Syntactic versus phonological generalizations in Hebrew verbal morphology*

Itamar Kastner

NYU

1. Introduction

Primary data in natural language contain various patterns that can be identified. Some patterns are "meaningful" in the sense that they lead to generalizations about the systematic makeup of the grammar. To take phonological alternations as an example, the prefix *in-* in English undergoes place assimilation to the following consonant: *indisputable*, *improbable*, *immaterial*, *i*[ŋ]*credible*. Other patterns seem spurious: the sounds /h/ and /ŋ/ are in complementary distribution in English, but it is not the case that they are allophones of the same phoneme. It is the task of the learner—and of the linguist—to extract contentful generalizations out of the various patterns in the data.

In any given dataset, a large number of patterns can be found if the hypothesis space is not constrained. It is therefore important to consider what generalizations the learner might plausibly make; not all patterns in the input are necessarily learned as such (Hayes et al. 2009, Hayes & White 2013, Becker et al. 2011). This paper illustrates how the grammar can help point to a structural generalization over a competing surface one. The task is to learn alternations in the verbal morphology of Modern Hebrew, where in two separate cases the data contain patterns that can form the basis for distinct generalizations: one structural, morphosyntactic, and one surface-based, morphophonological.

This question of learnability interacts with two other domains of inquiry. The first is the theoretical study of Semitic languages such as Hebrew which exhibit non-concatenative morphology of consonantal "roots" and prosodic "patterns" (or "templates"). Much work has attempted to describe such systems formally, with some accounts more syntactic in nature (Doron 2003, Arad 2005, Kastner 2016) and others more phonological (Bat-El 1994, Ussishkin 2005). All aim to explain how roots and patterns are represented, how they interact with the rest of the grammar, and ultimately how the crosslinguistic variation between concatenative and non-concatenative systems can be accounted for.

*I thank Michael Becker, Gillian Gallagher, Maria Gouskova, Alec Marantz, Ezer Rasin and the NYU Morphology Research Group for discussion.

The second domain of study is that of phonological alternations, allomorphy and syncretism: what constrains patterns of allomorphy crosslinguistically? When is syncretism in a paradigm predicted to arise? A number of recent works have suggested that syntactic structure is directly relevant for theories of locality and allomorphy (Bobaljik 2000, Embick 2010, Marantz 2013), a view I follow here as well.

In what follows we consider two case studies in Hebrew. In both cases I contrast my morphosyntactic account, in which roots combine with functional heads under strict locality conditions, with a morphophonological alternative, which does not make reference to underlying structure. The resulting comparison teases apart the kind of generalizations that learners might make, while supporting a syntactic account of verbal morphology with consequences for Semitic as well as for the study of syntax and the interfaces more generally.

2. Case Study 1: Vowels and Affixes

The first case study looks at stem vowels and how they alternate in different morphosyntactic contexts. The notation $\sqrt{\text{XYZ}}$ is used to indicate a triconsonantal root. In the three verbal templates *XiYeZ*, *hitXaYeZ* and *heXYiZ*, past tense vowels are determined by the subject, depending on whether it is 1st/2nd person or 3rd person. The paradigm in (1) uses $\sqrt{\text{bʃl}}$. In *XiYeZ* ('cooked') and *hitXaYeZ* ('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'), 1st/2nd have /a/ and 3rd has /i/. Angle brackets indicate syncopated vowels.

Boldfaced vowels show the difference in agreement: /a/ above the line (1st and 2nd person), /e/ or /i/ below it (3rd person).

(1) *Past tense, vowels alternate*

	XiYeZ $\sqrt{\text{bʃl}}$		*hitXaYeZ* $\sqrt{\text{bʃl}}$		*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

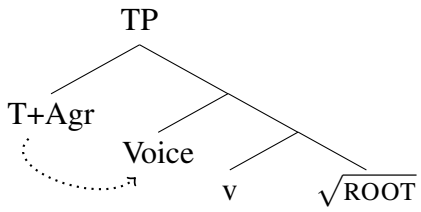
2.1 Morphosyntactic Analysis

Let us now consider two possible analyses of this pattern. First, we can make the division between /a/ and /e/–/i/ based on the phi-features of the subject.

