycle 2 (TP): hevʃíl-a

The correct placement of the agreement affixes is regulated by the same constraints seen in (27) above, with CONTIG crucially protecting a stem derived in a previous cycle.

(34) [T[3SG.F] *hevʃíl*] 'she ripened':

	$a_{3SG.F}$ + hevʃíl	ONSET	RM	CONTIG	ALIGN-WD	MAX
	a. a(hev.ʃíl)	*!				
☞	b. hev(ʃí.la)				*	
	c. (hav.ʃíl)			*!		*
	d. he(va.ʃíl)			*!		
	e. (hev.ʃál)			*!		*
	f. (hev.ʃíl)		*!			*

[3] https://goo.gl/mLX72c (retrieved April 2018).

An alternative to invoking CONTIG in this way would be to specify extrinsically that the agreement affix must attach as a suffix. I will maintain a working hypothesis in which the affix attaches on the left, as in the syntactic tree, and is then positioned by the phonology as in (34). Some proposals attempting to systematically distinguish prefixes from suffixes in Hebrew can be found in Ussishkin (2000), Graf and Ussishkin (2002) and Harbour (2008a).

I have no principled reason, however, for why the 1st and 2nd person vs 3rd person split happens in the past tense but not in the future. The contrast might have to do with the future being built on a more "general" nonpast form, since the same stem of the future is used for infinitives, participles and imperatives.

The VI in (32a) consists of two exponents for one morpheme, a situation raising the question of whether there are more underlying elements. However, it is unclear what additional morphemes could be part of the structure. Furthermore, if we posit a "dissociated" post-syntactic Theme node (end of Sect. 2.3.2), it can be assumed that the prefix spells out Voice and the stem vowel spells out Theme. Finally, there is increasing evidence that one morpheme can be spelled out by multiple exponents, albeit in different empirical domains (as in the hypocoristics documented by Weeda 1992 and related work). See Sande and Jenks (2017) for some examples, or McPherson (2017) and her discussion of van Oostendorp (2005), Wolf (2007) and Trommer (2012).

The current theory has derived its first generalizations by making use of the underlying syntactic structure: Voice spells out theme vowels that may be conditioned by the root and by T+Agr under linear adjacency. Returning to lexical exceptionality, the next section explores how the root conditions Voice.

3.2 Vowels conditioned by T+Agr and the root

The lower of the two arrows in (30) reminds us of the prediction that stem vowels can be conditioned by the identity of the root, since Voice and the root are adjacent over covert v; this is exactly what we have already seen in Sect. 2.2. The Vocabulary Insertion rules in (35) are repeated from above.

(35) a. $\sqrt{\text{XYj}} \leftrightarrow$ *XYe* / T[Fut] ___ (18b)

b. Voice $\leftrightarrow$ (covert) / T[Fut] ___ $\sqrt{\text{XYj}}$ (18e)

As an example of a verb in the class $\sqrt{\text{XYj}}$ take *jikre* 'will happen'. On the first cycle (VoiceP), the rules in (35) insert *kré* as the form of [Voice [v $\sqrt{\text{k̭rj}}$]]. On the second cycle, the 3SG.M prefix *ji*—which is generated on T, above VoiceP—is added. No noteworthy constraints are at play here so I give the simple concatenation:

(36) /ji-k̭ré/ → [jikré] 'will happen'

The templatic effect which could be described as "CaCaC$_{\text{past-I}}$ → jiCCe$_{\text{future-I}}$" is thus achieved without dedicated templates.

The combination of both arrows in (30) further predicts that the separate conditioning for T+Agr on the one hand and for the root on the other hand may interact. This is correct: for a /j/-final root like $\sqrt{\text{lvj}}$, the vowels in *helva* 'lent' are different than for a regular root like $\sqrt{\text{bʃl}}$. In (37), the regular root is on the left ('ripened') and the /j/-final root on the right. Underlined vowels are due to the root class and boldfaced ones are due to agreement. The derivation is sketched in (38).

(37) Past tense for two roots in *heXYiZ*:

	heXYiZ $\sqrt{\text{bʃl}}$		*heXYiZ* $\sqrt{\text{lvj}}$	
	SG	PL	SG	PL
1	hevʃ**á**l-ti	hevʃ**á**l-nu	helv**é**-ti	helv**é**-nu
2M	hevʃ**á**l-ta	hevʃ**á**l-tem	helv**é**-ta	helv**é**-tem
2F	hevʃ**á**l-t	hevʃ**á**l-tem	helv**é**-t	helv**é**-tem
3M	hevʃ**í**l	hevʃ**í**l-u	helv**á**	helv<**á**>-ú
3F	hevʃ**í**l-a	hevʃ**í**l-u	helv<**á**>e-tá	helv<**á**>-ú

(38) *heXYiZ*: *hevʃal-ti* 'I ripened' ∼ *helve-ti* 'I lent'

a. $\text{Voice}_{\{D\}} \leftrightarrow he, \begin{cases} a & /\ \text{T[1st]}\ \_\_ \\ i & \end{cases}$

b. $\sqrt{\text{bʃl}} \leftrightarrow$ *bʃl*

c. $\sqrt{\text{lvj}} \leftrightarrow$ *lve* / $\text{Voice}_{\{D\}}$ ___[4]

d. 1SG ↔ *ti* / ___ Past

Here is what I mean when I say that templates are *emergent* under this theory. Concatenation of the relevant exponents results in the verbal forms typical of the template we descriptively call *heXYiZ*, but there is no primitive *heXYiZ* to speak of. What we have is a syntactic head, in this case $\text{Voice}_{\{D\}}$, which is spelled out as a prefix and a stem vowel, (38a). Prosodic organization is the purview of the phonology: it ensures that verbal forms do not become arbitrarily long, for example, or do not have triconsonantal clusters. It is true that the language in general does not have any roots made up of a dozen consonants; but there is no CVCCVC skeleton in Hebrew that requires consonants and vowels to be filled in. Whether this claim can be extended to all languages is discussed in Sect. 7.2.

One loose end in (37) remains to be tied up. It can be seen that 3SG.F *helve̲tá* has the same vowel as the 1st/2nd forms, /e/, and not /a/ as in 3SG.M *helvá*. This surface similarity is due to the interaction of two separate processes: syncope of underlying *á* and epenthesis to repair an illegal cluster. As shown in Sect. 3.1.1, a stressed affix causes a stressed stem vowel to syncopate: *helv<á>-tá*. However, now an illegal cluster emerges, **hel**vt**á*. This state of affairs is repaired by an epenthetic *-e-*, yielding *helv<á>etá*. This process is regular and extends beyond *heXYiZ*. In the *niXYaZ* template, for instance, syncope of underlying /a/ leads to an illicit cluster, **xns* in (39). This cluster is repaired using an epenthetic /e/; a formal analysis would require a phonological framework built to handle cases of opacity, such as Harmonic Serialism (e.g. the papers in McCarthy and Pater 2016), but should be consistent with the current structural assumptions.

(39) Syncope followed by epenthesis in the regular past tense verb 'entered':

	niXYaZ $\sqrt{\text{kns}}$	
	SG	PL
1	ni-xnás-ti	ni-xnás-nu
2M	ni-xnás-ta	ni-xnás-tem
2F	ni-xnás-t	ni-xnás-tem
3M	ni-xnás	ni-xn<**á̲**>**e̲**s-ú
3F	ni-xn<**á̲**>**e̲**s-á	ni-xn<**á̲**>**e̲**s-ú

Looking at more root classes, the same pattern as in (37) can be seen for a "doubled" root like $\sqrt{\text{svv}}$. Again the vowels in the root class (*sovev* 'spun') are different than in the regular forms (*biʃel* 'cooked'), depending both on the root and on the combination of T+Agr, (40). Underlined vowels are due to the root class and boldfaced ones are due to agreement.

[4]The first cycle of *helvéti* yields /he+a+lve/ → *hel.vé*, which is preferred over *hel.ve.a* due to ONSET and ALLFTRT, and over *he.la.ve* due to ALLFTRT and CONTIG. Nothing said so far explains why *hel.vé* is preferred over *hel.vá* (both violate only MAX). We may assume that MAX or RM give precedence to segments within the most deeply embedded node in the cycle, here *lve*. This solution maintains a strict spell-out of $\sqrt{\text{lvj}}$ as *lve* as a strong hypothesis, but perhaps future work on phonological indices and diacritics will lead to a different conclusion. This case exemplifies how individual roots might have idiosyncratic exponents; see the related discussion concerning the VIs in (18) above.

(40) Past tense for two roots in *XiY̯eZ*:

	XiY̯eZ √bʃl		*XiY̯eZ* √svv	
	SG	PL	SG	PL
1	biʃ**á**l-ti	biʃ**á**l-nu	so̲v**á**v-ti	so̲v**á**v-nu
2M	biʃ**á**l-ta	biʃ**á**l-tem	so̲v**á**v-ta	so̲v**á**v-tem
2F	biʃ**á**l-t	biʃ**á**l-tem	so̲v**á**v-t	so̲v**á**v-tem
3M	biʃ**é**l	biʃ<**é**>l-u	so̲v**é**v	so̲v<**é**>ev-ú
3F	biʃ<**é**>l-á	biʃ<**é**>l-ú	so̲v<**é**>ev-á	so̲v<**é**>ev-ú

The lesson from structures such as (30) and the data above is that syntactic structure dictates what kind of allomorphy is allowed and what element it is conditioned by. Lexical considerations apply "first" (at Vocabulary Insertion), if the root has exceptional phonology such as that of a specific root class, simply because the root is the deepest embedded element in the structure. No other distinction between roots and function morphemes is necessary (Moskal and Smith 2016; Smith et al. 2016). Contextual allomorphy then applies (additional rules of Vocabulary Insertion), followed by the general phonology of the language.

Root classes are thus similar to the conjugation classes of Romance languages (e.g. Oltra Massuet 1999; Bermúdez-Otero 2013) in that a representative vowel or vowels are chosen by the root, in a way that feeds into the rest of the morphophonological derivation but carries no syntactic or semantic import. Diachronically, the classes are a result of phonological processes applying to different kinds of segments. This is why the root classes form natural classes, unlike European conjugation classes: √XYj, √XYY, and so on. However, a synchronic analysis cannot depend solely on phonological factors, as shown by Faust (2012, 2016) on the basis of the final /j/ in √XYj, as well as other Semitic data. In any case, this state of affairs is predicted by our framework: Voice is sensitive to T+Agr and can "see" the features on T while it also "sees" the root. The root classes do not carry morphosyntactic information any more than Indo-European conjugation classes do. Templates arise as an epiphenomenon.

3.3 Spirantization

I conclude the survey of allomorphic interactions with the postvocalic spirantization of /p/, /b/ and /k/. This lenition of stops to fricatives is modulated by both lexical and grammatical (morphosyntactic) factors. These factors are implemented as idiosyncratic information listed with roots, on the one hand, and as functional heads on the other: as before, it will be the case that some roots may be idiosyncratic but all are constrained by the structure.

Two historic processes have led to the two patterns of exceptions which I single out. First, some stops which were historically "guttural" (uvular and pharyngeal) persist in not alternating with fricatives. Second, in two verbal templates spirantization of the middle consonant is blocked.

3.3.1 Exceptions by root

Some roots are exceptional in that they block postvocalic spirantization. These are cases where /k/ and /x/ were historically part of a phonemic distinction between voiceless pharyngeal /ħ/, voiceless uvular /q/ and voiceless velar /k/, plus an allomorphic distinction between /k/ and /x/ (the latter postvocalically unless geminated). In the historic system /ħ/ and /q/ did not participate in alternations but /k/ spirantized to [x]. These distinctions have been preserved in the orthography, (41).

(41) Synchrony and diachrony in spirantization:

Orthography	Historically	Modern	Alternation
ח	/ħ/	/x/	✗
ק	/q/	/k̯/	✗
כ	/k/∼[x]	/k/∼[x]	✓

Following previous studies on spirantization, I assume that the alternation /k/∼[x] is regular and that non-alternating /k̯/ and /x/ are exceptions to the rule. There is evidence that speakers attempt to reduce spirantization irregularities such as these (Schwarzwald 1981; Adam 2002; Temkin Martínez 2008, 2010). Since my aim here is to point out the lexical exceptionality of individual roots, I will not pursue a more precise description of the empirical landscape.

The system must be characterized independently of orthographic aids and diachronic considerations for two main reasons. First, children are only taught the orthography after acquisition of the morphological system has been in full swing. And second, native speakers perform the alternations on nonce words which have no orthographic cues (Temkin Martínez and Müllner 2016).

