Morphologically conditioned V–Ø alternation in Hebrew

Distinction among nouns, adjectives & participles, and verbs*

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I argue in this paper that phonology plays a role in enhancing the distinction among the lexical categories. The argument is based on V–Ø alternation in the inflectional paradigms of CVCVC stems which varies in position and type of vowel depending on the lexical category. For example, adjectives exhibit a–Ø alternation in the penultimate syllable, while verbs in the final syllable. The Optimality Theoretic analysis reveals that the phonological difference among the lexical categories is minimal (one unique ranking of two constraints for each category), allowing a category distinction without a major increase in the complexity of the phonological system.

Keywords: Hebrew morpho-phonology; vowel-zero alternation; category-specific phonology; lexical categories; lexical representation; paradigmatic relations; Optimality Theory

1. Introduction

In this paper I examine the manifestation of V–Ø alternation in four lexical categories in Modern Hebrew: nouns, adjectives, participles, and verbs. I argue that this alternation distinguishes among three groups of lexical categories: (i) nouns, (ii) adjectives and participles, and (iii) verbs. This morpho-phonological distinction is demonstrated using an Optimality Theoretic analysis, where each group has one unique ranking of two constraints.

The argument for the categorical distinction is based primarily on V–Ø alternation in CVCVC stems with final stress where V appears in the free stem and Ø in the suffixed form. Adjectives and participles exhibit *a*–Ø alternation in the penultimate stem syllable and *e*–Ø alternation in the final one. Verbs exhibit *a*–Ø and *e*–Ø alternation in the final stem syllable. No other vowel except *e* and *a* participates in this alternation, and no other position beyond those mentioned above exhibits V–Ø alternation.

Table 1. V–Ø alternation in CVCVC stems (free stem – MS.SG, 3rd person for verbs)

	Adjectives	Participles	Verbs
a: Penult stem σ	gadól gdol-á "big FM.SG"	katúv ktuv-á "written FM.SG"	–
a: Final stem σ	–	–	katáv katv-á "wrote 3FM.SG"
e: Final stem σ	xivér xivr-ím "pale MS.PL"	kotév kotv-ím "write MS.PL"	sipér sipr-ú "told 3PL"

Nouns, like adjectives and participles, exhibit *a*–Ø alternation in the penultimate stem syllable (e.g., ʃafán – ʃfan-ím "rabbit MS.SG–MS.PL", ʃaxén – ʃxen-á "neighbor MS.SG–FM.SG"), and no alternation in the final stem syllable. However, unlike in adjectives and participles, V–Ø in nouns is irregular, since not every CVCVC noun with *a* in the penultimate stem syllable exhibits *a*–Ø alternation (e.g., *gamád – gamad-á* "dwarf MS.SG–FM.SG", *sapár – sapar-ím* "hairdresser MS.SG–MS.PL"). I claim that the latter type of nouns is not exceptional with regard to *a*–Ø alternation because (i) the number of nouns displaying V–Ø alternations is much smaller than that which does not, and (ii) the type-frequency of nouns exhibiting *a*–Ø alternation is significantly lower than that of adjectives and participles. That is, in the case of nouns, the exception is the presence rather than the absence of V–Ø alternation.

The irregularity displayed by nouns is not limited to V–Ø alternations, but also manifested in the stress patterns and in the selection of the plural and feminine suffixes. The stress pattern in nouns is not always predictable, requiring a lexical specification for quite a few stems. The plural suffixes, which are subcategorized for gender, are sometimes attached to nouns specified for the opposite gender. The attachment of a feminine suffix is also not always predictable by the phonological structure or semantic properties of the noun.

The distinction between nouns (which exhibit irregularities in their morphophonology) and adjectives, participles, and verbs (which hardly ever do) suggests different types of relations in the inflectional paradigms. I argue that inflected nouns are derived from a lexical base (input-output relation; IO), while inflected adjectives, participles, and verbs are derived from a surface base (output-output relation; OO). In addition, I argue that the lexical representation of nouns exhibiting V–Ø alternation consists of two stems, CVCVC and CCVC. In derivational terms, it means that
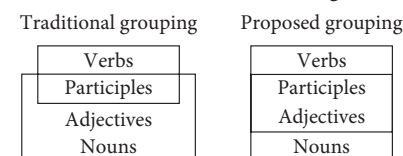
the V–Ø alternation in verbs, adjectives, and participles is due to a process of vowel deletion, while in nouns it is a matter of stem selection, i.e., there is no active vowel deletion process in nouns. The properties of the three groups are summarized below:

Table 2. Grouping of the lexical categories

	I	II		III
	Nouns	Adjectives	Participles	Verbs
a. Irregularities in suffixation	✓	–	–	–
b. Irregularities in stress pattern	✓	–	–	–
c. V–Ø alternation	–/✓	✓	✓	✓
i. *e* in final stem syllable	–	✓	✓	✓
ii. *a* in final stem syllable	–	–	–	✓
iii. *a* in penultimate stem syllable	–/✓	✓	✓	–

The properties in table (2a–c) distinguish between nouns on the one hand, and adjectives, participles, and verbs on the other. The details of V–Ø alternation, in particular of the site of *a*–Ø alternation (table 2c–ii, iii), distinguish between verbs on the one hand, and adjectives and participles on the other. That is, adjectives and participles display the same morpho-phonology.

The grouping of the lexical categories proposed above differs from that of traditional approaches to Hebrew grammar, which distinguish between two groups: (i) nouns and adjectives and (ii) participles and verbs. Blau (1975), for example, is a grammar book consisting of two volumes. The first volume, devoted to verbs, presents verb paradigms, which include the past, future, and participial forms, where the participle functions as the present tense. The second volume, devoted to nouns, presents paradigms of nouns and adjectives (singular, plural, and possessive) without distinguishing between adjectives and nouns (e.g., *zakén* "old" and *xacér* "yard" appear in the same paradigm (p. 98)). However, these two groups overlap, since participles appear also in the volume devoted to nouns and adjectives. That is, in the first volume the participles appear in their present tense function (e.g., ʃomr-ím "they are guarding" (p. 37)), and in the second, in their nominal function (e.g., ʃomr-ím "guards" (p. 103)).

Traditional grouping	Proposed grouping
Verbs	Verbs
Participles	Participles
Adjectives	Adjectives
Nouns	Nouns

Figure 1. Two approaches to grouping of the lexical categories.[1]

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1. It should be noted that the proposed grouping does not make any claims with regard to the syntactic properties of participles. It is quite possible that the traditional grouping is based on the view that participles are non-finite verbs.

2nd proofs

The data base in this paper is limited to CVCVC stems with final stress followed by a vowel initial suffix, as this is the potential structure of V–Ø alternation (see table (1) above). Several types of CVCVC stems are excluded, due to idiosyncrasies not directly relevant to the issue discussed here. (i) Segholate nouns exhibit various alternations in the vocalic pattern and prosodic structure (e.g., *dégel* "flag" *dgal-ím* "flags", *digl-ám* "their flag"), which strongly suggest that all the stems of the paradigm are lexically listed.[2] In particular, the different bases of the two vowel-initial suffixes (plural *-im* and possessive *-am*) indicate that the alternation is not phonologically conditioned. (ii) Stems with an initial sonorant do not exhibit V–Ø alternation due to the Sonority Sequencing Principle, which does not allow a sonority fall from the margins of the syllable towards the peak. In such cases *e* appears instead of Ø (e.g., *yaʃár* – *yeʃar-ím* "straight MS.SG–MS.PL; **yʃar-ím*). (iii) Stems with identical consonants in the final syllable also exhibit V–*e* alternation, rather than V–Ø, due to the Obligatory Contour Principle, which prohibits adjacent identical segments (e.g., *garár* – *garer-á* "dragged 3FM.SG"; **garr-á*). (iv) The historical gutturals *x* (from historical *ħ*), *ʔ* (from historical *ʔ* and *ʕ*) and *h* suppress V–Ø (e.g., *xalák* – *xalak-á* "smooth "MS–FM.SG") in most cases, more so in the stem penultimate syllable (see Faust 2006 for detailed discussion). (v) CVCVC forms whose initial C position is occupied by a prefix consonant (e.g., *h* in *hebét* "aspect" and *m* in *mabát* "view") never exhibit V–Ø alternation due to historical reasons. Notice, however, that since I argue that V–Ø alternation is the exception in nouns, all nouns that do not exhibit this alternation, including monosyllabic nouns (e.g., *gan* – *gan-ím* "garden(s)"), do not pose a problem to the analysis.

I begin the discussion with a review of the types of relations in a paradigm, with reference to two parameters: (i) representation – IO vs. OO, and (ii) directionality – asymmetric vs. symmetric. I assume the asymmetric OO relation to be the unmarked setting, which gains positive evidence from verbs and participles (§2.2). Nouns, however, provide evidence for an asymmetric IO relation as well as an OO relation, supported by the phonological and morphological idiosyncrasies (§2.1). The brief historical overview of the V–Ø alternation (§3.1) is followed by the relevant descriptive generalizations (§3.2). The generalizations are then captured in an Optimality Theoretic analysis, beginning with a discussion on the trigger of V–Ø alternation (§3.3.1). The distinction in the constraint rankings

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[2]. Segholates have the following structural properties (see Bolozky 1995 for detailed discussion): (i) their stress pattern is penultimate in the free stem and final in the suffixed form (e.g., *dégel* – *dgal-ím* "flag(s)"); (ii) their free stem is CVCVC, where V is a non-high vowel (e.g., *xóʃex* "darkness", *náxal* "river", *kélev* "dog", *kémax* "flour"); (iii) the base of their plural form is usually CCaC- (e.g., *kélev* – *klav-ím* "dog(s)").

proposed for verbs (§3.3.2), participles and adjectives (§3.3.3), and nouns (§3.3.4) is limited to one unique ranking of two constraints for each group. The general picture of the constraint rankings is then provided with reference to two approaches to category-specific phonology, co-phonologies and indexed constraints (§3.3.5). The concluding remarks (§4) draw attention to the role of category-specific phonology in language.