In my system (Kastner 2016) vowels are treated as the spell-out of a Voice head (Oltra Massuet 1999, Wallace 2013, Tucker 2015) which introduces the external argument (Kratzer 1996, Harley 2013), working within Distributed Morphology (Halle & Marantz 1993). Contextual allomorphy is triggered under string adjacency (Bobaljik 2000, Embick 2010, Marantz 2013): X can trigger an allomorphy of Y if the two are adjacent, but not if an overt element Z intervenes: [X **Z** Y]. Since Voice is local to T, the latter can condition allo-

morphy of the vowels on the former. This conditioning is symbolized by the dotted arrow in (2). The upshot is that different phi-feature values condition different stem vowels, as could be seen in (1).

(2)



This analysis implements the generalization in (3).

(3) ***Morphosyntactic generalization***
The learner notices that the vowel changes when the structure/meaning changes.

2.2 Morphophonological Analysis

There is a competing analysis. In all 1st and 2nd person forms the suffix begins with a consonant. Under the morphophonological analysis, a consonant-initial suffix triggers lowering of the vowel to [a]:

(4) a. [**i**], V/Ø-initial suffix: *hevʃ**i**l-Ø, hevʃ**i**l-a, hevʃ**i**l-u*
b. [**a**], C-initial suffix: *hevʃ**a**l-ti, hevʃ**a**l-ta, hevʃ**a**l-t, hevʃ**a**l-nu, hevʃ**a**l-tem*

Under this view all verbs have the underlying template-specific vowel, i.e. /e/ for *XiYeZ* and *hitXaYeZ*, and /i/ for *heXYiZ*. Consonant-initial suffixes trigger lowering to [a], and it is this generalization that holds in the grammar. In the third person all suffixes are vowel-initial and the underlying vowel remains.

(5) a. ***Putative morphophonological generalization***
The learner notices that in verbs, the vowel changes when the suffix begins with a consonant.

b. V → [**a**] / ___ (C) + C (for verbal suffixes)

(6) *Schematic derivations under the morphophonological account*

1SG	hevʃil-ti	→	hevʃal-ti	→	hevʃalti
3PL	hevʃil-u	→	—	→	hevʃilu

The morphophonological rule in (5b) must be restricted to verbal environments. It is not generally the case that Hebrew vowels lower before a consonant, nor at any syllable boundary, (7a), nor at any morpheme boundary, (7b).

(7) *Vowel lowering before a consonant is not a general rule*

	Form	If the rule applied	Gloss
a.	h**e**ʃ.lím	*h**a**ʃ.lim	'completed'
b.	ʃam**é**n-tʃik	*ʃam**a**n-tʃik	'fat-DIM'

On the morphophonological account, then, it is the form of the suffix that leads to the alternation. No reference is made to syntactic or semantic features, though the suffix must be recognized as part of a verbal form. Two patterns can be recognized in the data.

2.3 Discussion

Are there any other V-initial or C-initial suffixes on which these hypotheses can be tested? The answer is equivocal. The standard language has a 2PL.F suffix that has fallen out of use in everyday speech. In (8), the suffix is *-na* but the second vowel is /e/, which is not found elsewhere in the feminine paradigm for *heXYiZ*:

(8) ***t**-albéʃ-**na***
2-dress.CAUS-PL.F
'you (PL.F) will dress (someone) up'

If the vowel depends on T then dialects containing this form can be readily explained by my system. In contrast, the morphophonological account would falsely predict **talbaʃna*. Yet it is possible, pending further study, that this affix fell out of use precisely because it is incompatible with the phonological generalization (alongside other sociological or pragmatic factors).