Consider, then, the three roots in (42). The first is regular, √ktb: in the future tense, its underlying initial /k/ spirantizes postvocalically to [x], as in (42a). The second root, √xnj, has an underlying /x/ and does not undergo fortification to *[k] word-initially in the past tense, (42b) – it was historically √ħnj. The third, √knj, is exceptional: even after a vowel, initial /k̯/ does not spirantize, (42c) – it was historically /qnj/.

(42) Three roots in *XaYaZ*:

	Root		Past 3SG.M	Future 3SG.M
a.	'write'	√ktb	**k**atav	ji-x̱tov
b.	'park'	√xnj	x̱ana	ja-x̱ne
c.	'buy'	√k̯nj	**k**ana	ji-**k**ne

The conclusion is again that individual roots might have special phonology associated with them, which can be looked up e.g. by their abstract index (Sect. 2.3.2), just as they have idiosyncratic interpretations in the semantics. The exceptionality of lexical items must be listed at some level (Chomsky and Halle 1968; Itô and Mester 1995; Pater 2010; Gouskova 2012). Formally, these lexical exceptions can be accounted for either by a constraint which prevents /k̯/ from being realized as [x], or by assuming that a floating [–continuant] feature docks onto the relevant segment in the root. But the syntactic structure plays a role as well, one which I will now delineate.

3.3.2 Exceptions by template

The middle root consonant of the templates *XiY̯eZ*, *hitXaY̯eZ* and *XuY̯aZ* does not spirantize. The former two are demonstrated in (43b,d).

(43) No spirantization of Y̯ in *XiY̯eZ* and *hitXaY̯eZ*:

			Template	Past 3SG.M	Future 3SG.M
√s**p**r	a.	'counted'	*XaYaZ*	saf̱ar	jis**p**or
	b.	'told'	*XiY̯eZ*	si**p**er	jesa**p**er
√l**b**ʃ	c.	'wore'	*XaYaZ*	lav̱aʃ	jil**b**aʃ
	d.	'dressed up'	*hitXaY̯eZ*	hitla**b**eʃ	jitla**b**eʃ

The middle Y̯ was originally geminated (*XiYYeZ*, *hitXaYYeZ* and *XuYYaZ*). These templates are often still notated in similar fashion, in acknowledgment of gemination that is not preserved in contemporary usage (gemination in cognate templates has been preserved in many dialects of Arabic; Tucker 2010; Wallace 2013). A similar phenomenon in Caha was taken by Faust and Hever (2010) as evidence for the consonantal root.

As emphasized throughout this paper, the seven templates have not only unique morphophonological properties but their own syntactic and semantic properties (see Table 2 above). The *XiY̯eZ* template has been called the "intensive" form of the verb (Doron 2003, 2013; Arad 2005). Unlike in studies that implicitly treat *XaYaZ* and *XiY̯eZ* as conjugation classes (Temkin Martínez 2008, 2010, 2013; Temkin Martínez and Müllner 2016; Gouskova 2012), it is worth pointing out that a grammatical difference holds between the two. As discussed by Doron (2003) and Kastner (2017), verbs in *XiY̯eZ* have a more strongly agentive reading than verbs with the same root in *XaYaZ*. In (44a) both an animate agent and an inanimate cause are possible with the "simple" *ʃavrú* 'broke' in *XaYaZ*, but in (44b) only the agent is available with the "intensive" *ʃibrú* 'broke to bits' in *XiY̯eZ*. The latter example does not spirantize /b/ to [v].

(44) Phonological and semantic differences, *XaYaZ* vs. *XiY̯eZ* (Doron 2003:20):

a.

{✓ *ha-jeladim*	/ ✓ *ha-tiltulim*	*ba-argaz*}	***ʃa<u>v</u>r**-u*	*et*	*ha-kosot*
the-children	the-shaking	in.the-box	**broke**-PL	ACC	the-glasses

'{The children / Shaking around in the box} broke the glasses.'

b.

{✓ *ha-jeladim*	/ ✗ *ha-tiltulim*	*ba-argaz*}	***ʃi<u>b</u>r**-u*	*et*	*ha-kosot*
the-children	the-shaking	in.the-box	**broke**-PL	ACC	the-glasses

'{The children / *Shaking around in the box} broke the glasses to bits.'

In order to derive the semantic difference I adopt the morphosemantic analysis of Kastner (2017), which adapts the original proposal by Doron (2003) to state that an abstract root $\sqrt{\text{ACTION}}$ modifies Voice, forcing an agentive reading. It is $\sqrt{\text{ACTION}}$ that blocks spirantization in the phonology and triggers the correct vowels for the templates currently under discussion, *XiY̯eZ* and *hitXaY̯eZ*. Specifically, I propose that the exponent of $\sqrt{\text{ACTION}}$ carries a [–continuant] feature which docks onto the middle consonant for lexical roots that have a medial /p/, /b/ or /k/ (Zoll 1996; Wolf 2007). The exact docking is taken care of by the (morpho-)phonology as shown after (45), where subscript ACT on [–cont] is used for notational convenience.

(45) a. $\sqrt{\text{ACTION}} \leftrightarrow [\text{–cont}]_{\text{ACT}}$ / ___ { $\sqrt{\text{XYZ}}$ | Y ∈ p, b, k }

b. Voice ↔ *i,e* / T[Past] ___ $\sqrt{\text{ACTION}}$

See Faust (2016) for additional evidence that morphophonological processes target root classes differentiated by specific segments in Semitic languages, Wallace (2013) for a similar account of gemination in Akkadian, Emirati Arabic and Iraqi Arabic, and Moore-Cantwell (2013) for a wug study of irregular verbs in *XiY̯eZ*.

The floating [–cont] feature is docked using the following constraint, which Wallace (2013) adapted from the treatment of infixation by Yu (2003, 2005). It will account for the morphosyntactic exceptions to spirantization—i.e. blocked spirantization in *XiY̯eZ*/*XuY̯aZ*/*hitXaY̯eZ*—and outranks CONTIG.

(46) **ALIGN-R([–cont]$_{\text{ACT}}$, [σ-)**: Dock the [–cont] feature of $\sqrt{\text{ACTION}}$ on the second syllable of the base.
Assign a violation mark for each [–cont]$_{\text{ACT}}$ feature not aligned with the right edge of the first syllable of the following morphological word.

The tableau in (23) derived *safar* 'counted' in *XaYaZ*. The *XiY̯eZ* instantiation of the same root, *siper* 'told', follows, where the ranking ALIGN($\sqrt{\text{ACT}}$) ≫ *V-STOP protects non-spirantizing /p/. The passive form in *XuY̯aZ* is likewise *supar*. The relevant cases of (non-)spirantization in each of the candidates are boldfaced.

(47) [Voice $\sqrt{\text{ACTION}}$ [v $\sqrt{\text{spr}}$]] 'told':

	i,é-[–cont]$_{\text{ACT}}$-$\sqrt{\text{spr}}$	AL($\sqrt{\text{ACT}}$)	*V-STOP	SWP	ID(CONT)
☞	a. si**p**ér		*		
	b. si**f**ér	*!			*
	c. si**p**ré		*	*!	
	d. **t**ifér	*!			*

This discussion highlights once more the claim that syntactic structure predictably delimits allomorphic possibilities and phonological spell-out. Spirantization in Hebrew is not arbitrary (Temkin Martínez and Müllner 2016); lack of it is based on a morphosyntactic element. The template *XiY̯eZ* is not a basic building block of the lexicon; it arises as an epiphenomenon when a certain functional morpheme, one whose semantic effects are readily observed, is embedded in syntactic structure.

3.4 Summary

This section showed how the spell-out of syntactic elements gives rise to templatic effects without treating the templates themselves as prosodic primitives. In Sect. 5 I show that a stem-based approach is not able to make the fine-grained distinctions between the exceptionality exhibited by root classes and the alternations induced by morphosyntactic heads. That kind of theory has no roots to begin with.

In keeping with the other theoretical claim about combining roots and structure, we have seen how functional material combines with lexical material in ways that are mutually constrained: the structure allows certain allomorphic patterns while individual roots can exercise their own idiosyncrasy. The next section tests this claim by examining cases in which the structure allows no allomorphic interactions.

4 Predictions for intervention

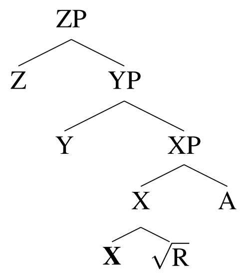
Any theory of morphology, in particular cyclic ones like the one employed here, must define locality domains for contextual allomorphy. In this section I describe what I call the Strict Linear Adjacency Hypothesis of Embick (2010), testing a prediction which has so far only been evaluated on languages with concatenative morphology. Contextual allomorphy is predicted to hold solely between adjacent overt elements as discussed next in Section 4.1. I confirm this prediction in Hebrew, arguing that it is borne out in two domains: linear intervention in agreement affixes (Section 4.2) and in passives (Sections 4.3 and 4.4). Given that the patterns discussed in this section make crucial reference to the internal syntactic makeup of the verb, I do not believe they can be captured in a stem-based approach, a point I make explicit in Sect. 5.2.

4.1 The Strict Linear Adjacency Hypothesis

Studies of opacity effects in phonology have suggested that a "flat" derivation, proceeding wholesale with no internal cycles, cannot account for various phenomena in which the original existence of a certain conditioning environment is made opaque by subsequent operations. A number of frameworks have arisen in order to account for opacity within Optimality Theory, including OT-CC (McCarthy 2007), Harmonic Serialism (McCarthy 2008a,b; McCarthy and Pater 2016) and OT-OI (Wolf 2008). All share a cyclic spell-out of morphological material.

I have assumed a version of the cycle in which each morpheme is spelled out in turn. Building on proposals developed by Bobaljik (2000) and Embick (2010, 2015), Sect. 3 took Vocabulary Insertion to proceed "inside-out", from the most deeply embedded element outwards. This process must be constrained by locality considerations; I adopt the Strict Linear Adjacency Hypothesis, according to which only adjacent overt elements can condition allomorphy on each other (Embick 2010; Marantz 2013a). As seen in Sect. 3, this theory can correctly analyze cases of allomorphy and other alternations in Hebrew. But the Strict Linear Adjacency Hypothesis also makes predictions regarding where *linear intervention* is expected to arise: if an overt element Y appears between X and Z, [[X **Y**] Z], X will not be able to condition allomorphy of Z. And as shown by Embick (2010, 2015), the result of this configuration is usually a default exponent of Z, such that Z has the same form regardless of X or any material below X. On the other hand, if Y is *covert*, X may still condition allomorphy on Z, (48)–(50).

(48)



(49) Allomorphic alternations are possible between adjacent elements. If overt, each can require specific exponents from the other:

a. √R and X

b. X and Y

c. Y and Z

(50) Allomorphy is possible across null exponents (according to the original proposal – if they are in the same syntactic phase):

a. √R and Y if X is covert

b. X and Z if Y is covert

What this means is that if the root is in the position marked R, and X is the verbalizer v (assuming a covert verbalizer), then the root R will be visible to Y and not to Z, unless Y is covert. It is predicted that an overt head in Y would block the local configuration necessary for allomorphy of Z given a root in R, and that is what we will see for the Passive head in Sect. 4.3.

Here is an example of what these allomorphic interactions look like. In Latin a linear intervention effect holds in the perfect: an overt Perf head can condition special person/number endings only if there is no overt intervening exponent of T (Embick 2010; Kastner and Zu 2017). In the present tense, T is covert and a special ending arises after the perfective morpheme *v*, namely -*ī* in (51b).

(51) Perfect and imperfect endings:

a. *am-**ō***
√LOVE-**1SG**
'I love'

b. *am-ā-v-**ī***
√LOVE-THEME-Perf-**1SG**
'I have loved'

Yet when T is spelled out by an overt exponent such as *ba/ra* in (52) or *b/r* in (53), the 1SG ending for a Class I root like √LOVE 'love' is consistent—*m* in the past and *o* in the future, without reference to the non-local Perf element.

(52) Past tense with -*m*:

a. *am-ā-ba-**m***
√LOVE-THEME-Past-**1SG**
'I loved'

b. *am-ā-ve-ra-**m***
√LOVE-THEME-Perf-Past-**1SG**
'I loved'

(53) Future tense with -*ō*:

a. *am-ā-b-**ō***
√LOVE-THEME-Fut-**1SG**
'I will love'

b. *am-ā-ve-r-**ō***
√LOVE-THEME-Perf-Fut-**1SG**
'I will have loved'

Perf can only condition the agreement ending when no overt exponent of T intervenes. This logic will guide our investigation of the Hebrew data. Similar patterns have been discussed by Gribanova (2015) for Russian, by Božič (2016) for Slovenian and by Embick (2010) for a variety of other languages, although arguments have been made that a strong version of the adjacency hypothesis must be weakened (Merchant 2015; Bermúdez-Otero 2016; Grestenberger 2016; Moskal and Smith 2016). See Božič (2017) for a recent synthesis.