2. Paradigmatic relations

Starting with McCarthy & Prince (1995), the role of faithfulness constraints has been extended to requiring identity not only between a lexical/underlying form and a surface form (input-output; IO), but also between two surface forms (output-output; OO). The related surface forms can a base and a reduplicant in a reduplicated form (i.e., within a word), as well as related forms in a paradigm. The latter type is relevant here.

When one member in a pair of related forms is lexical (IO), the relation between the forms is asymmetric, such that the lexical form (I) can affect the surface form (O) but not vice versa. Such a relation can also be found between two surface forms (OO), where one of them serves as the base (Benua 1997). However, it is also possible that none of the two surface forms serves as a base, in which case the relation is symmetric and the two forms may affect each other. The latter relation has been proposed in McCarthy (2005), to account for paradigm uniformity in Arabic. Thus, faithfulness constraints can be specified for IO, OO, and, paradigm uniformity (PU). The combination of the two parameters, i.e., the representation of the input and the directionality of the faithfulness constraints, yields three types of relations (rather than four, since IO relation is always asymmetric).

Representation	Directionality
Lexical – Surface (IO)	Asymmetric; I = base
Surface – Surface (O_iO_j)	Asymmetric; O_i = base
Surface – Surface (OO)	Symmetric; No base

Figure 2. Types of relations.

Note that the relations in a paradigm are determined by the active faithfulness constraints, which can be of different types. That is, a paradigm may provide evidence for, say, an IO relation with respect to one phenomenon and an OO for another (same for directionality). However, in the absence of evidence to the contrary, I assume one type of relation within a paradigm.

In the ensuing subsections, I argue that V–Ø alternation provides evidence for the following morphological relations in Hebrew inflectional paradigms:
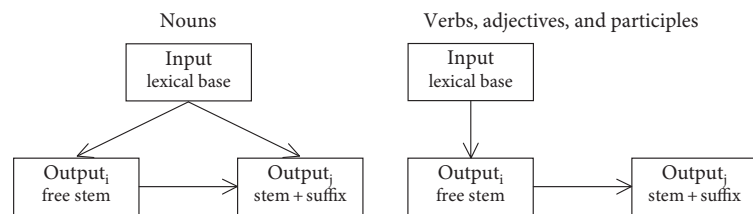

Figure 3. Relations in Hebrew inflectional paradigms (based on V–Ø alternation).

I assume that in the absence of evidence to the contrary, the unmarked output-output relation is asymmetric. That is, the active constraints are those that relate between surface forms (thus OO), where one of the forms serves as a base (thus asymmetric). Verbs, adjectives, and participles display such a paradigm (see Graf 2005 for a different view), which is further supported by generalizations referring to stress, where stress is a surface property in these categories.

The noun paradigm is, however, more complex. V–Ø alternation in nouns is irregular, and along with other idiosyncratic properties it must be lexically specified. Therefore, it is necessary to assume a lexical base and thus an (asymmetric) IO relation. In addition, the Optimality Theoretic analysis proposed here also requires a relation between the surface forms in the noun paradigm (OO), which is assumed to be asymmetric in the absence of evidence for the contrary.

2.1   Noun idiosyncrasies: Evidence for a lexical base

This section provides independent arguments for a lexical base in the noun paradigm. The arguments are based on the idiosyncratic properties associated with the morphology of number and gender (§2.1.1) and the (morpho-)phonology of stress (§2.1.2).

2.1.1   *Selection of inflectional suffixes*
Hebrew has two plural suffixes, *-ot* and *-im*, which attach to nouns, adjectives, and participles.[3] The plural suffixes are not specified for gender, as they do not change

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3.   The dual suffix *-aim*, which also functions as a plural suffix, is ignored since its plural function is limited to a small group of nouns. However, it exhibits V–Ø alternation like the other plural suffixes (e.g., *kanáf – knaf-áim* "wing(s)", *katéf – ktef-áim* "shoulder(s)").

the gender of the base. They are, instead, subcategorized for gender, such that *-ot* selects a feminine form and *-im* a masculine one (Bat-El 1997).

Plural is an inflectional category in Hebrew, as it is relevant for agreement (Anderson 1992), and thus its assignment could be suspected to be a syntactic operation on a surface form. However, there are plenty of inanimate nouns, which are exceptional with regard to the gender subcategorization of the plural suffixes (a fact which requires to view subcategorization as a violable morphological constraint). Quite a few masculine nouns take the plural suffix *-ot* and some feminine nouns take the plural suffix *-im* (Schwarzwald 1991a). It should be noted that every noun in Hebrew is specified for gender, though there are a few which can be either masculine or feminine (e.g., *sakín* "knif"). The examples of masculine minimal pairs provided in table (3), show that neither phonological structure nor semantic properties allow speakers to predict the attachment of an *-ot* to a masculine noun, though Becker (2007) argues that the great majority of irregular masculine nouns, i.e., those that take *-ot*, have an *o* in the final syllable.

Table 3.   Plural *-ot* vs. *-im* in masculine nouns (lexical contrast)

-ot (exceptional)			*-im*		
kir	kir-ót	"wall SG-PL"	gir	gir-ím	"chalk SG-PL"
xol	xol-ót	"sand SG-PL"	xof	xof-ím	"beach SG-PL"
knas	knas-ót	"fine SG-PL"	prat	prat-ím	"detail SG-PL"
xalón	xalon-ót	"window SG-PL"	sabón	sabon-ím	"soap SG-PL"
zanáv	znav-ót	"tail SG-PL"	davár	dvar-ím	"thing SG-PL"
eʃkól	eʃkol-ót	"cluster SG-PL"	mixʃól	mixʃol-ím	"obstacle SG-PL"
cinór	cinor-ót	"tube SG-PL"	kiyór	kiyor-ím	"sink SG-PL"

As noted above, the plural suffixes do not change gender, since a masculine noun that takes *-ot* remains masculine, as evidenced by agreement. In phrases such as *kir-ót levan-ím* "white walls", the masculine noun *kir* "wall" takes the plural suffix *-ot*, but the adjective *levan-ím* "white" gets the plural suffix subcategorized for masculine. The same is true for feminine nouns that take *-im*, such as *nemalá – nemal-ím* "ant FM.SG–PL", as in the phrase *nemal-ím ktan-ót* "little ants".

Also the attachment of the feminine suffix in nouns, which can be *-et*, *-it*, or *-a*, is not entirely predictable. Schwarzwald (1991b) suggests that the distinction between the suffixes in the feminine forms *xayél-et* "soldier FM.SG" and *sapar-ít* "hairdresser FM.SG", which are both related to the same CaCáC masculine form (*xayál* and *sapár* respectively), is due to the feature [+occupational] associated with the latter. However, *zamár* "singer MS.SG", *cayár* "painter (artist) MS.SG", and

calám "photographer MS.SG" are also occupations, but they take the feminine suffix *-et* rather than *-it* (*zamér-et*, *cayér-et*, and *calém-et* respectively).[4]

Schwarzwald argues that the idiosyncrasies associated with the plural (Schwarzwald 1991a) and the feminine (Schwarzwald 1991b) suffixes suggest a lexical rather than a syntactic process. This argument is further supported by the stress pattern discussed in the ensuing section.

2.1.2 *Stress*

Hebrew distinguishes among three types of noun stem, on the basis of the alternation in the stress pattern in the inflectional paradigm (Bat-El 1993). The first two types are accented and unaccented stems. In accented stems, stress remains on the same stem syllable when a suffix is added, while in unaccented stems stress appears on the suffix.[5]

Table 4. Accented vs. non-accented nouns (lexical contrast)

	Accented stems			Unaccented stems	
bazár	bazár-ím	"bazaar SG-PL"	gamád	gamad-ím	"dwarf SG-PL"
rabát	rabát-ít	"corporal MS-FM"	tabáx	tabax-ít	"cook MS-FM"
galón	galón-im	"gallon SG-PL"	sabón	sabon-ím	"soap SG-PL"
xamsín	xamsín-im	"hot wave SG-PL"	tavlín	tavlin-ím	"spice SG-PL"
túʃ	túʃ-im	"marker SG-PL"	xúʃ	xuʃ-ím	"sense SG-PL"
gól	gól-im	"goal SG-PL"	xór	xor-ím	"hole SG-PL"

On the surface, the accented free stems in table (4) look exactly like the unaccented ones (there are also accented stems with non-final stress; e.g., *tíras – tíras-im* "corn(s)"). Their distinction must then be lexically encoded, by marking the accented syllable (or vowel). This lexical accent is relevant for the formation

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4. Other idiosyncrasies associated with nouns (which are of no concern here) have to do with the prosodic structure and vocalic pattern of the suffixed stems (see Bolozky 1995). Identical structures of free stems may have different suffixed stems. A form with the configuration CiCCá may have CCaC- as the base of the plural suffix (e.g., *simlá – smal-ót* "dress SG–PL") or CiCC- (e.g., *biktá – bikt-ót* "hut SG–PL"). Similarly, a form with the configuration CéCeC may have CaCC- as the base of the feminine suffix (e.g., *yéled – yald-á* "boy–girl") or CiCC- (e.g., *kéves – kivs-á* "lamb MS–FM").