The two accounts make different predictions that could be tested in a wug study. Two tacks could be taken here. On the Hebrew-centric tack, the materials would include nonce suffixes and perhaps nonce templates. Participants would be presented with training data compatible with the morphophonological generalization and asked to produce forms in the target test condition. Alternatively, an artificial language could be devised that mirrors the Hebrew patterns, though to a simplified extent. Speakers of a non-Semitic language would then be exposed to training data and tested on the relevant target items in order to see whether they attuned to the structural pattern, the phonological pattern, or both.

The results of such an experiment may then be contrasted with that of Gagliardi & Lidz (2014), who found that speakers of Tsez assign noun declension classes based on phonological information rather than semantic information. However, the semantic information relevant to Tsez nouns is not represented as morphosyntactic features. That case might be more similar to gender distinctions in European languages, where phonological and semantic cues both influence the assignment of gender to a given noun.

Returning to our main discussion, the morphosyntactic proposal is part of a research program that makes crosslinguistic predictions. If the theory presented here is on the right track, then an overt affix intervening between T and Voice should *always* lead Voice to syncretize. This prediction is tested in the next case study.

3. Case Study 2: Passive Vowels

We have seen in (1) that 1st and 2nd person might have a different second vowel associated with them than does 3rd person, (9a). This split is neutralized in the passive: all phi-feature combinations have the same /u/-/a/ vowels, (9b).

(9) *Active vs passive for* $\sqrt{bʃl}$ *'cook' agreement*

	Template	Past 3SG.M	Past 1SG
a.	*XiYeZ* (active)	biʃ<u>e</u>l	biʃ<u>a</u>l-ti
b.	*XuYaZ* (passive)	b**u**ʃ**<u>a</u>**l	b**u**ʃ**<u>a</u>**l-ti

Another generalization about syncretism in 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, (10a), but not in the passive, (10b).

(10) *Active vs passive for* $\sqrt{bʃl}$ *'cook' tense*

	Template	Past 3SG.M	Future 3SG.M
a.	*XiYeZ* (active)	bi<u></u>ʃel	je-va<u></u>ʃel
b.	*XuYaZ* (passive)	b**<u>u</u>**ʃ**a**l	je-v**<u>u</u>**ʃ**a**l

The full paradigm follows below. Passive forms are derived either from *XiYeZ* verbs (yielding *XuYaZ*) or *heXYiZ* verbs (yielding *huXYaZ*). The vowels on all stems are /u/-/a/ in the following two tables.

(11) a. *Past tense for passive* gudal *'was raised' and* hugdal *'was enlarged'*

	XuYaZ $\sqrt{gdl}$		*huXYaZ* $\sqrt{gdl}$	
	SG	PL	SG	PL
1	gudál-ti	gudál-nu	hugdál-ti	hugdál-nu
2M	gudál-ta	gudál-tem	hugdál-ta	hugdál-tem
2F	gudál-t	gudál-tem	hugdál-t	hugdál-tem
3M	gudál	gud<á>l-ú	hugdál	hugd<á>el-ú
3F	gud<á>l-á	gud<á>l-ú	hugd<á>el-á	hugd<á>el-ú

b. *Future tense for passive* jegudal *'will be raised' and* jugdal *'will be enlarged'*

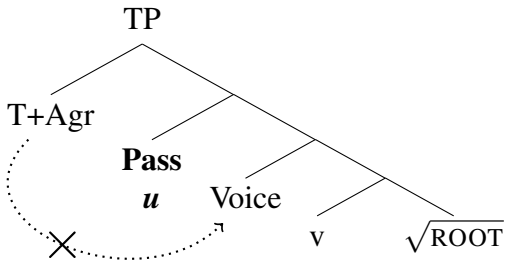
	XuYaZ $\sqrt{gdl}$		*huXYaZ* $\sqrt{gdl}$	
	SG	PL	SG	PL
1	j-e-gudál	n-e-gudál	j-ugdál	n-ugdál
2M	t-e-gudál	t-e-gud<á>l-ú	t-ugdál	t-ugd<á>el-ú
2F	t-e-gud<á>l-í	t-e-gud<á>l-ú	t-ugd<á>el-í	t-ugd<á>el-ú
3M	j-e-gudál	j-e-gud<á>l-ú	j-ugdál	j-ugd<á>el-ú
3F	t-e-gudál	j-e-gud<á>l-ú	t-ugdál	j-ugd<á>el-ú