4.2 Agreement affixes do not depend on the root

As we have already seen, agreement affixes depend mostly on the tense of the verb and in some cases on the template. Crucially though, they never depend on the root. For example, 2PL agreement is marked by the suffix *-tem* in the past and by the circumfix *t-u* in the future: *bi∫áltem* 'you all have cooked' ∼ *teva∫lú* 'you all will cook'. But the root never influences the choice of affix, as can be seen from the paradigm in (54), contrasting past and future forms for √b∫l in *XiY̯eZ*.

(54) Past and future for *bi∫el* 'cooked':

	Past, *XiY̯eZ* √b∫l		Future, *XiY̯eZ* √b∫l	
	SG	PL	SG	PL
1	bi∫ál-**ti**	bi∫ál-**nu**	**j**-eva∫él	**n**-eva∫él
2M	bi∫ál-**ta**	bi∫ál-**tem**	**t**-eva∫él	**t**-eva∫<é>l-**ú**
2F	bi∫ál-**t**	bi∫ál-**tem**	**t**-eva∫<é>l-**í**	**t**-eva∫<é>l-**ú**
3M	bi∫él	bi∫<é>l-**ú**	**j**-eva∫él	**j**-eva∫<é>l-**ú**
3F	bi∫<é>l-**á**	bi∫<é>l-**ú**	**t**-eva∫él	**j**-eva∫<é>l-**ú**

And as shown in (55), the same agreement affixes are used regardless of root class: √lvj, the root that exhibited exceptional alternations in (37), has the same affixes in (55) as √b∫l does in (54). The verb is *helva* 'lent'.

(55) Past and Future forms for a verb in √XYj:

	Past, *heXYiZ* √lvj		Future, *heXYiZ* √lvj	
	SG	PL	SG	PL
1	helvé-**ti**	helvé-**nu**	**j**-alvé	**n**-alvé
2M	helvé-**ta**	helvé-**tem**	**t**-alvé	**t**-alv<é>-**ú**
2F	helvé-**t**	helvé-**tem**	**t**-alv<e>-**í**	**t**-alv<é>-**ú**
3M	helvá	helv<á>-**ú**	**j**-alvé	**j**-alv<é>-**ú**
3F	helv<á>e-**tá**	helv<á>-**ú**	**t**-alvé	**j**-alv<é>-**ú**

The only potential falsification lies with the past 3SG.F, which introduces *-ta*. I assume that the conditioning environment of this allomorph of the suffix is predictable: it is a postvocalic variant of the feminine suffix *-a*. See also the characterization of *t-* as a feminine marker by Harbour (2008b) and a different take in Faust (2016).[5]

Agreement affixes do depend on the template, to a small degree. The 3rd person affixes are stressed in all templates save for *heXYiZ*, as was seen in (29), repeated here as (56).

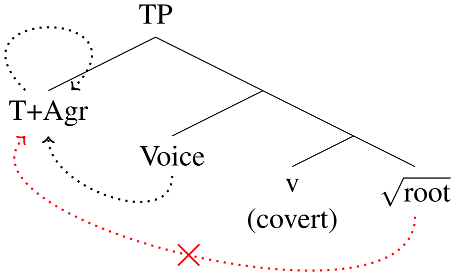
[5] Faust (2016) claims that roots can condition exceptional allomorphy of T based on forms like *kar-ta* 'she happened'. See Kastner (2016:169) for more detailed discussion and possible technical solutions.

(56) 3rd person suffixes are stressed in past tense *XiY̯eZ* ‘cooked’ and *hitXaY̯eZ* ‘got cooked’ but not *heXYiZ* ‘ripened’:

	XiY̯eZ √bʃl		*hitXaY̯eZ* √bʃl		*heXYiZ* √bʃl	
	SG	PL	SG	PL	SG	PL
1	biʃál-ti	biʃál-nu	hitbaʃál-ti	hitbaʃál-nu	hevʃál-ti	hevʃál-nu
2M	biʃál-ta	biʃál-tem	hitbaʃál-ta	hitbaʃál-tem	hevʃál-ta	hevʃál-tem
2F	biʃál-t	biʃál-tem	hitbaʃál-t	hitbaʃál-tem	hevʃál-t	hevʃál-tem
3M	biʃél	biʃ<é>l-**ú**	hitbaʃél	hitbaʃ<é>l-**ú**	hevʃíl	hevʃíl-**u**
3F	biʃ<é>l-**á**	biʃ<é>l-**ú**	hitbaʃ<é>l-**á**	hitbaʃ<é>l-**ú**	hevʃíl-**a**	hevʃíl-**u**

Revisiting the diagram from (30) as (57), it is evident that Agr is local to T (the two are exponents of the same head), so T can condition allomorphy on it. In addition, Agr is local to Voice. Both Voice and T should be able to trigger allomorphy of Agr, which they do. But the root cannot condition allomorphy of T over overt Voice.

(57)



Additional lexical items are given in (58). T+Agr is not local enough to the root to be conditioned by it, since Voice contains overt material that intervenes, namely the vowels and a possible prefix. And so, different root classes cannot condition special agreement markers.

(58) Consistent agreement affixes: no reference to root class.

a. $$2\textsc{sg.m} \leftrightarrow \begin{cases} \textit{ta} & /\ \text{T[Past]}\ \_\_\_ \\ \textit{t} & /\ \text{T[Fut]}\ \_\_\_ \end{cases}$$

b. $$3\textsc{pl} \leftrightarrow \begin{cases} \textit{u} & /\ \text{T[Past]}\ \_\_\_\ \text{Voice}_{\{\text{D}\}} \\ \textit{ú} & /\ \text{T[Past]}\ \_\_\_ \end{cases}$$

What this brief study of agreement affixes shows is that allomorphy is sensitive to linear adjacency of hierarchically arranged elements, as expected. Agreement affixes cannot be derived in the phonology proper: there is no reason for the past tense 1PL suffix *-nu* to alternate with the future 1PL prefix *n-*. This much must be treated by using separate Vocabulary Items. But allomorphy of this item cannot be conditioned by low material such as the root. If a theory derived verbs in a dedicated lexicon, a stem class could condition special endings; this is a false prediction of the stem-based account, since (54)–(55) all show that suffixes have nothing to do with individual roots or stems. An analysis that eschews internal structure cannot make the predictions explored here: that agreement affixes depend on the tense but not on the root (even though the “stem” does depend on the root) and especially that the paradigm is uniform across templates and across otherwise exceptional roots.

The current analysis makes another prediction. If additional overt material intervenes between T+Agr and Voice, agreement affixes should show some default form. This is the case with passives.

4.3 Consistent vowels in the passive

Sect. 3.1.2 demonstrated that 1st and 2nd person might have a different second vowel associated with them than does 3rd person, (59a). I note here that this split is neutralized in the passive: all phi-feature combinations have the same vowels, *u-á*, (59b).

(59) Passive vowels for √bʃl 'cook', agreement:

	Template	Past 3SG.M	Past 1SG
a.	*XiY̯eZ* (active)	biʃél	biʃál-ti
b.	*XuY̯aZ* (passive)	**bu**ʃ**ál**	**bu**ʃ**ál**-ti

Another generalization about the passive is that tense does not matter for the vowels either: there might be a difference in vowels between past and future in the active, (60a), but not in the passive, (60b).

(60) Passive vowels for √bʃl 'cook', tense:

	Template	Past 3SG.M	Future 3SG.M
a.	*XiY̯eZ* (active)	biʃél	je-vaʃél
b.	*XuY̯aZ* (passive)	b**u**ʃ**ál**	je-v**u**ʃ**ál**

Together with a substantial body of work from both syntax-based and lexicalist camps, I assume that the Hebrew passive is generated by passivizing an existing active verb in the syntax (Doron 2003; Reinhart and Siloni 2005; Ussishkin 2005; Laks 2011; Alexiadou and Doron 2012; Borer 2013; Kastner and Zu 2017). Passive forms are derived either from *XiY̯eZ* verbs (yielding *XuY̯aZ*) or *heXYiZ* verbs (yielding *huXYaZ*). This is done through the passive head Pass which merges above VoiceP but below T+Agr. The consistency of vowels falls out naturally under our existing assumptions regarding linear intervention effects, as I will now demonstrate.

The full paradigms follow below, showing that the 1st/2nd person vs 3rd person split is neutralized in the passive, as is any distinction based on tense; the vowels on all stems are *u-a* in the following two tables. In addition, for each pair of templates, the affixes are the same in each of the two tenses; for example, the standard 2SG.M past suffix *-ta* is used in both *XuY̯aZ* and *huXYaZ*.

(61) a. Past of passive *gudal* 'was raised' and *hugdal* 'was enlarged':

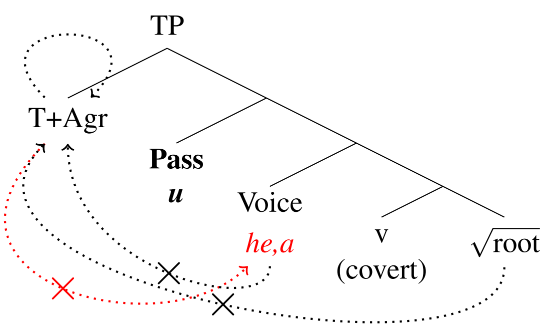
	XuY̯aZ √gdl		*huXYaZ* √gdl	
	SG	PL	SG	PL
1	g**u**d**á**l-ti	g**u**d**á**l-nu	h**u**gd**á**l-ti	h**u**gd**á**l-nu
2M	g**u**d**á**l-ta	g**u**d**á**l-tem	h**u**gd**á**l-ta	h**u**gd**á**l-tem
2F	g**u**d**á**l-t	g**u**d**á**l-tem	h**u**gd**á**l-t	h**u**gd**á**l-tem
3M	g**u**d**á**l	g**u**d<**á**>l-ú	h**u**gd**á**l	h**u**gd<**á**>el-ú
3F	g**u**d<**á**>l-á	g**u**d<**á**>l-ú	h**u**gd<**á**>el-á	h**u**gd<**á**>el-ú

b. Future of passive *jegudal* 'will be raised' and *jugdal* 'will be enlarged':

	XuY̯aZ √gdl		*huXYaZ* √gdl	
	SG	PL	SG	PL
1	j-e-g**u**d**á**l	n-e-g**u**d**á**l	j-**u**gd**á**l	n-**u**gd**á**l
2M	t-e-g**u**d**á**l	t-e-g**u**d<**á**>l-ú	t-**u**gd**á**l	t-**u**gd<**á**>el-ú
2F	t-e-g**u**d<**á**>l-í	t-e-g**u**d<**á**>l-ú	t-**u**gd<**á**>el-í	t-**u**gd<**á**>el-ú
3M	j-e-g**u**d**á**l	j-e-g**u**d<**á**>l-ú	j-**u**gd**á**l	j-**u**gd<**á**>el-ú
3F	t-e-g**u**d**á**l	j-e-g**u**d<**á**>l-ú	t-**u**gd**á**l	j-**u**gd<**á**>el-ú

This pattern is exactly what our theory of locality predicts: overt Pass blocks T+Agr from conditioning allomorphy on Voice as in (62), developing (57). Similarly, there is no special spell-out for the passive conditioned by certain roots since overt Voice intervenes. I give Pass as *-u-* in the tree but become more precise in (63c).

(62)



Derivations now follow for the different cycles deriving *XuYaZ* future tense *jegudal* 'he will be raised' and *huXYaZ* future tense *jugdal* 'he will be enlarged': first the combination of Voice and $\sqrt{\text{gdl}}$, then adding in Pass, and then the agreement affixes.

(63) a. Voice$_{\{D\}}$ ↔ *he,a* / Pass ___

b. Voice ↔ *e,a* / Pass ___ $\sqrt{\text{ACTION}}$

c. $\sqrt{\text{gdl}}$ ↔ *gdl*

d. Pass ↔ [+high +round]$_{\text{Pass}}$[6]

e. 3SG ↔ *j*

The passive -*u*- is analyzed as a floating autosegment, (63d), that attaches from the left and must dock onto an existing vowel. I assume below that the constraint regulating this docking is REALIZE-MORPHEME for simplicity, though it might be more accurate to model it using a separate constraint such as MAXFLT (Wolf 2007:3). Subscript PASS is used for notational convenience on the floating feature.