5. There are a few cases of (register/age-based) free variation (e.g., *salát – salátim ~ salatím* "salad SG–PL", *balón – balónim ~ baloním* "balloon SG–PL"). As argued in Becker (2003), accented stems with final stress may lose their accent if they have a native prosodic structure, characterized by disyllabicity. One exception is acronym words, which do not seem to lose their accent although their prosodic structure is native, CVCVC or CVCCVC (Bat-El 1994b).

of plural and feminine, since accented syllables are stressed when the plural or feminine suffix is added. Thus, the formation of the plural and feminine forms must have access to the lexical form, which carries the idiosyncratic properties. Therefore, the noun paradigm must consist of an (asymmetric) IO relation.

The third stress pattern is that of segholates, where stress fall on the penultimate syllable in the free stem and on the final in the suffixed form. As noted in §1, all the stems of the segholates paradigm should be lexically listed, given that the prosodic and vocalic alternation are not phonologically conditioned.

2.2 Adjectives, participles, and verbs

The pluralization of nouns differs from that of adjectives and participles, since the latter ones never take a plural suffix that does not match the gender of the base (Schwarzwald 1991a). That is, adjectives, participles and verbs, unlike nouns, display regular inflectional morphology and are thus free from lexical specification.

This is a distinction between contextual (syntactic) inflection and inherent inflection, drawn in Anderson (1992) and Booij (1996). Anderson defines inflectional morphology as the properties relevant to the syntax, but distinguishes between inherent properties that are "accessed" by the syntax (e.g., for agreement purposes) and contextual properties that are "derived" by the syntax (due to syntactic configuration, agreement properties, or phrasal properties).

Inherent properties are lexical, and thus can bear idiosyncratic features, as is the case with noun inflection. Inflectional morphology in adjectives and verbs is derived via agreement, and is thus a contextual property, which does not display irregularities.

Participles, however, may function as nouns, verbs, and adjectives (e.g., *bogéd* means either "traitor" or "betrays" and *me-nahél* means either "manager" or "manages"). We do not expect irregularities in the adjectival and verbal function of participles, but we could expect irregularities in the nominal function, as it is the case with other nouns. However, participles never display irregularity regardless of their function, which suggests that morphological properties are associated with a stem rather than its function. This accounts for all the participles whose nominal function is directly related to that of a verb/adjective. That is, the regularity imposed by the contextual inflection of verbs/adjectives is carried over to the nominal function of the participles. However, there are nouns with a participle configuration, which do not have a related verb (e.g., *noxél* "crook"), others which are remotely related to a verb (e.g., *meʃorér* "poet" vs. *ʃár* "to sing"), and yet others whose meaning is idiosyncratic with respect to that of the verb (e.g., *colélet* "submarine" vs. "dives FM.SG"). Even in such cases there is no irregularity in the inflectional paradigm. This, I suggest, is due to the fact that participles are structurally identifiable by their

configuration, in particular the vocalic pattern, and in some forms the prefix *mV-* (see table (7) below). The structural uniqueness of the participles serves as a base for paradigm uniformity, requiring all forms that share the participle configuration to have a consistent inflection.

Also the feminine suffix of participles is predictable, although there are three gender marking feminine suffixes in Hebrew: *-a*, *-et*, and *-it* (e.g., *sus-á* "horse FM.SG", *ʃomér-et* "guard FM.SG", *rakdan-ít* "dancer FM.SG"). All polysyllabic participles whose final stem syllable has a non-high vowel (only *a* and *e* are in this position) take the feminine suffix *-et*. This suffix has idiosyncratic lexical properties, which require the stem final syllable to be stressed and to have a mid vowel (e.g., *me-xubád – me-xubéd-et* "respected MS–FM.SG").

High vowels in the final stem syllable resist phonological alternations (also in the verb paradigm). Thus, since *-et* requires a mid vowel in the stem final syllable and high vowels resist lowering, the suffix *-et* cannot be attached to a stem with a high vowel in the final syllable. In such cases, *-a* is the feminine suffix (e.g., *ʃavúr – ʃvur-á* "broken MS–FM.SG", *m-atxíl-a – m-atxil-á* "begins, beginner MS–FM.SG"). The feminine suffix *-it* never attaches to participles, or to adjectives in the canonical pattern CVCVC, where the suffix is usually *-a* (e.g., *gdol-á* "big FM.SG" *ktan-á* "small FM.SG", *zken-á* "old FM.SG", *ʃvir-á* "fragile FM.SG", *kxul-á* "blue FM.SG"), unless the form is CiCeC, in which case the suffix is *-et* (e.g., *xivér-et* "pale FM.SG").

One other phonological condition for the feminine suffix *-a* in participles is monosyllabicity (e.g., *rác-a* "run FM.SG", *ʃár-a* "sings FM.SG"). The attachment of *-et* would require changing the stem vowel (e.g., **réc-et*), which probably resists alternation when it is the only vowel in the stem. Notice, however, that unlike in polysyllabic participles with *-a*, where stress is on the suffix (e.g., *ma-txil-á* "starts FM.SG"), in monosyllabic ones stress is on the stem (e.g., *ʃár-a* "sings FM.SG"). Consequently, monosyllabic participles are homophonous with verbs but distinguished from nouns (e.g., *sar-á* "minister FM.SG"). Although limited to monosyllabic forms (which are rare), the loss of contrast between the past and the participle forms may support the view that participles inherently are verbs. This is, however, not a necessary conclusion, given that in all other cases the forms of the verb and the participle are structurally distinct (cf. *h-itxíl-a* "started 3FM.SG" vs. *m-atxil-á* "starts FM.SG"). I believe that the loss of contrast is due to the fact that almost all monosyllabic participles function only as verbs. Notice in particular, that the masculine form *rac* means "ran", "run", as well as "runner MS.SG", but speakers do not agree as to whether its feminine counterpart *rác-a* can function as the noun "runner FM.SG" in addition to its verbal function. This state of affairs is not surprising given that the monosyllabic participles do not have a unique configuration; CaC can be a verb (*rac* "ran 3MS.SG") a participle (*rac* "run MS.SG"), an adjective (e.g., *dak* "thin MS.SG"), and a noun (e.g., *daf* "page MS.SG").

2.2.1   *Verbs: Evidence for OO relation*

Graf and Ussishkin (2003) argue for an independent assignment of feet and stress in the verb paradigm. A binary syllabic foot, not specified for prominence, is assigned at the right edge of the prosodic word. Stress is assigned independently, on the final syllable in the prosodic word. Vowel deletion, i.e., V–Ø alternation, is triggered by a constraint requiring a prosodic word to equal a binary foot (see §3.3.1 for an alternative trigger). Thus, in $\{[\text{gadál}]_F\}_{\text{PRWD}}$ "grew 3MS.SG" the prosodic word is a binary foot, but in $*\{[\text{gadal-á}]_F\}_{\text{PRWD}}$ or $*\{\text{ga}[\text{dal-á}]_F\}_{\text{PRWD}}$ it is not, and therefore there is vowel deletion resulting in $\{[\text{gadl-á}]_F\}_{\text{PRWD}}$ "grew 3FM.SG".

However, vowel deletion does not always apply. Monosyllabic verbs (not considered by Graf and Ussishkin) are disyllabic when a suffix is added, and therefore there is no trigger for vowel deletion. In addition, vowel deletion in monosyllabic verbs would result in a complex onset, which is impermissible in the verb paradigm (see, however, fn. 13). When the vowel is not deleted, stress is not final in the suffixed form, contrary to what is expected by the constraint assigning final stress. Rather, stress remains in the same position as in the free stem (e.g., *ʃár – ʃár-a* "sang 3MS.SG–3FM.SG"). Stress also persists on the same syllable when the stem is followed by a consonant initial suffix. In this case too, the suppression of vowel deletion could be attributed to the prohibition of a complex onset (e.g., *zarák – zarák-ti *zark-ti* "threw 3MS.SG–1SG").[6]

The generalization relevant here is that when the stressed vowel of the base persists in the derived form, it also preserves its stress.[7] Stress in verbs is a surface property (rather than lexical), and therefore V–Ø alternation, which is interconnected with stress, must be a property of OO relation.

2.2.2   *Participles: Evidence for OO relation*

Participles delete an *e* in the final stem syllable (e.g., *me-xabél – me-xabl-ím* "saboteur MS.SG–MS.PL"), but not an *a* (*me-vukáʃ – me-vukaʃ-ím* "wanted MS.SG–MS.PL").

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6.   In order to account for the non-final stress in verbs with consonant-initial suffixes, Graf and Ussishkin propose that consonant initial suffixes are extraprosodic, i.e., outside the domain of the prosodic word. Assuming extraprosidicity, the constraint assigning stress to the final syllable in the prosodic word is respected. However, extraprosidicity can be eliminated if the stress pattern is viewed in light of an OO relation. Note that extraprosidicity cannot be invoked for monosyllabic verbs with a vowel initial suffix, whose stress, as noted above, is not final.