Note again the cyclic derivation: in the (a) examples the cycle is VoiceP. Stem vowels are placed in their optimal places by *COMPLEX and ONSET, as already seen above. In the (b) examples the cycle is PassP, featuring phonological overwriting of a vocalic segment by Pass, regulated by RM. In the (c/d) examples the T affixes are added, attached as prefixes, again satisfying prosodic considerations: ALLFTRT ensures a disyllabic output when possible. In 64c) and (65d) epenthetic vowels create additional initial syllables.[7]

(64) VoiceP (a), PassP (b), TP (c):

'he will be raised'	W ∼ L	*COMPLEX	ONSET	RM	ALLFTRT	MAX	DEP
Cycle 1: Only VoiceP a. (j + [+high +round]$_{\text{Pass}}$) + **e,á-$\sqrt{\text{gdl}}$**	gedál ∼ egádl	W	W				
Cycle 2: Only PassP b. (j) + **[+high +round]$_{\text{Pass}}$-gedál**	gudál ∼ gedúl			W			
Cycle 3: TP c. **j-gudál**	je.gu.dál ∼ jgu.dál	W			L		L

(65) VoiceP (a), PassP (b), TP (c–d):

'he will be enlarged'	W ∼ L	*COMPLEX	ONSET	RM	ALLFTRT	MAX	DEP
Cycle 1: Only VoiceP a. (j + [+high +round]$_{\text{Pass}}$) + **he,á-$\sqrt{\text{gdl}}$**	hegdál ∼ hegádl	W					
Cycle 2: Only PassP b. (j) + **[+high +round]$_{\text{Pass}}$-hegdál**	hugdál ∼ hegdúl			W			
Cycle 3: TP c. **j-hugdál**	jug.dál ∼ jhu.gdál	W				L	
d. **j-hugdál**	jug.dál ∼ je.hug.dál				W	L	W

[6] Hebrew does not have a high rounded front vowel.

[7] In the following comparative tableaux each line derives a cycle. W/L indicate whether a candidate prefers the winning or losing candidate: an L must be dominated by at least one W in a well-formed derivation (Prince 2002).

The overall thrust of this analysis is consistent with the point defended so far: the intervention patterns are predicted by cyclic application of the phonology, based on the morphosyntactic structure, which in turn limits allomorphic possibilities. Technically, Pass overwrites the first vowel it encounters, regardless of whether this vowel is part of the stem, (64b), or part of the prefix, (65b). This is a case of phonology operating on segments, regardless of their morphosyntactic origin. In this regard Pass is different than the exponent of $\sqrt{\text{ACTION}}$, which is local to the root and docks directly onto its middle consonant, just as the structure dictates.

In addition, ALLFTRT triggers deletion of /h/ in (65d), forcing a disyllabic verb. In Sect. 2.1 I pointed out that many speakers drop the initial *h-* of *heXYiZ* altogether, and so this analysis mirrors to some extent the facts of language change (albeit without an explicit markedness constraint against /h/).

It bears emphasizing that while these facts are consistent with the Strict Linear Adjacency Hypothesis, they do not provide a conclusive argument for it. One could imagine a language Hebrew′ with the following passive VIs:

(66) Hypothetical Hebrew′

$$\text{Pass} \leftrightarrow \begin{cases} \text{[+low]} & \text{/ T[Fut] \_\_} \\ \text{[+high +round]} & \end{cases}$$

In this language stem vowels would not be identical throughout the passive: future tense would have a low first stem vowel, while past would have *-u-*. I thank an anonymous reviewer for bringing up this possibility.

But let me summarize the structural claim I have been developing. Voice cannot "see" past Pass and onto T+Agr, so it inserts one set of vowels for the entire passive paradigm. We now have a crosslinguistic prediction for passive suffixes as a special case of the Strict Linear Adjacency Hypothesis, building on Embick (2010): no contextual allomorphy should obtain on a verb stem across an overt passive affix.

4.4 Passive with different root classes

As a final verification of the predictions made by the current theory, we must examine the interaction of different root classes with Pass. The expectation is confirmed: paradigm invariance is compatible with lexical exceptionality—here identified as the conditioning of theme vowels by the root—since the two are triggered by different parts of the structure.

I take the root $\sqrt{\text{pnj}}$ to be representative of the class of /j/-final $\sqrt{\text{XYj}}$ roots in particular and of exceptional root classes in general. The paradigms in (67a) are for the pair *XiY̯eZ–XuY̯aZ* and those in (67b) are for the pair *heXYiZ–huXYaZ*. All forms are in the singular. Past tense is given on the left and future tense on the right, for each pair. Both parts of the prediction are borne out when compared to paradigms such as (61): vowels are consistent in the passive (on the right-hand side of each tense), although the form of the vowels is not regular *u-á* but rather a root-specific form.

(67) a. *XiY̯eZ* $\sqrt{\text{pnj}}$ 'evacuate' in active and passive, for each tense:

	Past		Future	
	XiY̯eZ	*XuY̯aZ* (Pass)	*XiY̯eZ*	*XuY̯aZ* (Pass)
1	p**i**ní-ti	p**u**né-ti	j-e-f**a**né	j-e-f**u**né
2M	p**i**ní-ta	p**u**né-ta	t-e-f**a**né	t-e-f**u**né
2F	p**i**ní-t	p**u**né-t	t-e-f**a**n<é>-í	t-e-f**u**n<é>-í
3M	p**i**n<é>-á	p**u**n<é>-á	j-e-f**a**né	j-e-f**u**né
3F	p**i**n<é>-tá	p**u**n<é>-tá	t-e-f**a**né	t-e-f**u**n<é>-ú

b. *heXYiZ* $\sqrt{\text{pnj}}$ 'refer' in active and passive, for each tense:

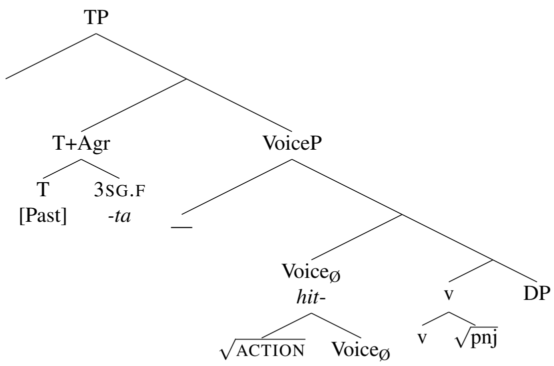
	Past		Future	
	heXYiZ	*huXYaZ* (Pass)	*heXYiZ*	*huXYaZ* (Pass)
1	hefné-ti	h**u**fné-ti	j-**a**fné	j-**u**fné
2M	hefné-ta	h**u**fné-ta	t-**a**fné	t-**u**fné
2F	hefné-t	h**u**fné-t	t-**a**fn<é>-í	t-**u**fn<é>-í
3M	hefn<é>-á	h**u**fn<é>-á	j-**a**fné	j-**u**fné
3F	hefn<é>e-tá	h**u**fn<é>e-tá	t-**a**fné	t-**u**fné

A falsification would consist of a new, unexpected form making reference to both the root and higher material such as Pass or T+Agr. Nothing would stop such a form from emerging if stems are created in the lexicon, but the current theory makes the right predictions: (67) looks like (55) with the passive vowels of (61) overlaid on it.

4.5 Summary

The purpose of this section was to test the prediction that exceptional phonology is handled "low" (locally to the root) and then passed on to additional cycles, which themselves are not exceptional. This claim was borne out: linear adjacency is a key component in the calculation of allomorphy after syntactic structure is linearized.

To make things more concrete, here are summarized derivations for past tense *hitXaY̑eZ hitpantá* 'she evacuated (herself)' in (68)–(70) and future tense *titpané* 'she will evacuate (herself)' in (71)–(73). These verbs instantiate the /j/-final root $\sqrt{\text{pnj}}$ in *hitXaY̑eZ*. The head Voice$_{\varnothing}$ is modified here by the agentive modifier $\sqrt{\text{ACTION}}$. The former contributes a prefix, the latter blocks spirantization of the middle root consonant, and both condition the vowels of the stem jointly.

(68)


(69) Vocabulary Items:

a. $\sqrt{\text{pnj}} \leftrightarrow$ *pne*

b. $\sqrt{\text{ACTION}} \leftrightarrow$ [–cont]$_{\text{ACT}}$ / ___ { $\sqrt{\text{XYZ}}$ | Y ∈ p, b, k }

c. Voice$_{\varnothing}$ $\leftrightarrow$ *hit,a,e* / T[Past] ___ $\sqrt{\text{ACTION}}$

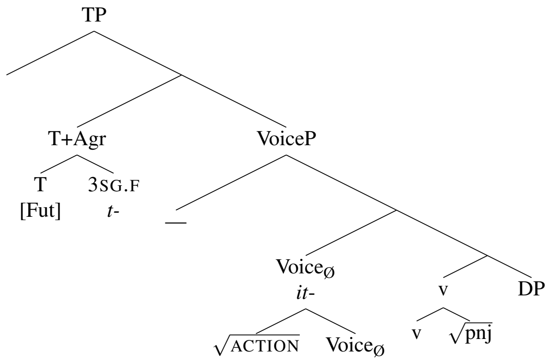
d. 3F.SG (Past) $\leftrightarrow$ *ta* / ___ V

(70) ta + /hit-a,e-pne/ → ta + [hit.pa.né] → /ta-hit.pa.né/ → [hit.pan.tá][8]

The head Voice$_{\varnothing}$ on its own inserts a prefix, *ni-* in the past tense, and conditions the vowels typical of the template *niXYaZ*. Full derivations are omitted in the interest of keeping the discussion focused.

Continuing on to the future tense equivalent of (68)–(70):

[8] The stem is kept as short as possible by AllFtRt; cf. (27), (38c), (65).

(71)


(72) Vocabulary Items:

a. √pnj ↔ *pne*

b. √ACTION ↔ [–cont]$_{ACT}$ / ___ { √XYZ | Y ∈ p, b, k }

c. Voice$_{\varnothing}$ ↔ *it,a,e* / T[Fut,3SG.F] ___ √ACTION

d. 3SG.F ↔ *t* / ___ T[Fut]

(73) t + /it-a,e-pne/ → t + [it.pa.né] → [tit.pa.né]

The verbal templates are again epiphenomenal, arising due to combinations of vocalic affixes with a consonantal root. I believe that these results go beyond those of the alternative systems surveyed next in Sect. 5–6. Table 2 is repeated here as Table 3 with a summary of the different functional heads, all of which are motivated on both syntactic-semantic and morphophonological grounds (empty cells are underspecified).

Heads			Syntax	Semantics	Phonology	Sect.
	Voice				*XaYaZ*	3
	Voice	√**ACTION**		**Agentive**	*XiYeZ*	3.3.2
Pass	Voice	√**ACTION**	*Passive*	**Action**	*XuYaZ*	4.3
	Voice$_{\{D\}}$		EA		*he-XYiZ*	3.1.2
Pass	Voice$_{\{D\}}$		*Passive*		*hu-XYaZ*	4.3
	Voice$_{\varnothing}$		No EA		*ni-XYaZ*	4.5
	Voice$_{\varnothing}$	√**ACTION**	No EA	**Action**	*hit-XaYeZ*	4.5

Table 3: The requirements of functional heads in the Hebrew verb.

5 Alternatives: the stem-based approach

In this section I present a number of arguments against the stem-based theory of Semitic morphology (Bat-El 1989, 1994, 2002, 2003, 2008; Laks 2011, 2013a,b, 2014; Ussishkin 1999, 2000, 2003, 2005, 2006). I will mostly be arguing against the proposal in Ussishkin (2005), since it is the most explicit in trying to link morphosyntactic affixation with morphophonological processes. As such, it is more readily falsifiable than related proposals such as those above or those of Aronoff (1994, 2007). Three arguments are leveled against this theory: the problem of the missing base (Section 5.1), the problem of overgeneration (Section 5.2), and the lack of a link to the syntax and semantics (Section 5.3). I then draw broader conclusions regarding the root-vs-stem debate.

On my analysis, the root is a morpheme and templates are epiphenomenal. Under the stem-based approach, all verbs are said to be derived from a base form in *XaYaZ* using a morphemic template, rather than by combining a root with functional heads. The root does not exist as a syntactic, morphological or phonological object. In direct juxtaposition to the proposal here, the stem-based approach treats the root as epiphenomenal and the templates as independent morphemes. Faithfulness to affixation, alongside modification of a stem in *XaYaZ*, are coupled with output-output faithfulness to derive the correct forms. The smallest morphological unit in the Hebrew verb, in a manner of speaking, is the verbal stem.

In the following example, Ussishkin (2005:194) derives *gidel* 'raised' in *XiYeZ* from *gadal* 'grew up' in *XaYaZ* by treating the templates as an affix and using three constraints:

(74) a. **MAX-AFFIX:** assigns a violation mark for each segment in an affix (the template) that does not have a correspondent in the output.

b. **MAX-IO:** assigns a violation mark for each segment in the input that does not have a correspondent in the output.

c. **MAX-OO:** assigns a violation mark for each segment in the base form that does not have a correspondent in the output.

(75) Instead of violation marks, individual vowels point out the violating segments.

	gadal-i,e	MAX-AFFIX	MAX-IO	MAX-OO
	a. gadal	i!e	ie	
	b. gadel	i!	i	a
	c. gidal	e!	e	a
☞	d. gidel			aa

In effect, the "affix" *i-e* spells out the template and is protected by highly-ranked MAX-AFFIX. The basic stem is *gadal*, source of all further derivations. This configuration, in which FAITH-AFFIX ≫ FAITH-STEM, was explicitly argued against by McCarthy and Prince (1995). Ussishkin (2006) has provided reasons to dismiss this objection, presenting a number of examples from different languages in which affix faithfulness seems to take precedence over stem faithfulness. Let us assume that the theoretical grounding is not problematic and see what other problems arise.

5.1 Issue 1: The problem of the missing base

At its core, the difference between the two theories traces back to the question of whether the grammar stores entire stems or smaller pieces that are then put together. The stem-based approach denies the existence of the root as a grammatical object, deriving instead surface forms from each other. However, a system in which one verb is derived from the other either assumes or predicts that there must always be a *XaYaZ* form to use as a base. As Ussishkin (2005:212) himself notes, this is incorrect:

(76) a. *nirdam* 'fell asleep' (≮ **radam* in *XaYaZ*)

b. *nifrad* 'separated' (≮ **parad* in *XaYaZ*)

c. *diber* 'spoke' (≮ **davar* in *XaYaZ*)

d. *kibel* 'received' (≮ **kabal* in *XaYaZ*)

Doron (2003) and Kramer (2006) list similar examples in Hebrew and Coptic.

As was mentioned earlier, gaps are the norm in the Hebrew system: not all roots are instantiated in all templates. A root-based account must list a variety of idiosyncratic information, including which functional heads a root simply does not combine with. On such an approach, gaps such as those in (76) are to be expected and are not particularly interesting, theoretically speaking, since they are simply part of the information encoded per root and no assumptions are violated. As for the stem-based analysis, Ussishkin (2005:213) speculates that it could be modified to allow derivation from a different base, in which case the base would have to be identified on a verb-by-verb basis. Bat-El (2003) allows bidirectional derivations between templates, constraining the theory even less. I contend that having one root as the base of derivation for all forms is a more useful generalization.

5.2 Issue 2: Overgeneration

For the most part, stem-based analyses limited themselves to third person singular past tense forms (the citation form). Recall now that agreement affixes can be conditioned by the tense and the template, but not by root class. This behavior has a locality-based explanation in our theory but is not predicted on the stem-based approach. Since the stem-based approach does not permit hierarchical structure within the word, the questions of allomorphy raised in this paper are difficult to address. Would the grammar be sensitive to the individual consonants in the stem? This must be the case, since the analysis in (75) distinguishes consonants from vowels. But if so, how come these consonants never condition allomorphy of the affix? That appears to be an instance of overgeneration. The stem-based approach is not a theory that takes allomorphy into account, a clear problem when dealing with a language that squeezes four or five different morphemes into two or three syllables.

Illustrating with the passive, consider how Ussishkin (2005:196) derives passive forms for 3SG.M past. In (77), σ-ALIGN is a disyllabic constraint. The passive "affixes" are privileged by MAX-AFFIX, resulting in overwriting of the base vowels.

(77) a. *XuYaZ* from *XiYeZ*:

	gidel-u,a	MAX-AFFIX	σ-ALIGN	MAX-IO	MAX-OO
	a. gidel	u!e		ua	
	b. gudel	a!		a	
☞	c. gudal				ie

b. *huXYaZ* from *heXYiZ*:

	hegdil-u,a	MAX-AFFIX	σ-ALIGN	MAX-IO	MAX-OO
	a. hegudal		*!		i
	b. hegadil	u!		u	
☞	c. hugdal				ei

This analysis does not explain why vowels are consistent across person/gender combinations in the passive, as was attributed to linear intervention in Sect. 4.3–4.4. In order to capture the facts additional constraints would have to be introduced. These constraints would specify which vowel gets inserted for which combination of person and gender. While this undertaking is not impossible, the constraints on affixes would have to be ranked correctly with respect to affix faithfulness for both the base and the derived form.

In order to appreciate the problem we will go beyond citation forms. To create a future passive in this theory, first derive the correct tense and then passivize. But it is not clear how the grammar would know which vowel in the stem to passivize without additional stipulations:

(78) a. hegdil → jagdil → ✓ jugdal
b. gidel → jegadel → ✗ jugadel / ✗ jugadal / ✓ jegudal

In addition, it is well accepted that the semantic interpretation of passivization applies before tense; Passive composes with the verb phrase first, before other inflection (Kratzer 1996; Bruening 2013).

We could instead try to first derive the passive base and then allow tense and agreement to overwrite it. However, this kind of system allows for vowel allomorphy where consistent vowels exists:

(79) a. gidel → gudal → ✗ jegadel / ✗ jegadul / ✗ jegodol / . . . / ✓ jegudal
b. hegdil → hu-gdal → ✗ j(eh)agdal / ✗ j(eh)agdul / ✗ j(eh)ugdal / . . . / ✓ jugdal

One solution would be to apply inflection as "blind" affixes attaching to an existing stem, but this process would void our ability to create active forms in the first place and stand in conflict with the treatment of affixes in (75).

For these reasons, we must continue to assume that Voice, Pass and T attach cyclically within the same component (namely the syntax). The morphosyntactic status of the affixes is not explicitly defined in the stem-based theory, leading us to the next problem.

5.3 Issue 3: Arbitrary affixation

On a general level, the problem of explanatory adequacy with the stem-based approach is that it stipulates certain vowel combinations without explaining where they come from. Are these vowels morphemes, and if so, what does the morpheme denote? What is its role in the syntax? The approach I am developing uses functional heads, which allow for a better description of the system as a whole (Sect. 2.3.1).

Agreement affixes can be conditioned by the tense and the template but not by a special class of the root (Sect. 4). This behavior has a locality-based explanation in our theory but is not predicted by the stem-based approach. The root-based approach provides an answer to the question of what templates are: morphosyntactically, morphosemantically and morphophonologically. This answer requires a root.

The stem-based theory claimed to do away with the consonantal root as a theoretical device. This attempt to simplify the theory comes at a cost: an exaggerated role for templates which ignores their syntax and semantics. The theory also encounters empirical problems once we look past citation forms, since affixes are treated as arbitrarily placed exponents.

An anonymous reviewer suggests that another level of output-output faithfulness could be established, between forms of the passive across different tenses. This is a hybrid lexicalist syntax-based theory which uses stems instead of roots. In this case it would be an accident that passive stems are consistent across tenses, whereas on the current analysis, linear intervention is predicted by the architecture. Consider the overgeneration problem in (78)–(79) once more. Even if a specific constraint were created to ensure that **jehugdal* becomes *jugdal*, the theory loses its internal consistency because active *i-a* in *XiY̑eZ* and *e-i* in *heXYiZ* double as markers of past tense (inflection) and template (derivation), so the theory must allow tense information to combine with the active stem first. Otherwise there would not be a base to begin with. Put differently, this theory could be salvaged by making an additional assumption about the role of structure in the derivation; yet this type of assumption is exactly what this product-oriented theory is reacting against.

In essence, the stem-based approach accepts templates as morphemes but denies the root as a morpheme. The approach presented in this paper makes the opposite claim: roots are morphemes, but templates are an epiphenomenon of the spell-out of functional heads. Three weaknesses have been pointed out with a specific stem-based approach as a theory of morphophonology, but it is worth stepping back and asking whether these problems are fatal for *any* stem-based approach. The problem of the missing base has already been shown to be an issue for different stem-based analyses. The issues of overgeneration and arbitrary affixation also appear to be intractable.

In the theory developed in the current paper, different realization rules are sensitive to different structures and Pass is allowed to overwrite the first vowel it runs across. A similar solution could be devised for the stem-based theory, but this modification would admit a serial derivation based on hierarchical combination of the different morphemes. While such a derivation could be developed within the serialist frameworks mentioned earlier (McCarthy 2008a,b; McCarthy and Pater 2016), the important point is that each step in the derivation must spell out part of the syntactic tree in order: the root, then the "template" (Voice), then Pass, and then T+Agr, with particular conditioning of each other. Picking a stem such as *gidel* as an arbitrary starting point collapses a number of steps together (root + template + T+Agr). So while it is apparent that a serialist phonological framework like Harmonic Serialism would be necessary in order to handle cases of opacity like those in (37), these are within the purely phonological part of the derivation. As a stand-alone theory of morphology, Harmonic Serialism is ill-equipped to deal with the structural considerations laid out in the current paper since it makes no syntactic commitments.

Under the "weak lexicalist" variant suggested by the reviewer, T+Agr would be added in the syntax, attaching there to stems that had been formed in the lexicon. T+Agr may then be sensitive to Voice, for instance, but anything below Voice would be a stem. While this kind of approach needs to be fleshed out, it seems that this kind of lexicalism has Voice feeding into the stem as well as higher material: it is both in the lexicon and in the syntax, with allomorphy proceeding cyclically, in effect doing away with the distinction between inflection and derivation. Ultimately, such an analysis motivates a framework indistinguishable from the one presented here.

The current syntactic approach also allows us to describe the syntactic-semantic behavior of the templates more accurately (or rather, the behavior of the functional heads), without compromising the phonological grammar. The generalizations laid out here will hopefully invite competing analyses within a stem-based approach as well.

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6 Alternatives: a root-based approach

The system illustrated in the current paper shows rampant allomorphy: the spell-out of Voice may be conditioned by a number of different triggers simultaneously (tense, agreement, passivization, the modifier $\sqrt{\text{ACTION}}$, the features on Voice itself and the root). Within the same set of assumptions there is an alternative: each head is allowed to incrementally add single vowels and overwrite previous ones.

For example, Voice would add "default" /a/ and then $\sqrt{\text{ACTION}}$ would add /e/, since that is always the second vowel in *XiY̭eZ*. Pass could then overwrite one or both of these. Without Pass, T would overwrite the first vowel to /i/ in the past or /e/ in the future.

(80) a. $\sqrt{\text{bʃl}}$ + Voice = *ba̲ʃl*

b. Add $\sqrt{\text{ACTION}}$: *baʃe̲l*
Optionally add Pass: *bu̲ʃa̲l*

c. Add T[Past]: *bi̲ʃel*
Or T[Fut]: *je-vaʃel*

This process of single vowel insertion resembles the system in Faust (2012) where each vowel is considered individually. Faust (2012:481) ends up with rules like those in his (44), our (81)–(82), where "V" stands for "vowel" and the template is a morphological primitive.

(81) Vocabulary Items for *heXYiZ* with regular roots:

a. V2 ↔ XYaZ

b. V2 ↔ XYeZ / [present]

c. V2 ↔ XYoZ / [future], [infinitive]

d. $\text{V2}_{XiY̭eZ}$ ↔ XYeZ / active, ___C(V)]$_{\#}$

e. V2_{heXYiZ} ↔ XYiZ / active, ___C(V)]$_{\#}$

(82) Vocabulary Items for *heXYiZ* with $\sqrt{\text{XYj}}$ roots.

a. $\sqrt{\text{XYj}}$ ↔ XY / verb

b. $\text{V2}_{XaYaZ,XiY̭eZ}$ ↔ XYiZ / *heXYiZ* $\sqrt{\text{XYj}}$, [1/2 past]

c. V2 ↔ XYeZ / *heXYiZ* $\sqrt{\text{XYj}}$, [future]

d. V2 ↔ XYot / *heXYiZ* $\sqrt{\text{XYj}}$, [infinitive]

e. [feminine] ↔ [-ta] / *heXYiZ* $\sqrt{\text{XYj}}$, [past]

Unfortunately, such a system is unrestricted in terms of locality: any element is capable of overwriting any vowel (similar problems arise for Faust 2016). In addition, overwriting vowels in one fell swoop would miss out on the notion that the inner domain (VoiceP) can see the morphology of the root whereas outer heads add affixes or overwrite local vowels (in the case of Pass). To a lesser degree, it is also doubtful to what extent one could tap into single vowels as indicators of structure. In other words, to what extent these rules are psychologically real. In contrast, the current theory makes the case for

Vocabulary Insertion and the phonological derivation to feed directly off the locality inherent in the syntactic structure.

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7 Discussion and consequences

7.1 On underlying representations and surface forms

The syntactic root-based approach has so far been argued to be superior to a stem-based approach, as far as data coverage and predictive power are concerned. Yet there is also a potential argument for the stem-based approach which has not been pursued strongly, save for some discussion in Bat-El (2003): if surface forms all are that there is, this absolves the learner of the need to learn complicated underlying representations of roots and syntactic heads.