7.   One type of exception appears in CVCCVC stems, where the vowel in the final syllable cannot be deleted because it is preceded by a closed syllable (e.g., *tilfén – tilfen-á* "phoned 3MS.SG–3FM.SG", *nigmár – nigmer-á* "is/was finished 3MS.SG–3FM.SG"). It is possible that the preservation of stress is further conditioned by the type of vowel, assuming a hierarchy *á > é*, where a stressed *e* is more marked than a stressed *a* (see (8) and the discussion in §3.3.3).

That is, participles do not behave like verbs; (i) their stress is final whether or not the vowel is deleted (cf. *hitxíl-a* "started FM.SG" vs. *matxil-á* "starting FM.SG"), with the exception of monosyllabic stems (§2.2.1), and (ii) they do not delete an *a* in the stem final syllable. Also adjectives do not delete an *a* in this position, but actually there are no adjectives with a deleteable *a* in the final syllable, since all the adjectives with *a* in this position also have an *a* in the penultimate stem syllable, which takes priority in vowel deletion (see §3.3.3).

Since *e* is deleted in the final stem syllable, we cannot attribute the failure of *a* to delete in this same position to the resulting syllable structure, e.g., to the non-final coda created due to vowel deletion (e.g., *me.xab̲.lím* "saboteurs"). Similarly, we cannot attribute it to the quality of the vowel, since *a* is deleted in the penultimate syllable. I thus argue in §3.3.3 that unlike a stressed *e* (as well as unstressed *e* and *a*), a stressed *a* resists deletion.

Again, reference to stress, implies OO relation, since stress is entirely predictable in participles, and thus must be a derived, rather than a lexical property.

3.   V–Ø alternation

A brief historical review explains the source of the irregularity in V–Ø alternation in nouns, and the state of affairs the language learner has to deal with (§3.1). The detailed descriptive generalizations of V–Ø alternation are then provided (§3.2), followed by a formal analysis couched within the framework of Optimality Theory (§3.3). The analysis begins with a discussion on the trigger of V–Ø alternation (§3.3.1), and then proceeds with providing the constraint rankings for verbs (§3.3.2), adjectives and participles (§3.3.3), and nouns (§3.3.4). A general picture of the constraint rankings reveals a minimal distinction of the different categories (§3.3.5).

3.1   A historical perspective and learnability

The script of Tiberian Hebrew, the source of a vast majority of the native Hebrew lexicon, reflects the distinction between CV:.CV:C stems, where the penultimate syllable is open, and $CVC_i.C_iV:C$ stems, where the penultimate syllable is closed (by the first part of a geminate). Stems with an open syllable have undergone vowel reduction in Tiberian Hebrew (Gesenius 1910; Bolozky 1978b), whereby a vowel in an open syllable residing outside the (rightmost) strong foot was reduced to a schwa (table (5a–d)). In forms with an initial guttural (see §1), the schwa surfaced as a reduced *a* (marked *ă*), presumably via assimilation to the feature [low] of the gutturals (table 5 (e–g)).

Table 5.   Vowel reduction in Tiberian Hebrew nouns (SG – PL)

	Vowel reduction in CV: .CV: C stems			No vowel reduction in $CVC_i.C_iV:C$ stems		
a.	za:qá:n	zəqaan-ím	"beard"	naggá:r	nagga:r-ím	"carpenter"
b.	ka:zá:v	kəza:v-ím	"lie"	cawwá:r	cawwa:r-ím	"neck"
c.	na:ħá:ʃ	nəħa:ʃ-ím	"snake"	mallá:ħ	malla:ħ-ím	"mariner"
d.	ra:ví:ð	rəvi:ð-ím	"necklace"	lappí:ð	lappi:ð-ím	"torch"
e.	ʕa:ná:w	ʕăna:w-ím	"humble"	ʕawwá:l	ʕawwa:l-ím	"sinner"
f.	ħa:zó:n	ħăzo:n-ót	"vision"	ħalló:n	hallo:n-ót	"window"
g.	ʔa:sí:r	ʔăsi:r-ím	"prisoner"	ʔabbí:r	ʔabbi:r-ím	"mighty"

The revivers (or creators) of Modern Hebrew adopted the paradigms above, with their morpho-phonological alternations, thus preserving the distinction between alternating and non-alternating paradigms, i.e., between the paradigms of CV:CV:C and $CVC_iC_iV:C$ respectively. However, for various reasons (see Horvath and Wexler 1994), they failed to adopt the phonological structure that provides the context for the alternation. In particular, Modern Hebrew, unlike Tiberian Hebrew, does not display weight contrast, i.e., there is no phonemic distinction between short and long vowels or simple and geminate consonants. Thus, both CV:.CV:C and $CVC_i.C_iV:C$ stems, which were at the base of two different morpho-phonological paradigms in table (5), correspond to CVCVC in Modern Hebrew. In addition, the distinction between reduced and full vowels is also not a contrastive property in Modern Hebrew. Consequently, Modern Hebrew (MH) *a* corresponds to both a full *a* and a reduced *a* (*ă*) in Tiberian Hebrew (TH), and Tiberian Hebrew schwa corresponds in Modern Hebrew to *e* after a sonorant and between identical consonants, and Ø elsewhere.

	Prosodic structure		Vowels			
TH	CV:.CV:C	$CVC_i.C_iV:C$	a	ă		ə
MH	CVCVC			a	e	Ø

Figure 4.   Corresponding phonological properties in Tiberian and Modern Hebrew.

Due to these mergers, Modern Hebrew paradigms that correspond to those in table (5) are opaque. The learner of Hebrew is faced with the following types of stem allomorphs (C is any consonant and G is a guttural).

Table 6.   Neutralization in stem allomorphy

		Free stem		Bound stem		Historical source
a.	CaCVC	sabál	"porter"	CaCVC-	sabal-ím	$CaC_iC_iV:C$
b.		ʔagám	"lake"		ʔagam-ím	Ga:CV:C
c.		zakán	"beard"	CCVC-	zkan-ím	$C_i a:CV:C(C_i$ G)
d.	CCVC	kfár	"village"		kfar-ím	CəCV:C

The only secured conclusion the learner can reach is that CaCVC stems with an initial historical guttural do not exhibit V–Ø alternation (b in table (6)), assuming, for the sake of argument, that the historical gutturals are identifiable (see Faust 2006). For all other paradigms, the bound stem cannot be predictable from the free one (a vs. c in table (6)) and the free stem cannot be predictable from the bound one (c vs. d in table (6)).

Since Hebrew was not transmitted, but rather revived or recreated, the first native learners did not pass through an intermediate stage, where residues of the earlier stage were still available, presumably in free variation (see Horvath & Wexler 1994). Therefore, an analysis that recapitulates the history of the language, with underlying geminates and long vowels, is an implausible grammar not only for today's native speakers but also for the first generation of native speakers.

V–Ø alternation is statistically motivated for verbs, participles, and adjectives, with very few exceptions in adjectives (see below and §3.2), and thus it is reasonable that the learner would arrive at the system of alternating paradigms. Indeed, studies in the acquisition of Hebrew, such as Adam (2002), report that children hardly ever make errors with respect to V–Ø alternation in verbs and participles (I am not aware of such studies on adjectives). In nouns however, as reported in Berman (1981) and Levy (1983), children do make errors with respect to V–Ø alternation when they start producing the plural forms.

The errors in the noun paradigm are not surprising, since the children are faced with contradicting data. In some nouns, there is V–Ø alternation, and in structurally similar ones there is not. The children are thus left with two options to deal with the contradicting data:

a. To assume V–Ø alternation in nouns, and lexically mark the stems that fail to exhibit V–Ø alternation.
b. To assume that there is no V–Ø alternation in nouns, and lexically mark the stems that do exhibit V–Ø alternation.

Not surprisingly, neither option is clean; as Hayes (1999) said, "sometimes historical change deals the child a difficult hand".[8]

We could expect the native learner to select the first option, in analogous the adjectival paradigm, since (i) adjectives rarely display contradicting data with respect to V–Ø alternation, and (ii) adjectives and nouns employ the same morphological markers. That is, the moment the learner arrives at the V–Ø alternation for adjectives, she/he could generalize it to the nouns. However, given that nouns are produced

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before adjectives, and more crucially, that the noun paradigm is productive in children's speech before the adjective paradigm, this is quite unlikely to happen.

Moreover, the irregularities displayed by nouns (§2.1) point towards the second option, i.e., that stems exhibiting V–Ø alternation are lexically marked. While about 90% of the CaCVC adjectives undergo vowel deletion, only about 30% of the CaCVC nouns do so (only stems whose first consonant is neither a sonorant nor a historical guttural were counted). Participles undergo vowel deletion without exception (i.e., 100%). In addition, the number of new alternating noun stems is smaller than that of alternating ones. Avinery (1976) provides a list of all native nouns, organized according to their patterns and the period in which they entered the language (four periods). In the modern period, i.e., since the beginning of Modern Hebrew, there were much more new non-alternating nouns than alternating ones. These findings further support the claim that the V–Ø alternation in nouns is the exception, and thus should be lexically specified.

I thus propose that nouns exhibiting V–Ø alternation have two lexical stems, CaCVC and CCVC. Given that lexical specification is arbitrary, we would expect a variety of lexically specified pairs, for example, also CiCVC and CCVC stems. However, lexical specification is a consequence of historical evolution, and it is thus not surprising that it is limited in a way that reflects, to a certain extent, the historical source. The learner arrives at the lexical specification from the data he/she obtained, and thus refrains from adopting structures that are not surface true.