The argument goes as follows. If the stem-based approach uses product-oriented markedness constraints to regulate all derivations, there are much fewer underlying representations to learn. Stems and prosodic templates are learned as-is, without recourse to otherwise complicated rules or representations. There would be no need to posit an underlying $\sqrt{\text{knj}}$ for *kana* 'bought' – just learn the stem *kana* and inflect to future *jikne* 'will buy' by analogy to other forms, which themselves would be learned in a similar way. The noun *knija* 'buying' would presumably be learned separately.

While there is still much work to do on the acquisition of Semitic morphology, discarding the root is not the best way to go. A considerable psycho- and neurolinguistic literature singles out a role for the consonantal root in processing (Frost et al. 1997; Deutsch et al. 1998; Idrissi et al. 2008; Ussishkin et al. 2015; Brice 2016), though the findings indicate that verbal templates are processed differently than nominal patterns (see however Deutsch and Malinovitch 2016). Research into the exact factors is ongoing (Moscoso del Prado Martín et al. 2005; Berent et al. 2007; Farhy et al. To appear). Without going into these studies in depth, then, the relevant question is whether it makes sense to treat the consonantal root as an independent object which must be learned. As a matter of fact, the case can be made for roots as part of both the acquisition process and the synchronic system.

In recent computational work, Kastner and Adriaans (2017) have proposed that if the learner divides the input into consonants and vowels, it should be able to make progress on basic acquisition tasks in Semitic. A number of computer simulations found that ignoring the vowels in the input leads the learner to perform better on the task of segmenting the input stream into separate phonological words in Arabic: presumably, if the input consisted only of root consonants (and the occasional affix or clitic), this situation would lend itself surprisingly well to insertion of word boundaries. Comparison with a non-Semitic language shows that focusing only on the consonants hinders performance in English. In another set of simulations, the authors found that these segmented consonants can then be used to learn OCP-Place restrictions in Arabic (Greenberg 1950:et seq.). If the consonantal root carries semantic meaning, and if it can be used to facilitate early phonological learning, then it should be part of the acquisition process.

These findings complement a line of psycholinguistic work building on the hypothesis that consonants carry more linguistically relevant information (Cutler et al. 2000; Nespor et al. 2003; Newport and Aslin 2004). This difference appears to be magnified in Semitic. The question, then, is not whether consonantal co-occurrence patterns can be learned but how the consonantal root can be learned. The product-oriented considerations arising from a stem-based approach ought to guide continued research in this area, but they do not form an argument for one representation over another.

7.2 The fate of the CV morpheme

This paper started off by recapping the seminal analysis of McCarthy (1979, 1981) who proposed that the Semitic verb is made up of three tiers: a CV skeleton (the template), individual consonants (the root) and a vocalic melody (additional grammatical information). The current proposal supports some of his assumptions and rejects others: roots remain, but CV skeletons are no longer needed as primitives in the theory. If the current proposal is on the right track, is there ever a need for CV skeletons as morphemes?

A theory of morphological CV skeletons predicts patterns that are perhaps unattested crosslinguistically and are certainly unattested in Hebrew. If CV skeletons are primitives, a language might have the alternations in (83) which are purely prosodic, metathesizing different segmental chunks:

(83) a. Intransitive template: CVCVC (*pitok* 'wugged.intransitive')
Transitive template: CVCCV (*pitko* 'wugged.transitive')

b. Causative template: CaCV (*pato* 'wugged.causative')
Passive template: VCaC (*opat* 'wugged.passive')

This is not the case in Hebrew: any change from one template to another is the result of added segmental (and syntactic) material, namely vocalic and consonantal affixes.

It is too soon to rule out CV skeletons entirely, although these skeletons might turn out to be purely phonological objects, not morphosyntactic ones. It may well be the case that in some languages prosodic templates constrain the morphophonology. In Chol, roots must fit in a CV skeleton (Coon 2017), as do roots in Quechua (MacEachern 1999; Gallagher 2013), stems in Rotuman (McCarthy 2000) and word forms in a number of other families (McCarthy 1989). The templatic system of Sierra Miwok has likewise received contemporary analyses which make no reference to morphemic templates (Bye and Svenonius 2010, 2012; Zimmermann 2015). Yet with the exception of the sizable literature on reduplication, it is not clear at this point whether any language employs CV skeletons as morphemes, though some proposals to this extent have been made in Yucatecan languages (Lois 2011) and in previous studies of Semitic.

An analysis of Iraqi Arabic that sits on the continuum between my approach and that of McCarthy (1981) is the one put forward by Tucker (2010), building on ideas in Kramer (2006). Tucker (2010) also concatenates roots and vowels under strict prosodic conditions without making reference to independent CV skeletons. I differ from him, however, in placing my phonological system within a larger syntax-based framework. This difference allows me to match up templates with meanings via functional heads. Tucker (2010) also limits himself to citation forms; as I have argued, the most consistent account of the system as a whole must make reference to agreement patterns and requires a cyclic view of the derivation.

Drawing on the analysis of Tucker (2010), unpublished work by Wallace (2013) provided a detailed analysis of non-concatenative morphology in Akkadian, Iraqi Arabic and Emirati Arabic, with a focus on patterns of syncope and gemination. Her theory did not make reference to CV skeletons, either. The ideas presented here develop Wallace's account and extend it to the entire verbal paradigm, mounting a cross-Semitic argument for transitioning from skeletons to functional heads.

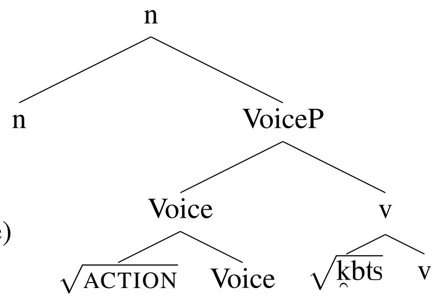
Before concluding in Section 7.3, I will briefly consider templatic morphology in Hebrew that does not fall neatly under my account (nouns, Section 7.2.1), and review recent work on one of the most famous cases of putative templatic morphology outside of Semitic (Yokuts, Section 7.2.2).

7.2.1 Nouns in Hebrew

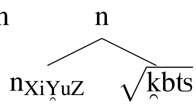
The original argument for roots within a syntactic approach to Semitic morphology was put forward by Arad (2003), who showed how nouns may be derived either from roots or from existing nouns. What this means in terms of the current proposal is that the verbal templates are special: each functional head in the verbal domain has deterministic spell-out, modulo contextual allomorphy. Nouns (and perhaps adjectives as well) can be derived using a range of nominal patterns. This much seems to be indicated by the data: while there are five active verbal templates, there are dozens of nominal patterns (especially if we wish to assume that a loanword like *ent͡siklopedja* 'encyclopedia' instantiates the one-off pattern *CeCCiCCoCeCCa*). Two additional considerations force the conclusion that there exist different nominalizing heads.

First, there exist nouns which are ambiguous between an action nominal and a simple noun. The action nominal is derived from an underlying verb, so its meaning is transparently related to that of its base, but the simple nominal can have a special meaning (for more on the distinction see e.g. Grimshaw 1990 and Borer 2014). The pair in (84) exemplifies for Hebrew. The form *kibut͡s* is ambiguous between an action nominalization of the verb *kibet͡s* 'gathered', (84a), and a noun derived directly from the root, (84b).

(84) a. *medina-t israel tihie ptuxa le-alia jehudit*
state-CS Israel will.be open to-immigration Jewish
*ve-le-**kibu**t͡s galujot*
and-to-gathering diasporas
'The State of Israel will be open for Jewish immigration and for the Ingathering of the Exiles.'
(Israeli Declaration of Independence)



b. "According to his testimony, in the early 60s, before he began his political career in the USA, . . .
ʃaha sanderz kama xodaim be-israel ve-hitnadev
stayed Sanders a.few months in-Israel and-volunteered
*be-**kibu**t͡s*
in-kibbutz
. . . Sanders stayed in Israel for a few months and volunteered in a Kibbutz."[9]



Second, a simple noun might not even have any corresponding action nominal if there is no underlying verb. The noun *kibuʃ* 'occupation' is not derived from an underlying verb in *XiY̯eZ*.

(85) a. *daj la-kibuʃ*
enough to.the-occupation
'Down with the occupation!'

b. **kibeʃ*

I conclude (with Arad 2003) that distinct nominal n heads are needed with potentially different spell-outs; verbs are more restricted than nouns in that the morphology tracks argument structure alternations. The functional heads in the verbal domain have predictable spell-out, but the morphophonology of nouns is able to more freely vary, perhaps because it is not tied down to argument structure.

Whether or not v and n are themselves phase boundaries is tangential to the current claims; it suffices that the derivation proceeds cyclically. As emphasized by Arad (2003, 2005) and assumed in related work since, phonological words can be derived both from the root and from an existing word. Further discussion of the nominal system is beyond the scope of the current paper, but see for instance Faust and Hever (2010) and Laks (2015).

[9] https://goo.gl/GzqQUQ (retrieved April 2016).

7.2.2 Yokuts

Chukchansi Yokuts exhibits a “templatic” system of morphology which can be described in terms of CV skeletons. Recently, Guekguezian (2017) has put forward an analysis which discards the morphemic templates, replacing them with a careful and more parsimonious analysis of the syntax and phonology of the language. His argument boils down to the claim that intricate phonology linearizes cyclic morphosyntax, just like in Hebrew.

In Chukchansi, templatic morphology is triggered by some suffixes and not others; Guekguezian (2017) argues that this difference is one of syntactic heads. This templatic change applies only to some roots and not others; Guekguezian argues that these roots are too small to form licit phonological words on their own. When these factors combine, we see templatic effects without templatic morphemes. The claim is particularly important since Chukchansi is closely related to another Yokuts language, Yowlumne (Yawelmani), which has served as one of the poster children for non-concatenative morphology since at least Archangeli (1983).

First, to address roots, Guekguezian (2017) argues that the optimal foot in the language is iambic, $\sigma_{\mu}\sigma_{\mu\mu}$. The templatic shape with is then simply an iambic foot. Roots like $\sqrt{\text{maːx}}$ ‘$\sqrt{\text{HELP}}$’ which cannot form an iamb get augmented to *ma.xaː*, giving the impression of a CVCVː template.

Next, there is the question of why only certain affixes trigger this augmentation. Guekguezian (2017) argues that these suffixes are cyclic, triggering spell-out of the stem (which itself consists of the root and a covert verbalizer). This stem must be a valid phonological word of the language; if it does not meet the minimality requirements when it is spelled out, it gets augmented.

Guekguezian (2017) goes on to show how his analysis explains additional interactions in Chukchansi, namely the fact that reduplication bleeds templatic effects, that quadriconsonantal roots bleed templatic effects, and that certain suffixes counterbleed templatic effects. Most relevant to present purposes, this work shows that a “templatic” system is best understood by combining cyclic spell-out of hiearchical syntactic material with the general phonological requirements of the language.

7.3 Conclusion

Templatic effects in Hebrew verbal morphology were argued in this paper to be epiphenomenal, resulting from the combination of functional heads and lexical roots in an independently motivated syntactic structure. This claim stands in contrast to accounts which treat the templates as morphological primitives.

This paper posed the following generalizations about Modern Hebrew and explained them within a theory of syntax-based morphology:

(86) a. Vowels in the verbal stem vary by root class.

b. The vowels vary by template, tense and phi-feature combination.

c. Agreement marking varies by template but not by root class.

d. Passive marking neutralizes vowel differences between templates.

Roots can belong to different classes, and their lexically specified phonology emerges only under the right locality conditions. This much is true of the theory employed here in general, before we have even considered Hebrew. But the same theoretical approach holds for non-concatenative morphology as well.

The theory makes use of the Semitic consonantal root as a store of idiosyncratic phonological and semantic information. A cyclic, locality-based theory of morphophonology was shown to make correct predictions about which elements can condition allomorphy on other elements and about the kind of information each element in the structure needs to provide: roots and functional heads. The theory was tested on Hebrew, allowing us to reconcile the idiosyncratic demands of consonantal roots with the grammatical constraints of verbal templates, in the morphophonology as well as the morphosyntax and morphosemantics.

How powerful is the resulting framework? Most of the empirical coverage is gained through a few familiar assumptions: that syntactic wordhood is dissociated from phonological wordhood, that morphemes are merged in the syntax, that spell-out is cyclic, and that allomorphy is local. Insofar as the account is convincing, it provides further support for these assumptions. In order to account for lexical exceptionality, morpheme-specific diacritics are used as well. In order to account for grammatical effects on spirantization, a floating feature is used within a local domain. The total inventory of tools is thus not particularly large. Nevertheless, it would be important to see whether the current array of tools can be reduced even further, or whether additional crosslinguistic work will show it to have been necessary.

The system presented here covered a range of data which are unexpected on a stem-based approach. Verbal templates have been shown to emerge as a by-product of spelling out individual functional heads, rather than independent CV skeletons. Contemporary theorizing considers syntactic structure to feed interpretation at the interfaces; the current proposal explains how lexical material and functional material combine, leading to the emergence of morphophonological templates.

References

Adam, Galit. 2002. From variable to optimal grammar: Evidence from language acquisition and language change. Doctoral Dissertation, Tel Aviv University, Tel Aviv. 18

Alexiadou, Artemis, Elena Anagnostopoulou, and Florian Schäfer. 2015. *External arguments in transitivity alternations: A layering approach*. Oxford: Oxford University Press. 7

Alexiadou, Artemis, and Edit Doron. 2012. The syntactic construction of two non-active voices: Passive and middle. *Journal of Linguistics* 48:1–34. 7, 24

Arad, Maya. 2003. Locality constraints on the interpretation of roots: The case of Hebrew denominal verbs. *Natural Language and Linguistic Theory* 21:737–778. 7, 34, 35

Arad, Maya. 2005. *Roots and patterns: Hebrew morpho-syntax*. Springer. 2, 4, 7, 18, 35

Archangeli, Diana. 1983. The root CV-template as a property of the affix: Evidence from Yawelmani. *Natural Language and Linguistic Theory* 1:347–384. 36

Aronoff, Mark. 1994. *Morphology by itself: Stems and inflectional classes*. Cambridge, MA: MIT Press. 7, 28

Aronoff, Mark. 2007. In the beginning was the word. *Language* 83:803–830. 28

Asherov, Daniel, and Outi Bat-El. 2016. Multiple defaults: feminine *-et* and *-a* in Hebrew present tense. *Morphology* 26:399–423. 6

Bat-El, Outi. 1989. Phonology and Word Structure. Doctoral Dissertation, UCLA. 28

Bat-El, Outi. 1993. Parasitic metrification in the Modern Hebrew stress system. *The Linguistic Review* 10:189–210. 11

Bat-El, Outi. 1994. Stem modification and cluster transfer in Modern Hebrew. *Natural Language and Linguistic Theory* 12:571–596. 2, 7, 28

Bat-El, Outi. 2002. Semitic verb structure within a universal perspective. In *Language processing and acquisition in languages of Semitic, root-based, morphology*, ed. Joseph Shimron, 29–59. Amsterdam: Benjamins. 2, 28

Bat-El, Outi. 2003. The fate of the consonantal root and the binyan in Optimality Theory. *Recherches Linguistiques de Vincennes* 32. 28, 29, 33

Bat-El, Outi. 2008. Morphologically conditioned v–ø alternation in Hebrew: Distinction among nouns, adjectives & participles, and verbs. In *Current issues in generative Hebrew linguistics*, ed. Sharon Armon-Lotem, Gabi Danon, and Susan Rothstein. Amsterdam: Benjamins. 2, 10, 11, 13, 28

Becker, Michael. 2003. Hebrew stress: Can't you hear those trochees? In *University of Pennsylvania working papers in linguistics*, volume 9, 45–57. 11

Berent, Iris, Vered Vaknin, and Gary F. Marcus. 2007. Roots, stems, and the universality of lexical representations: Evidence from Hebrew. *Cognition* 104:254–286. 33

Bermúdez-Otero, Ricardo. 2013. The Spanish lexicon stores stems with theme vowels, not roots with inflectional class features. *Probus* 25:3–103. 17

Bermúdez-Otero, Ricardo. 2016. We do not need structuralist morphemes, but we do need constituent structure. In *Morphological metatheory*, ed. Daniel Siddiqi and Heidi Harley, 385–428. Amsterdam: Benjamins. 22

Bobaljik, Jonathan David. 2000. The ins and outs of contextual allomorphy. In *University of Maryland working papers in linguistics*, ed. Kleanthes Grohmann and Caro Struijke, volume 10, 35–71. 9, 12, 20

Bobaljik, Jonathan David. 2012. *Universals in Comparative Morphology*. Cambridge, MA: MIT Press. 9

Borer, Hagit. 2013. *Structuring sense, vol. 3: Taking form*. Oxford: Oxford University Press. 24

Borer, Hagit. 2014. Derived nominals and the domain of content. *Lingua* 141:71–96. 35

Božič, Jurij. 2016. Locality of exponence in Distributed Morphology: Root suppletion in Slovenian. In *Proceedings of NELS 46*. 22

Božič, Jurij. 2017. Non-local allomorphy in a strictly local system. Ms., McGill. lingbuzz/003469. 22

Brice, Henry. 2016. The root and word distinction: an experimental study of Hebrew denominal verbs. *Morphology* . 33

Bruening, Benjamin. 2013. *By* phrases in passives and nominals. *Syntax* 16:1–41. 30

Bruening, Benjamin. 2014. Word formation is syntactic: Adjectival passives in English. *Natural Language and Linguistic Theory* 32:363–422. 7

Bye, Patrik, and Peter Svenonius. 2010. Exponence, phonology, and non-concatenative morphology. Ms., University of Tromsø. 34

Bye, Patrik, and Peter Svenonius. 2012. Nonconcatenative morphology as epiphenomenon. In *The morphology and phonology of exponence*, ed. Jochen Trommer, 427–495. Oxford: Oxford University Press. 34

Chomsky, Noam. 1995. *The minimalist program*. Cambridge, MA: MIT Press. 7

Chomsky, Noam. 2001. Derivation by phase. In *Ken Hale: A life in language*, ed. Michael Kenstowicz, 1–52. Cambridge, MA: MIT Press. 7

Chomsky, Noam, and Morris Halle. 1968. *The sound pattern of english*. New York: Harper & Row. 18

Coon, Jessica. 2017. Little-v agreement and templatic morphology in Chol. *Syntax* 20:101–137. 34

Cutler, Anne, Nuria Sebastian-Galles, Olga Soler-Vilageliu, and Brit Van Ooijen. 2000. Constraints of vowels and consonants on lexical selection: Cross-linguistic comparisons. *Memory and Cognition* 28:746–755. 33

Deutsch, Avital, Ram Frost, and Kenneth I. Forster. 1998. Verbs and nouns are organized and accessed differently in the mental lexicon: Evidence from Hebrew. *Journal of Experimental Psychology: Learning, Memory and Cognition* 24:1238–1255. 33

Deutsch, Avital, and Tamar Malinovitch. 2016. The role of the morpho-phonological word-pattern unit in single-word production in Hebrew. *Journal of Memory and Language* 87:1–15. 33

Doron, Edit. 2003. Agency and voice: The semantics of the Semitic templates. *Natural Language Semantics* 11:1–67. 2, 4, 8, 14, 18, 19, 24, 29

Doron, Edit. 2013. Voice. In *Syntax – an International Handbook of Contemporary Research*. Walter de Gruyter, 2 edition. 7, 18

Embick, David. 2010. *Localism versus globalism in morphology and phonology*. Number 60 in Linguistic Inquiry Monographs. Cambridge, MA: MIT Press. 9, 10, 20, 21, 22, 26

Embick, David. 2015. *The morpheme: A theoretical introduction*. Mouton de Gruyter. 7, 20

Farhy, Yael, João Veríssimo, and Harald Clahsen. To appear. Universal and particular in morphological processing: Evidence from Hebrew. *The Quarterly Journal of Experimental Psychology* . 33

Faust, Noam. 2012. Non-concatenative realization in the verbal inflection of Modern Hebrew. *Morphology* 22:453–484. 6, 17, 32

Faust, Noam. 2014. One advantage and three challenges to a theory of roots as indices. *Theoretical Linguistics* 40:389–400. 10

Faust, Noam. 2016. Weak radicals, weak suppletion, and phonological indices in Semitic. *Morphology* 26:379–397. 5, 10, 17, 19, 22, 32

Faust, Noam, and Ya'ar Hever. 2010. Empirical and theoretical arguments in favor of the discontinuous root in Semitic languages. *Brill's Annual of Afroasiatic Languages and Linguistics* 20:80–118. 18, 35

Frost, Ram, Kenneth I. Forster, and Avital Deutsch. 1997. What can we learn from the morphology of Hebrew? a masked-priming investigation of morphological representation. *Journal of Experimental Psychology: Learning, Memory, and Cognition* 23:829–856. 33

Gafter, Roey. 2014. "The most beautiful and correct Hebrew": Authenticity, ethnic identity and linguistic variation in the greater Tel Aviv area. Doctoral Dissertation, Stanford University, Stanford, CA. 4

Gallagher, Gillian. 2013. Speaker awareness of non-local ejective phonotactics in Cochabamba Quechua. *Natural Language and Linguistic Theory* 31:1067–1099. 34

Gouskova, Maria. 2012. Unexceptional segments. *Natural Language and Linguistic Theory* 30:79–133. 18

Graf, Dafna, and Adam Ussishkin. 2002. Emergent iambs: stress in Modern Hebrew. *Lingua* 113:239–270. 11, 12, 13, 15

Greenberg, Joseph H. 1950. The patterning of root morphemes in Semitic. *Word* 5:162–181. 33

Grestenberger, Laura. 2016. More span-conditioned allomorphy: Voice morphology in Classical Greek. In *Proceedings of the 46th annual meeting of the North East Linguistic Society (NELS 46)*, ed. Christopher Hammerly and Brandon Prickett, volume 3, 1–10. GLSA. 22

Gribanova, Vera. 2015. Exponence and morphosyntactically triggered phonological processes in the Russian verbal complex. *Journal of Linguistics* 51:519–561. 22

Grimshaw, Jane. 1990. *Argument structure*. Cambridge, MA: MIT Press. 35

Guekguezian, Peter Ara. 2017. Templates as the interaction of recursive word structure and prosodic well-formedness. *Phonology* 34:81–120. 36

Halle, Morris, and Alec Marantz. 1993. Distributed Morphology and the pieces of inflection. In *The view from building 20: Essays in linguistics in honor of Sylvain Bromberger*, ed. Ken Hale and Samuel Jay Keyser, 111–176. Cambridge, MA: MIT Press. 3, 7

Harbour, Daniel. 2008a. Discontinuous agreement and the Syntax–Morphology interface. In *Phi theory: Phi-Features across modules and interfaces*, ed. Daniel Harbour, David Adger, and Susana Béjar, 185–220. Oxford: Oxford University Press. 15

Harbour, Daniel. 2008b. On homophony and methodology in morphology. *Morphology* 18:75–92. 22

Harbour, Daniel. 2011. Valence and atomic number. *Linguistic Inquiry* 42:561–594. 7

Harley, Heidi. 2014a. On the identity of roots. *Theoretical Linguistics* 40:225–276. 10

Harley, Heidi. 2014b. Reply to commentaries, "on the identity of roots". *Theoretical Linguistics* 40:447–474. 10

Idrissi, Ali, Jean-Francois Prunet, and Renée Béland. 2008. On the Mental Representation of Arabic Roots. *Linguistic Inquiry* 39:221–259. 33

Itô, Junko, and Armin Mester. 1995. The core-periphery structure in the lexicon and constraints on re-ranking. In *Papers in optimality theory*, ed. Jill Beckman, Laura Walsh Dickey, and Suzanne Urbanczyk, 181–210. University of Massachusetts, Amherst: GLSA. 18

Kastner, Itamar. 2016. Form and meaning in the Hebrew verb. Doctoral Dissertation, New York University, New York, NY. Lingbuzz/003028. 7, 8, 22

Kastner, Itamar. 2017. Reflexive verbs in Hebrew: Deep unaccusativity meets lexical semantics. *Glossa* 2:75. 7, 8, 18, 19

Kastner, Itamar. To appear. Inchoatives in causative clothing: Change of state in Modern Hebrew heXYiZ. *The Linguistic Review* . 14

Kastner, Itamar, and Frans Adriaans. 2017. Linguistic constraints on statistical word segmentation: The role of consonants in Arabic and English. *Cognitive Science* . 33

Kastner, Itamar, and Vera Zu. 2017. Blocking and paradigm gaps. *Morphology* 27:643–684. 21, 24

Kiparsky, Paul. 1982. Lexical morphology and phonology. In *Linguistics in the morning calm*, ed. I.-S. Yang, 3–91. Seoul: Hanshin. 12

Kiparsky, Paul. 2000. Opacity and cyclicity. *The Linguistic Review* 17:351–365. 11

Kiparsky, Paul. 2012. Chains or strata? the case of Maltese. Ms., Stanford. lingbuzz/001379. 11

Kramer, Ruth. 2006. Root and pattern morphology in Coptic: Evidence for the root. In *Proceedings of NELS 36*, ed. Colin Davis, Amy Rose Deal, and Youri Zabbal, 399–412. Amherst, MA: GLSA. 29, 34