3.2   Descriptive generalizations

Only the non-high unrounded vowels (*e* and *a*) are subject to V–Ø alternation, which occurs in a morphologically derived environment, when a vowel initial suffix is added to a CVCVC stem. The table below provides all the vocalic patterns with *e* and/or *a* in CVCVC stems with final stress.

Table 7. Vocalic patterns that include the deletable vowels (*a* and *e*)

	Nouns		Adjectives		Participles		Verbs	
a-a	gamál	"camel"	katán	"small"			gadál	"grow"
a-e	ʃaxén	"neighbor"	zakén	"old"	me-xabél	"saboteur"	hit-raxéc	"washed"
a-o	ʃalóm	"peace"	gadól	"big"				
a-i	pakíd	"clerk"	ʃavír	"fragile"				
a-u	tapúz	"orange"	paʃút	"simple"	ʃamúr	"preserved"		
o-e					ʃomér	"guard"		
i-e			xivér	"pale"			gidél	"raise"
o-a	ʃofár	"horn"						
i-a	simán	"sign"						
u-a	sulám	"ladder"			me-vukáʃ	"wanted"		

Below, I provide the details of the alternation, starting with *a–Ø* alternation in the penultimate (table 8) and final (table 9) syllables, and then *e–Ø* alternation in final syllable (table 10).

In table (8) below I list all the configurations with *a* in the penultimate syllable, indicating whether the *a* alternates with Ø.

Table 8.   *a–Ø* alternation in the penultimate stem syllable (✓*a–Ø*; * no *a–Ø*)

Category	V-Pattern	*a–Ø*	Free stem	Suffixed form	
Nouns	a-a	✓	davár	dvar-ím	"thing sg-pl"
		*	davár	davar-ím	"postman sg-pl"
	a-e	✓	ʃaxén	ʃxen-á	"neighbor ms-fm"
	a-o	✓	karóz	kroz-ím	"announcer sg-pl"
		*	paʃóʃ	paʃoʃ-ím	"warbler sg-pl"
	a-i	✓	pakíd	pkid-á	"clerk ms-fm"
		*	sakín	sakin-ím	"knife sg-pl"
	a-u	*	tapúz	tapuz-ím	"orange sg-pl"
Adjectives	a-a	✓	katán	ktan-á	"small ms-fm"
	a-e	✓	zakén	zken-á	"old ms-fm"
	a-o	✓	gadól	gdol-ím	"big sg-pl"
	a-i	✓	ʃavír	ʃvir-á	"fragile ms-fm"
		*	cadík	cadik-ím	"righteous sg-pl"
	a-u	✓	paʃút	pʃut-á	"simple ms-fm"
Participles	a-e	*	me-vakéʃ	me-vakʃ-ím	"asking sg-pl"
	a-u	✓	ʃamúr	ʃmur-á	"guarded ms-fm"
Verbs	a-a	*	gadál	gadl-ú	"grew 3ms.sg-3pl"
	a-e	*	hit-raxéc	hit-raxc-ú	"washed 3ms.sg-3pl"

Participles display *a–Ø* alternation in the penultimate stem syllable, unless the stem is preceded by a prefix. Verbs never display alternation in the penultimate stem syllable. Most adjectives display the alternation, though there are a few exceptions in the *a-i* pattern, which is most productive in its "able" meaning. Adjectives with the "able" meaning (e.g., *ʃavír* "fragile") always exhibit *a–Ø* alternation, but the few that do not carry this meaning may suppress the alternation (cf. *cadík – cadik-ím* "righteous ms.sg–ms.pl" vs. *kaʃíf – kʃiʃ-ím* "old ms.sg–ms.pl"). Moreover, some of the adjectives that suppress the alternation in the normative register, exhibit V–Ø alternation in the vernacular one (e.g., *takíf – takifím ~ tkifím* "aggressive ms.sg–ms.pl"; see §3.3.1).

In contrast with these three categories, *a–Ø* alternation in nouns is much less common. Out of 67 nouns with the pattern *a-a*, only 20 (30%) exhibit *a–Ø* alternation. Notice also in table (8), that the sporadic suppression of the alternation in adjectives is limited to one pattern only (*a-i*), while in nouns, there are several patterns that include stems that do not exhibit the alternation (*a-a*, *a-o*, and *a-i*). In addition, nouns with the pattern *a-u* (which are rare) never display *a–Ø* alternation, unlike the participles and adjectives with *a-u*, which always do.

In the final stem syllable, as shown in table (9) below, *a* is deleted only in verbs (unless the verb stem is monosyllabic, as in *rác-a* "ran fm.sg"). There is no *a–Ø* alternation in the final syllable in the other categories, not even in participles. Adjectives with *a* in the final syllable also have *a* in the penultimate one, and it is the latter *a* that alternates with Ø.

Table 9.   *a–Ø* alternation in the final stem syllable (✓*a–Ø*; * no *a–Ø*)

Category	V-Pattern	*a–Ø*	Free stem	Suffixed form	
Nouns	a-a	*	gamád	gamad-ím	"dwarf sg-pl"
	o-a	*	ʃofár	ʃofar-ót	"ram's horn sg-pl"
	i-a	*	simán	siman-ím	"sign sg-pl"
	u-a	*	sulám	sulam-ót	"ladder sg-pl"
Adjectives	a-a	*	katán	ktan-á	"small ms-fm"
Participles	u-a	*	me-vukáʃ	me-vukaʃ-ím	"wanted sg-pl"
Verbs	a-a	✓	gadál	gadl-ú	"grew 3ms.sg-3pl"

The V–Ø alternations in table (8) and table (9) draw the distinctions among the groups. The site of deletion, final stem syllable in verbs and penultimate in the other categories, secludes the verbs from other categories. The irregularities found in nouns and the minority of *a–Ø* alternation, seclude the nouns from adjectives and participle. Adjectives and participles are indistinguishable with respect to V–Ø alternation, and thus form one group.

As shown in table (10) below, *e–Ø* alternation in the final stem syllable, applies across the board regardless of the category.

Table 10.   *e–Ø* alternation in the final stem syllable

Category	V-Pattern	*e–Ø*	Free stem	Suffixed form	
Adjectives	i-e	✓	xivér	xivr-ím	"pale sg-pl"
Participles	a-e	✓	me-xabél	me-xabl-ím	"saboteur sg-pl"
	o-e	✓	ʃomér	ʃomr-ím	"guard sg-pl"
Verbs	i-e	✓	gidél	gidl-ú	"raised 3ms.sg-3pl"

Notice that nouns and adjectives with the pattern *a–e* exhibit *a–Ø* alternation in the penultimate syllable, which blocks the *e–Ø* alternation in the final one.[9] However, since the *a–Ø* alternation appears only when the penultimate stem syllable is also the first syllable in the word, in forms with a prefix, *e–Ø* alternation gets to be surface true.

3.3   An Optimality Theoretic analysis

Optimality Theory (Prince & Smolensky 1993) and its later developed branch known as Correspondence Theory (McCarthy & Prince 1995), account for phonological (and other grammatical) phenomena in terms of constraint interaction. Candidates of output forms are evaluated by a hierarchy of violable constraints, which assess the wellformedness of the outputs (markedness constraints) and the relationship between the input and the output (faithfulness constraints). As noted in §2, there are three types of relations, IO and OO, where the latter can be symmetric or asymmetric. Given a language specific hierarchy of violable constraints, the optimal candidate, i.e., the actual output, is the one that has the least violations of the higher-ranked constraints.

The constraints are of a general schema, such as the faithfulness constraint Max (short for Maximality), which prohibits deletion by requiring the output to preserve the structure of the input. Each constraint can be further specified by particular properties, such as MaxV (do not delete a vowel), MaxV$_{[+high]}$ (do not delete a high vowel), etc. A specified constraint Cx is active only if it is ranked above its general counterpart C (the Elsewhere Condition).

3.3.1   *The trigger of V–Ø alternation*

Vowel deletion in Hebrew verb paradimgs is often attributed to the Minimal Word restriction (Prince 1980; Broselow 1982; and McCarthy & Prince 1986 et. seq.), which in Hebrew restricts the size of the verb to no more and no less than two syllables (see Ussishkin 2000 and references therein for a constraint-based statement of the Minimal Word as a minimal and maximal bound). This approach can be expanded to the data considered here, which are restricted to disyllabic stems. That is, the deletion of a vowel in the suffixed form allows the derived suffixed form to be disyllabic. The same constraint can be responsible for the selection of CCVC for suffixed nouns whose lexical representation consists of two stems, and CVCVC for the free-standing stem (e.g., *gamál – gmál-im* "camel(s)").

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9.   There is one CaCeC noun that displays *e–Ø* alternation – *makél – makl-ót* "stick(s)". Notice also the form *gibén* "hunchback", which I classified as adjective, could be viewed as a noun. This, however, is not crucial here since *e–Ø* alternation does not distinguish among the categories.

There is, however, an alternative constraint that could trigger vowel deletion and also be responsible for noun stem selection. This constraint, which relies on paradigmatic relations, requires the related forms in a paradigm to have the same number of syllables.

(1)   Depσ: A derived form has the same number of syllables as its base

Dep, usually used as an anti-epenthesis constraint, does not allow phonological material to be added to the input. I assume that lexical inputs are not syllabified, and therefore Depσ, which refers to syllables, is inevitably an OO constraint evaluating surface forms in the paradigm. That is, this is a constraint imposing paradigm uniformity with respect to the number of syllables.