Kratzer, Angelika. 1996. Severing the external argument from its verb. In *Phrase structure and the lexicon*, ed. Johan Rooryck and Laurie Zaring, 109–137. Dordrecht: Kluwer. 7, 30

Kurisu, Kazutaka. 2001. The phonology of morpheme realization. Doctoral Dissertation, University of California, Santa Cruz, CA. ROA-490. 12

Labelle, Marie. 2008. The French reflexive and reciprocal *se*. *Natural Language and Linguistic Theory* 26:833–876. 7

Laks, Lior. 2011. Morpho-phonological and morpho-thematic relations in Hebrew and Arabic verb formation. Doctoral Dissertation, Tel Aviv University, Tel-Aviv. 24, 28

Laks, Lior. 2013a. Passive formation in Palestinian and Standard Arabic: Lexical vs. syntactic operations. *Word Structure* 6:156–180. 28

Laks, Lior. 2013b. Why and how do Hebrew verbs change their form? A morpho-thematic account. *Morphology* 23:351–383. 28

Laks, Lior. 2014. Morpho-thematic mismatches in Hebrew: What happens when morphological and thematic criteria collide? *Lingua* 138:107–127. 28

Laks, Lior. 2015. Variation and change in instrument noun formation in Hebrew and its relation to the verbal system. *Word Structure* 8:1–28. 35

Lois, Ximena. 2011. Roots and patterns in Yucatecan languages. In *Proceedings of Formal Approaches to Mayan Linguistics (FAMLi)*, ed. Kirill Shklovsky, Pedro Mateo Pedro, and Jessica Coon. Cambridge, MA: MITWPL. 34

MacEachern, Margaret. 1999. *Laryngeal co-occurrence restrictions*. New York, NY: Garland. 34

Marantz, Alec. 2001. Words. In *The 20th West Coast Conference on Formal Linguistics (WCCFL 20)*. 7

Marantz, Alec. 2013a. Locality Domains for Contextual Allomorphy Across the Interfaces. In *Distributed Morphology Today: Morphemes for Morris Halle*, ed. Alec Marantz and Ora Matushansky, 95–115. Cambridge, MA: MIT Press. 9, 20

Marantz, Alec. 2013b. Verbal argument structure: Events and participants. *Lingua* 130:152–168. 7

McCarthy, John J. 1979. Formal problems in Semitic phonology and morphology. Doctoral Dissertation, Massachusetts Institute of Technology. 2, 34

McCarthy, John J. 1981. A prosodic theory of nonconcatenative morphology. *Linguistic Inquiry* 12:373–418. 2, 9, 34

McCarthy, John J. 1989. Linear order in phonological representation. *Linguistic Inquiry* 20:71–99. 34

McCarthy, John J. 2000. The prosody of phase in Rotuman. *Natural Language and Linguistic Theory* 18:147–197. 34

McCarthy, John J. 2007. *Hidden generalizations: Phonological opacity in Optimality Theory*. London: Equinox. 12, 20

McCarthy, John J. 2008a. The gradual path to cluster simplification. *Phonology* 25:271–319. 12, 20, 31

McCarthy, John J. 2008b. The serial interaction of stress and syncope. *Natural Language and Linguistic Theory* 26:499–546. 12, 20, 31

McCarthy, John J., and Joe Pater, ed. 2016. *Harmonic grammar and harmonic serialism*. Equinox. 16, 20, 31

McCarthy, John J., and Alan S. Prince. 1990a. Foot and Word in Prosodic Morphology: The Arabic Broken Plural. *Natural Language and Linguistic Theory* 8:209–283. 2

McCarthy, John J., and Alan S. Prince. 1990b. Prosodic morphology and templatic morphology. In *Perspectives on Arabic linguistics*, ed. Mushira Eid and John J. McCarthy, volume 2, 1–54. Benjamins. 2

McCarthy, John J., and Alan S. Prince. 1995. Faithfulness and reduplicative identity. In *University of Massachusetts occasional papers in linguistics*, ed. Jill Beckman, Laura Walsh Dickey, and Suzanne Urbanczyk, volume 18, 249–384. Amherst, MA: GLSA Publications. 12, 13, 29

McPherson, Laura. 2017. Multiple feature affixation in Seenku plural formation. *Morphology* 27:217–252. 15

Merchant, Jason. 2015. How much context is enough? Two cases of span-conditioned stem allomorphy. *Linguistic Inquiry* 46:273–303. 22

Moore-Cantwell, Claire. 2013. Over- and under- generalization in learning derivational morphology. In *Proceedings of NELS 42*, ed. Stefan Keine and Shayne Sloggett. 6, 19

Moskal, Beata, and Peter Smith. 2016. Towards a theory without adjacency: hyper-contextual VI-rules. *Morphology* 26:295–312. 17, 22

Nespor, Marina, Marcela Peña, and Jacques Mehler. 2003. On the different roles of vowels and consonants in speech processing and language acquisition. *Lingue e linguaggio* 2:203–230. 33

Newport, Elissa L., and Richard N. Aslin. 2004. Learning at a distance I. Statistical learning of non-adjacent dependencies. *Cognitive Psychology* 48:127–162. 33

Oltra Massuet, Isabel. 1999. On the Notion of Theme Vowel: A New Approach to Catalan Verbal Morphology. Master's thesis, Massachusetts Institute of Technology, Cambridge, MA. 10, 17

van Oostendorp, Marc. 2005. Expressing inflection tonally. *Catalan Journal of Linguistics* 4:107–127. 15

Pater, Joe. 2010. Morpheme-specific phonology: Constraint indexation and inconsistency resolution. In *Phonological argumentation: Essays on evidence and motivation*, ed. Steve Parker, 123–154. London: Equinox. 18

Pollock, Jean-Yves. 1989. Verb movement, UG, and the structure of IP. *Linguistic Inquiry* 20:365–424. 2

Moscoso del Prado Martín, Fermín, Avital Deutsch, Ram Frost, Robert Schreuder, Nivja H. De Jong, and R. Harald Baayen. 2005. Changing places: A cross-language perspective on frequency and family size in Dutch and Hebrew. *Journal of Memory and Language* 53:496–512. 33

Prince, Alan. 2002. Arguing optimality. In *Papers in Optimality Theory II*, ed. Andries Coetzee, Angela Carpenter, and Paul de Lacy, 269–304. Amherst, MA: GLSA. ROA-562. 25

Prince, Alan, and Paul Smolensky. 1993/2004. *Optimality theory: Constraint interaction in generative grammar*. Malden, MA, and Oxford: Blackwell. Revision of 1993 technical report, Rutgers University Center for Cognitive Science. ROA 537. 10, 12

Prince, Alan S. 1990. Quantitative consequences of rhythmic organization. In *Proceedings of CLS 26*, volume 2, 355–398. 11

Pylkkänen, Liina. 2008. *Introducing arguments*. Number 49 in Linguistic Inquiry Monographs. Cambridge, MA: MIT Press. 7

Reinhart, Tanya, and Tal Siloni. 2005. The lexicon-syntax parameter: Reflexivization and other arity operations. *Linguistic Inquiry* 36:389–436. 24

Rose, Sharon. 1997. Theoretical issues in comparative Ethio-Semitic phonology and morphology. Doctoral Dissertation, McGill University, Montreal, QC. 12

Sande, Hannah, and Peter Jenks. 2017. Cohponologies by phase. In *NELS 48, University of Iceland*. 12, 15

Schäfer, Florian. 2008. *The syntax of (anti-)causatives*. Amsterdam/Philadelphia: John Benjamins. 7

Schwarzwald, Ora (Rodrigue). 1981. *dikduk u-metzi'ut ba-po'al ha-ivri [*Grammar and Reality in the Hebrew Verb*]*. Ramat Gan: Bar Ilan University Press. 4, 18

Shlonsky, Ur. 1989. The hierarchical representation of subject verb agreement. Ms., University of Haifa. 2

Smith, Peter W, Beata Moskal, Ting Xu, Jungmin Kang, and Jonathan David Bobaljik. 2016. Case and number suppletion in pronouns. Ms., Frankfurt/Syracuse/Connecticut, lingbuzz/003110. 17

Spathas, Giorgos, Artemis Alexiadou, and Florian Schäfer. 2015. Middle Voice and reflexive interpretations: *afto*-prefixation in Greek. *Natural Language and Linguistic Theory* 33:1293–1350. 7

Temkin Martínez, Michal. 2008. Exceptions encoded at the segmental level. In *Proceedings of WCCFL 26*, ed. Charles B. Chang and Hannah J. Haynie, 463–470. Somerville, MA: Cascadilla Press. 18

Temkin Martínez, Michal. 2010. Sources of non-conformity in phonology: Variation and exceptionality in Modern Hebrew spirantization. Doctoral Dissertation, University of Southern California, Los Angeles, CA. 10, 18

Temkin Martínez, Michal. 2013. Variation and preferences in Modern Hebrew nonce verbs. In *87th meeting of the LSA*. Boston, MA. 18

Temkin Martínez, Michal, and Ivana Müllner. 2016. Specific exceptions driving variation: The role of orthography in Modern Hebrew spirantization. In *Supplemental proceedings of the Annual Meeting on Phonology (AMP) 2015*. 18, 19

Trommer, Jochen. 2012. Constraints on multiple-feature mutation 122:1182–1192. 15

Tucker, Matthew. 2010. Roots and prosody: the Iraqi Arabic derivational verb. *Recherches Linguistique de Vincennes: Racine et Radical* 39:31–68. 18, 34

Ussishkin, Adam. 1999. The inadequacy of the consonantal root: Modern Hebrew denominal verbs and output-output correspondence. *Phonology* 16:401–442. 28

Ussishkin, Adam. 2000. The emergence of fixed prosody. Doctoral Dissertation, University of California, Santa Cruz, Santa Cruz, CA. 15, 28

Ussishkin, Adam. 2003. Templatic effects as fixed prosody: the verbal system in Semitic. In *Research in Afroasiatic Grammar III*, ed. Jacqueline Lecarme, Jean Lowenstamm, and Ur Shlonsky, 511–530. Benjamins. 28

Ussishkin, Adam. 2005. A fixed prosodic theory of nonconcatenative templatic morphology. *Natural Language and Linguistic Theory* 23:169–218. 2, 7, 11, 24, 28, 29, 30

Ussishkin, Adam. 2006. Affix-favored contrast inequity and psycholinguistic grounding for non-concatenative morphology. *Morphology* 16:107–125. 28, 29

Ussishkin, Adam, Colin Reimer Dawson, Andrew Wedel, and Kevin Schluter. 2015. Auditory masked priming in Maltese spoken word recognition. *Language, Cognition and Neuroscience* 30:1096–1115. 33

Wallace, Katherine. 2013. A Concatenative Approach to Semitic Templatic Morphology. Ms., NYU. lingbuzz/002299. 11, 18, 19, 34

Weeda, Donald. 1992. Word truncation in prosodic morphology. Doctoral Dissertation, University of Texas, Austin. 15

Wolf, Matthew. 2007. For an autosegmental theory of mutation. In *University of Massachusetts occasional papers in linguistics 32: Papers in Optimality Theory III*, ed. Leah Bateman, Michael O'Keefe, Ehren Reilly, and Adam Werle, 315–404. Amherst, MA: GLSA. 15, 19, 25

Wolf, Matthew. 2008. Optimal Interleaving: Serial phonology-morphology interaction in a constraint-based model. Doctoral Dissertation, University of Massachusetts, Amherst, MA. 12, 20

Wolf, Matthew. 2011. Cyclicity and non-cyclicity in Maltese: Local ordering of phonology and morphology in OT-CC. Lingbuzz/001319. 11

Wood, Jim. 2015. *Icelandic morphosyntax and argument structure*. Number 90 in Studies in Natural Language and Linguistic Theory. Springer. 7

Wood, Jim, and Alec Marantz. 2017. The interpretation of external arguments. In *The verbal domain*, ed. Roberta D'Alessandro, Irene Franco, and Ángel Gallego, 255–278. Oxford: Oxford University Press. 7

Yu, Alan C. L. 2003. The morphology and phonology of infixation. Doctoral Dissertation, University of California, Berkeley. 19

Yu, Alan C. L. 2005. Quantity, stress, and reduplication in Washo. *Phonology* 22:437–475. 19

Zimmermann, Eva. 2015. Templates as affixation of segment-sized units: The case of Southern Sierra Miwok. In *The segment in phonetics and phonology*, ed. Eric Raimy and Charles E. Cairns, 314–336. Wiley-Blackwell. 34

Zoll, Cheryl. 1996. Parsing below the segment in a constraint-based framework. Doctoral Dissertation, University of California, Berkeley. ROA 143. 19