Depσ is less restrictive than the Minimal Word, since it is not limited to disyllabic free stems, like the ones discussed so far. To determine whether the Minimal Word or Depσ is the relevant constraint, it is necessary to find V–Ø alternation in stems longer than two syllables. Indeed, Hebrew has trisyllabic nouns of the configuration CiCaCon, which also exhibit V–Ø alternation.

Table 11.   V–Ø alternation in trisyllabic *-on* nouns

SG	PL		SG	PL	
ʃitafón	ʃitfon-ót	"flood"	nicaxón	nicxon-ót	"victory"
kiʃalón	kiʃlon-ót	"failure"	pikadón	pikdon-ót	"deposit"
nisayón	nisyon-ót	"experiment"	ʃigaʔón	ʃigʔon-ót	"madness"

As in the disyllabic stems considered earlier (e.g., *gamál – gmal-ím* "camel(s)"), the vowel *a* in the stem penultimate syllable alternates with Ø. Thus, as proposed for all nouns exhibiting V–Ø alternation, the nouns in table (11) have two lexical stems, CiCaCon and CiCCon.

V–Ø alternation in the trisyllabic *-on* nouns cannot be attributed to the Minimal Word because the constraints defining the Minimal Word would be violated with either lexical stem, CiCaCon-ot or CiCCon-ot; in either case the output is not disyllabic (e.g., **nicaxon-ót*, *nicxon-ót*). In contrast, Depσ, which requires the related forms in the paradigm to have the same number of syllables, accounts for the V–Ø alternation in table (11), as well as in the CVCVC stems discussed earlier. Suffixed forms take the CiCCon stem such that the number of syllables in the related forms in the paradigm, CiCaCon and CiCCon-ot, will be identical.

The base of the plural forms in table (11), CiCCon, is structurally identical to the singular and plural stems of the *-on* nouns in table (12) below, which do not exhibit V–Ø alternation.

Table 12. No V–Ø alternation in disyllabic *-on* nouns

SG	PL		SG	PL	
pidyón	pidyon-ót	"ransom"	ʃivyón	ʃivyon-ót	"equality"
yitrón	yitron-ót	"advantage"	dimyón	dimyon-ót	"resemblance"
riʃyón	riʃyon-ót	"permit"	ʃiltón	ʃilton-ót	"government"

In the absence of V–Ø alternation, the paradigm in table (12) above violates Depσ.

However, as shown in Bolozky (1999), these two types of *-on* nouns seem to merge in the vernacular register, in favor of the trisyllabic type in table (11) i.e., towards an alternating paradigm that obeys Depσ (and which is also more frequent). That is, the free stem of some disyllabic *-on* nouns in table (12) has an alternative trisyllabic form in the vernacular register, to the extent that some of the normative forms are rarely used (marked with (?)).[10]

Table 13. Merger towards an alternating paradigm

Normative SG			Vernacular SG	PL	
pitrón	(?)	~	pitarón	pitron-ót	"solution"
yitrón	(?)	~	yitarón	yitron-ót	"advantage"
riʃyón	(?)	~	riʃayón	riʃyon-ót	"permit"
ʃivyón		~	ʃivayón	ʃivyon-ót	"equality"
dimyón		~	dimayón	dimyon-ót	"resemblance"

Although there is a merger of paradigms in other configurations as well, the merger in the *-on* configurations is unique because it is unidirectional, i.e., from a non-alternating to an alternating paradigm. In the other patterns, as shown in table (14) below, there is no specific direction of merger.

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10.   As Bolozky (1999) notes, the merger is gradual; it does not affect all the disyllabic *-on* nouns, and there is also disagreement among speakers with respect to the vernacular form of some nouns (the last two in table 13). This picture also emerges in a comparison between old and new dictionaries. While Even-Shoshan (1982) provides the normative forms only, Avneyon (1997) provides some of the vernacular forms as well. For the last two nouns in table (13), it provides the normative forms only, while for the other three it provides both the normative and the vernacular forms. However, for the first two nouns, the vernacular forms are indicated as non-normative, while for the third one it is the other way around, i.e., the normative form is indicated as non-normative.

Table 14. Multi-directional merger

a.   Non-alternating paradigm > alternating paradigm

i.   CCVC > CVCVC (free stem)

Normative	SG	Vernacular	SG	PL	
prit	~	parit		prit-ím	"item"
cmig	~	camig		cmig-ím	"tire"

ii.   CVCVC- > CCVC- (bound stem)

SG	Normative PL		PL	Vernacular PL	
takin	takin-ím	~	tkin-ím	"normal"	
takif	takif-ím	~	tkif-ím	"rigorous"	

b.   Alternating paradigm > non-alternating paradigm

i.   CVCVC > CCVC (free stem)

Normative	SG	Vernacular SG		PL	
ʃalav	~	ʃlav		ʃlav-ím	"stage"
ʃatil	~	ʃtíl		ʃtil-ím	"plant"
kalid	~	klid		klid-ím	"key (of keyboard)"

ii.   CCVC- > CVCVC- (bound stem)

SG	Normative PL		Vernacular PL	
pagaz	pgaz-ím	~	pagaz-ím	"cannon shell"

The merger in table (14) is multi-directional, given the contrast between the merger in *ʃalav > ʃlav – ʃlavim* "stage(s)" (table 14b) and in *prit > parit – pritim* "item(s)" (table 14a). In addition, it is of a limited effect, found in relatively few nouns. It is thus difficult to draw generalizations as to its trigger (see Bolozky 1999), whether it is due to dominant configurations in the language, confusion with similar words, or restrictions on consonant clusters.

It seems, however, that a merger towards a non-alternating paradigm (table 14b), which violates Depσ, is more common in nouns. Recall that nouns that violate Depσ do not require two lexical stems. That is, a simpler lexicon is gained at the cost of Depσ violation (where "simpler" means a lexicon with fewer semantically non-contrastive items).

The *-on* nouns, however, go towards an alternating paradigm, i.e., in favor of Depσ. This is also true for the CaCiC nouns (table 14a), which are structurally identical to the "able" adjectives, whose paradigm is always alternating. This is

probably a case of paradigm uniformity for particular configurations, which may eliminate the necessity for two lexical stems. That is, speakers would be able to identify an alternating paradigm according to the configuration.[11]

Given the V–Ø alternation in the trisyllabic -*on* nouns and the unidirectional merger towards an alternating paradigm, the analysis provided in the following subsections assumes that Depσ is the constraint triggering V–Ø alternation.

3.3.2 *Verbs*

Following the discussion in §2.2, the unmarked asymmetric OO relation is assumed for the verb paradigm. The base is the 3rd person singular, which does not have any suffix. The discussion is limited to past tense verbs, inflected for person-number-gender. Only the suffixes -*a* "3fm.sg" and -*u* "3pl" are relevant, since these are the only vowel initial suffixes in this paradigm. There is no alternation when the suffix is consonant initial, due to *Complex (see below). Inflected future forms that have a CVCVC stem behave exactly like past forms with respect to V–Ø alternation (e.g., *sipér – sipr-ú* "told 3ms.sg–3pl", *ye-sapér – ye-sapr-ú* "will tell 3ms.sg–3pl"). Recall that only *e* and *a* participate in the alternation.[12]

The V–Ø alternation in CVCVC verbs suggests that Depσ outranks MaxV^{OO}. Depσ, as stated in (1), requires a derived form to have the same number of syllables as its base. MaxV^{OO} does not allow vowel deletion, thus prohibiting V–Ø alternation among surface forms (thus the superscript OO). However, these two constraints alone cannot determine the site of the alternation, since both *gadl-á* "grew 3fm.sg" and **gdal-a*, derived from *gadál* "grew 3ms.sg", respect Depσ and violate MaxV^{OO}. As demonstrated below, the constraint determining the site of the alternation is *Complex, which prohibits a complex sub-syllabic constituent, in this case, a complex onset. Notice that the input is a surface form, which includes stress (a broken line in the tableau indicates no evidence for crucial ranking).[13]

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11. Note that the nouns in table (14a-i) have the configuration of the "able" adjectives. Indeed, *camíg* is also an adjective meaning "adhesive", and *parít*, although not a listed lexical item, can interpreted as an "able" adjective of the verb *parát* "to brake into change".

12. The fact that only *e* and *a* participate in the alternation, while *i*, *u*, and *o* always persist, is due to the ranking MaxV$_{[high]}$, MaxV$_{[round]}$ >> Depσ, where the MaxV constraints, referring to round and high vowels, dominate Depσ.

13. *Complex is violated in denominative verbs (Bolozky 1978a; Bat-El 1994a), such as *sindlér* "make shoes" and *priklét* "practice law" (see also the productivity tests in Bolozky 1999). The generalization is that if there is a complex onset in the base, it persists in the denominative verb, but it is never the case that a complex onset appears in the derived verb but not in its base in the inflectional paradigm. One way to account for the persistence of complex onsets in denominative

(2) Depσ, *Complex >> MaxV^{OO}: *zarák-a* → *zarká* "threw 3fm.sg"

zarák		*Complex	Depσ	MaxV^{OO}
a.	zarak-a		*!	
b.	zrak-a	*!		*
c.☞	zark-a			*

The ranking of *Complex with respect to Depσ is established in (3) below, by monosyllabic verbs, which do not exhibit V–Ø alternation and thus violate Depσ.

(3) *Complex >> Depσ: *ʃár-u* --> *ʃáru* "sang 3pl"

ʃár		*Complex	Depσ	MaxV^{OO}
a. ☞	ʃár-u		*	
b.	ʃr-u	*!		*

The high ranking of *Complex is also responsible for the absence of V–Ø alternation when the stem is followed by a consonant initial suffix (e.g., *gadál – gadál-ta *gad.lta* "grew 3ms.sg–2ms.sg), and when the penultimate stem syllable is CVC (e.g., *tilfén – tilfen-ú *til.fn-u* "phoned 3ms.sg–3pl").

The constraint ranking responsible for V–Ø alternation in verbs is thus as follows:

(4) Constraint ranking – Verbs: *Complex >> Depσ >> MaxV^{OO}

3.3.3 *Participles and adjectives*

Inflected participles and adjectives, like verbs, are derived from a surface base. The base is the masculine singular form, which does not take any suffix. Being a surface form, the base is also specified for stress, which will become relevant in the following analysis.

Participles and adjectives display *a*–Ø alternation in the penultimate stem syllable, when it is also initial in the word (see below for non-initial penultimate syllable). Forms in which the vowel in the penultimate syllable is not *a*, display

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verbs is to assume that the faithfulness relations between the denominative verb and its base have priority (in terms of constraint ranking) over *Complex. Alternatively, we could assume that *Complex is dominated by faithfulness constraints that preserve the consonants and their adjacency throughout the inflectional paradigm; for example, Dep which blocks vowel epenthesis (*priklét → *periklét*) and MaxC, which blocks consonant deletion (*priklét → *piklét*).

e–Ø alternation in the final stem syllable. This suggests that Depσ dominates both MaxV^OO and *Complex.

(5)   Depσ >> *Complex, MaxV^OO

a.   *katúv-a → ktuvá* "written FM.SG" (Participle)

	katúv	Depσ	*Complex	MaxV^OO
a.	katuv-a	*!		
b.☞	ktuv-a		*	*

b.   *xivér-im → xivrím* "pale MS.PL" (Adjective)

	xivér	Depσ	*Complex	MaxV^OO
a.	xiver-im	*!		
b.☞	xivr-im			*

The undominated Depσ selects the candidates that consist of the same number of syllables as the input, although they violate *Complex, which prohibits a complex onset, and/or MaxV^OO, which prohibits vowel deletion.

   The stems in (5) above include only one deleteable vowel (*e* or *a*); the other vowels, *u* in *katuv* and *i* in *xiver* always resist deletion (see fn. 12). Stems with deleteable vowels in both syllables exhibit alternation in the penultimate stem syllable (e.g., *katán – ktana-á* "small MS.SG–FM.SG", *zakén – zken-ím* "old MS.SG–MS.PL"). I attribute this generalization to the persistence of stressed vowels. Such a phenomenon is known as positional faithfulness (Steriade 1995; Beckman 1997), whereby a stressed syllable is a privileged position within a word, which may resist phonological processes and remains faithful to the base.[14]

   MaxV^OO must then be viewed as a family of constraints, which at this point of the analysis consists of MaxV́^OO, which prohibits deletion of a stressed vowel, and the general MaxV^OO, which prohibits deletion of any vowel.

(6)   MaxV^OO >> *Complex
a.   *kavéd-im → kvedím* "heavy MS.PL" (Adjective)

	kavéd	Depσ	MaxV́^OO	*Complex	MaxV^OO
a.	kaved-im	*!			
b.	kavd-im		*! (é)		*
c.☞	kved-im			*	*

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14.   The preference of deletion in the penultimate rather than the final stem syllable could also be due to the ranking *Coda » *Complex, where *Coda prohibits syllables with a coda (see Bat-El 2006 for the role of *Coda in Hebrew). However, since reference to a stressed vowels is independently required later on, I ignore *Coda.

b.   *katán-im → ktaním* "small MS.PL" (Adjective)

	katán	Depσ	MaxV́^OO	*Complex	MaxV^OO
a.	katan-im	*!			
b.	kavd-im		*! (á)		*
c.☞	kavd-im			*	*

   However, MaxV́^OO itself must be further dissected into Max[á] and Max[é], given the presence of *é*–Ø alternation (e.g., *me-xabél – me-xabl-ím* "saboteur MS.SG–MS.PL") but not *á*–Ø alternation (e.g., *me-vukáʃ – me-vukaʃ-ím* "wanted MS.SG–MS.PL"). This suggests that Max[á]^OO is ranked above Depσ, while Max[é]^OO is below Depσ.

(7)   Max[á]^OO >> Depσ >> Max[é]^OO

a.   *me-vukáʃ-im→ mevukaʃím* "wanted MS.PL" (Participle)

	me-vukáʃ	Max[á]^OO	Depσ	Max[é]^OO	MaxV^OO
a.☞	me-vukaʃ-im		*		
b.	me-vukʃ-im	*!			*

b.   *me-xabél-ím → mexablím* "saboteur MS.PL" (Participle)

	me-xabél	Max[á]^OO	Depσ	Max[é]^OO	MaxV^OO
a.☞	me-xabl-im			*	*
b.	me-xabel-im		*!		

   Note that the specific MaxV constraint must be ranked above the general one, otherwise the former will have no effect (the Elsewhere Condition). Thus, Max[á]^OO is ranked above MaxV^OO, where the latter refers to any vowel. Following the same principle, Max[é]^OO is also ranked above MaxV^OO, but since both are below Depσ, the ranking Max[é]^OO >> MaxV^OO has no effect.

   The resistance to alternation is thus conditioned by stress as well as vowel quality.

(8)   Resistance to V–Ø alternation: MaxV^OO family

Max[á] >> Depσ >> $\underbrace{\text{Max[é] >> Max[a], Max[e]}}_{\text{MaxV́}}$

a.   Resistance by stress: $\underbrace{\text{Max[á], Max[é] >> Max[a], Max[e]}}_{\text{Max}}$

b.   Resistance by quality: Max[á] >> Max[é]

   Recall from §3.3.2 that in the verbal paradigm, it is the vowel in the stressed syllable that alternates with Ø. It thus must be assumed that in this category, all MaxV^OO constraints, including the stress-sensitive ones, are ranked below Depσ.

One final issue is concerned with prefixed participles with *a* in a penultimate stem syllable (e.g., *me-xabél* "saboteur MS.SG"). Since *a* alternates in the penultimate stem syllable (e.g., *katúv – ktuv-ím* "written MS.SG–MS.PL"), even when there is an *e* in the final one (e.g., *kavéd – kved-ím* "light MS.SG–MS.PL"), we would expect to get **me-xbel-ím* from *me-xabél*. However, the *e*, and not the *a*, is deleted, i.e., we get *me-xabl-ím* (7b).

I attribute this apparent discrepancy to the morphological structure. Notice that the deletion of *a*, resulting in **me-xbel-ím*, blurs the boundary between the prefix and the stem, such that the left edge of the stem does not coincide with the left edge of a syllable (**me[$_{Stem}$x[$_\sigma$bel-im]). Such misalignment is not found in uninflected forms (*me*[$_{Stem}$[$_\sigma$*xabel*]), or in inflected forms without a prefix ([$_{Stem}$[$_\sigma$*kved-im*]). It is thus necessary to assume the following alignment constraint (McCarthy & Prince 1993).

(9)   ALIGNL(Stem,σ)
       The left edge of a stem corresponds to the left edge of a syllable

As demonstrated below, ALIGNL blocks the deletion of the vowel in the penult stem syllable when it is preceded by a prefix (cand-b), thus allowing the vowel in the final syllable to delete ("[" indicates a stem boundary and "." a syllable boundary).

(10)   ALIGNL effect: *me-xabél-im* → *mexablím* "saboteur MS.PL"

me-xabél		ALIGNL	DEPσ	MAX[é]^{OO}
a.	me-[.xa.be.l-im		*!	
b.	me-[x.be.l-im	*!		
c. ☞	me-[.xab.l-im			*

Given the ranking DEPσ >> MAX[é]^{OO} established in (7), ALIGNL must be ranked above MAX[é]^{OO} (and thus above MAXV^{OO}), otherwise **me-xbel-ím* (cand-b) would be optimal. There is no evidence for the ranking of ALIGNL with respect to DEPσ, since there are no forms with a prefix and a deletable vowel only in the penultimate stem syllable (e.g., the hypothetical form *me-xabil*).[15] The ranking obtained for adjectives and participles is given below.

(11)   Constraint ranking – Adjectives and participles

                        ALIGNL
                          |
MAX[á]^{OO} >> DEPσ >> *COMPLEX, MAX[é]^{OO} >> MAXV^{OO}

---

15.   It is quite possible that ALIGNL is a faithfulness constraint (i.e., ANCHORL), since there are CVCCVC nouns with a prefix (e.g., *mavrég* "screwdriver"), where the left edge of the stem does not align with the left edge of a syllable. Taking such forms into consideration, alignment in the suffixed form must hold only if it holds in the base. I will, however, abstract away from this issue, as it requires expanding the analysis far beyond the central issue of this paper.

3.3.4   *Nouns*

In the discussion on the idiosyncratic properties associated with noun inflection (§2.1), I claimed that the suffixed form is derived from a lexical stem, thus exhibiting IO relations. This was further supported by the irregularity of V–Ø alternation (see §3.2). I thus proposed that nouns exhibiting alternation have two lexical stems, one with a V and another without a V. Consequently, V–Ø alternation in nouns does not involve a process of vowel deletion; it is merely a manifestation of stem selection.

Given that the base is lexical, we must refer to the faithfulness constraint MAXV^{IO}, which relates between a lexical base (I) and a surface form (notice the superscript IO, rather than OO). In the absence of vowel deletion, MAXV^{IO} must be ranked above DEPσ.

However, IO cannot be the only relation in the noun paradigm, since DEPσ is an output-output constraint, given that it refers to syllable structure, which is not included in a lexical input.

The tableaux in (12) below illustrate the selection of the appropriate stem, for nouns with one and two lexical stems. Notice the two inputs in the top cell in the leftmost column; "I" stands for the lexical input, without stress, and "O" for the surface form with stress (these nouns are not lexically accented).

(12)   MAXV^{IO} >> DEPσ

a.   One lexical stem: *gamád – gamad-á* "dwarf MS–FM"

I: gamad O: gamád	MAXV^{IO}	DEPσ	*COMPLEX	MAXV^{OO}
a.☞ gamad-a		*		
b. gamd-a	*!			*
c. gmad-a	*!		*	*

b.   Two lexical stems: *ʃafán – ʃfan-á* "rabbit MS–FM"

I: ʃafan^a, ʃfan^b O: ʃafán	MAXV^{IO}	DEPσ	*COMPLEX	MAXV^{OO}
a. ʃafan^a-a		*!		
b. ʃfan^a-a	*!			*
c. ☞ ʃfan^b-a			*	

The dominating constraint MAXV^{IO} blocks V–Ø alternation in nouns where there is only one lexical stem available (12a); violation of DEPσ is then inevitable, given the ranking MAXV^{IO} >> DEPσ. When two lexical stems are available (12b), the optimal candidate is the one that respects both MAXV^{IO} and DEPσ. For ease of exposition, I added a superscript to each one of the lexical stems in (12b). Notice

that cand-b and cand-c in (12b) are identical on the surface, but not in their relation to the input. The base of cand-b is the one with the vowel ($\int afan^a$), and therefore cand-b violates MaxV^{IO}. The base of cand-c is without the vowel ($\int fan^b$), and therefore, the absence of the vowel in the surface form is not due to a violation of MaxV^{IO}.[16]

Below is the constraint ranking proposed for nouns:

(13)   Constraint ranking – Nouns: MaxV^{IO} >> Depσ >> *Complex, MaxV^{OO}

3.3.5   *Category specific phonology*
It has long been recognized that phonological alternations are often conditioned by morphological categories. Within the rule-based approach, such variation was first encoded by specifying the rules for the relevant lexical categories (Chomsky & Halle 1968), and later on, with the development of Lexical Phonology (Kiparsky 1982), by assigning the rules to different lexical strata.

Optimality Theory offers two approaches to morphologically conditioned phonological process: constraint indexing and co-phonologies. Under the constraint indexing approach (McCarthy & Prince 1995; Benua 1997; Smith 1997, 2001; Alderete 1998, 2001; Itô & Mester 1999, 2003), there is one ranking for all categories, in which a constraint (or several constraints) may be indexed for a specific lexical category. The indexing is eliminated in the co-phonologies approach (Orgun 1996; Inkelas 1998; Anttila 2002; Inkelas & Zoll 2003, 2005), in favor of different rankings for different lexical categories.

To illustrate the formal distinction between the approaches, consider the ranking of *Complex and Depσ discussed above. Under the co-phonologies approach, there are two independent rankings, *Complex >> Depσ for verbs and Depσ >> *Complex for the other categories. The indexing approach assumes one ranking, $\text{*Complex}_{[Verb]}$ >> Depσ >> *Complex, where *Complex is indexed for verbs.

Below are the co-phonologies proposed in the preceding sections (AlignL is ignored since its effect arises only in participles):

(14)   The co-phonologies of V–Ø alternation
        a.   Verbs
              *Complex >>   Depσ >> $\text{MaxV}^{OO}[\acute{a}/\acute{e}]$ >> $\text{MaxV}^{I/OO}$
        b.   Adjectives and Participles
              $\text{MaxV}^{OO}[\acute{a}]$ >> Depσ >> *Complex $\text{MaxV}^{OO}[\acute{e}]$ >> $\text{MaxV}^{I/OO}$

---

16.   I assume that DepV^{IO} outranks Depσ, thus blocking epenthesis in monosyllabic stems, such as *kfar* "village" and *ʃvil* "path", which would otherwise be expected given their disyllabic suffixed counterparts, *kfar-ím* and *ʃvil-ím* respectively.

        c.   Nouns
              MaxV^{IO} >>   Depσ >> *Complex $\text{MaxV}^{OO}[\acute{a}/\acute{e}]$ >> MaxV^{OO}

Depσ, the constraint that triggers vowel deletion, and thus V–Ø alternation, is crucially ranked with respect to five constraints; that is, as shown in (15) below, there are five pairs of crucially ranked constraints. All the categories share the ranking Depσ >> MaxV^{OO} (15a) and Depσ >> $\text{MaxV}[\acute{e}]^{OO}$ (15b). However, each group has one unique ranking (shaded in (15) below), where Depσ is dominated by another constraint: *Complex >> Depσ for verbs (15c), $\text{Max}[\acute{a}]^{OO}$ >> Depσ for adjectives and participles (15d), and MaxV^{IO} >> Depσ for nouns (15e). In all other pairs Depσ is dominant.

(15)   Common and distinct rankings

	Verbs	Adjectives & Participles	Nouns
a.		Depσ >> MaxV^{OO}	
b.		Depσ >> $\text{MaxV}[\acute{e}]^{OO}$	
c.	*Complex >> Depσ	Depσ >> *Complex	Depσ >> *Complex
d	Depσ >> $\text{Max}[\acute{a}]^{OO}$	$\text{Max}[\acute{a}]^{OO}$ >> Depσ	Depσ >> $\text{Max}[\acute{a}]^{OO}$
e.	Depσ >> MaxV^{IO}	Depσ >> MaxV^{IO}	MaxV^{IO} >> Depσ

The ranking under the indexing approach is as follows (see also Bat-El 2001):

(16)   Ranking with indexed constraints
        $\text{*Complex}_{[Verbs]}$, $\text{MaxV}^{OO}[\acute{a}]_{[A\&P]}$, $\text{MaxV}^{IO}_{[Nouns]}$ >>
        Depσ >> *Complex, $\text{Max}[\acute{a}/\acute{e}]^{OO}$ >> $\text{MaxV}^{I/OO}$

It is generally assumed that the ranking of the non-indexed constraints reflects the general tendency in the language. Therefore, since Depσ dominates all the other non-indexed constraint (in the second row in (16)), V–Ø alternation is the preferred state of affairs. That is, nouns are distinct from the other categories, as they do not display V–Ø alternation. In addition, since *Complex and $\text{Max}[\acute{a}/\acute{e}]^{OO}$ are not crucially ranked, the ranking of the non-indexed constraints does not favor either verbs or adjectives and participles. The exceptional behavior of nouns, which turns out under the indexing approach, is compatible with Smith's (1998, 2001) proposal, that nouns enjoy a greater privilege than other categories. As in the languages discussed by Smith, the privileged status of Hebrew nouns is manifested by the richer inventory of stress patterns and the resistance to V–Ø alternation.

V–Ø alternation thus serves as a distinctive property of the different categories. Further distinction is drawn by the morphology, where verbs are inflected for person, number and gender, while nouns, adjectives and participles are inflected only for number and gender. A similar case is presented in Anttila (2002), where

stem-final vowel alternation in Finnish distinguishes among lexical categories in places where the phonology is non-deterministic.

4.   Concluding remarks

As argued in this paper, V–Ø alternation in Hebrew inflectional paradigms distinguishes among the following three groups of lexical categories: (i) nouns, (ii) adjectives and participles, and (iii) verbs. The distinction is, however, minimal, limited to one unique ranking for each group.[17]

This is a typical case of category-specific phonology, found in other languages (see Kelly 1996). Category-specific phonology increases the complexity of the phonological system, and thus seems to be undesirable. However, as argued in Bat-El (2007), it serves a purpose in the grammar, by facilitating processing machinery, like parsing and lexical access. In this sense, category-specific phonology is "supportive phonology", i.e., it assists other faculties of language.

The role of phonology in distinguishing among categories is evident already in early speech. Based on data from a Hebrew-speaking child, Bat-El (2007) shows that the prosodic development of verbs lags behind that of the nouns until morphology starts emerging. When the child starts producing verbs, which appear after nouns, he does not assume the prosodic structures already available for nouns, but rather starts afresh and proceeds on an independent (but not different) developmental path.

Categorical distinctions have conceptual and grammatical role in language learning and processing, and thus should be transparent. Phonology enhances the transparency, and thus category-specific phonology is a desirable state of affairs in languages.

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17.   One issue remains open for further study: the grouping of participles with adjectives is not compatible with the syntactic grouping of participles with verbs. However, Siloni (2002) shows that in construct state constructions, participles function like adjectives, such that constructs with nouns can take the possessive ʃel "of", but constructs with adjectives and participles do not. However, as Ravid & Shlesinger (1995) point out, a participle lexicalized with its nominal function may behave like a noun in construct state constructions.

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