3.1 Morphosyntactic Analysis

I have adopted a theory of allomorphy that relies on strict linear adjacency. This theory makes predictions regarding where *syncretism* is expected to hold: if an overt element Pass appears between T and Voice, [T [**Pass** [Voice ...]]], T will not be able to condition allomorphy of Voice. And as shown by Embick (2010), the result of this configuration is usually syncretism, such that Voice should have the same form regardless of T or any material above T.

For Hebrew it is generally accepted that verbal passives are derived from an active counterpart via passivization in the syntax, be the framework syntactic (Doron 2003, Alexiadou & Doron 2012, Borer 2013, Kastner & Zu 2015) or lexicalist (Ussishkin 2005, Laks 2011). I adopt the proposal in Doron (2003) and Alexiadou & Doron (2012) that passives are brought about by merger of a head Pass above VoiceP. The pattern of syncretism in passives is exactly what our theory of locality predicts: overt Pass blocks T from conditioning allomorphy on Voice as in (12), contrasting with (2).

(12)



All surface forms that do not conform to the generalization are independently predicted. For example, the /e/ in *jugd<á>elú* 'they will be enlarged' arises from syncope of destressed vowels which feeds potential epenthesis, attested beyond passives:

(13) a. /á/ → [e] when destressed.

b. Independently: *nixnás* 'entered.M' ∼ *nixn<á>es-á* 'entered.F'

Syncretism in the second case study is thus predicted based on the same account that explains the first case study. See Kastner (2016) for the complete derivation.

3.2 Phonological Analysis

An alternative analysis of the passive pattern can be developed based on the stem-based theory of Semitic morphophonology developed by Bat-El (1994), Laks (2011) and Ussishkin (2005). 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 morphemes. Faithfulness to affixation, alongside modification of a stem in *XaYaZ*, are coupled with output-output faithfulness to derive the correct forms.

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

(14) 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.

The affix (here *i-e*) spells out the template and is protected by highly-ranked MAX-AFFIX.

(15) *Individual vowels point out the violating segments (Ussishkin 2005, 194)*

	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

For the most part, stem-based analyses limited themselves to third person singular past tense forms. Since the stem-based approach does not permit hierarchical structure, the questions of allomorphy presented here are difficult to address. Would the OT grammar be sensitive to the individual consonants in the stem? This is necessary, since the analysis in (15) distinguishes vowels from consonants. But if so, then how come these consonants never condition allomorphy on the affix?

Turning to the passive, consider how Ussishkin (2005, 196) derives passive forms for 3SG.M in the past tense. In (16), σ-ALIGN is a disyllabic constraint. The passive "affixes" are privileged by MAX-AFFIX, resulting in overwriting of the base vowels.

(16) a. *gudal* (*XuYaZ*) *from gidel* (*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. *hugdal* (*huXYaZ*) *from hegdil* (*heXYiZ*)

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

The passive template overwrites the vowels of an active base: tense and agreement kick in first (yielding *gidel*) and are then overwritten by the passive.

This analysis does not predict the syncretic pattern. 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. As shown above in (16), passive forms are derived by melodic overwriting of vowels in the active forms:

To create passives in this system, first derive the correct tense and then passivize. But it is not clear how the grammar would know which vowel to passivize in the future tense without additional stipulations:

(17) a. he-gdil → ja-gdil → ✓ jugdal
b. gidel → je-gadel → ✗ jugadel / ✗ jugadal / ✓ jegudal

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 syncretism exists:

(18) a. gidel → gudal → ✗ jegadal / ✗ jegadul / ✗ jegodol / … / ✓ jegudal
b. he-gdil → hu-gdal → ✗ jehagdal / ✗ jehagdul / ✗ jehugdal / … / ✓ jugdal

These patterns—alongside interpretation of passivization before tense—show that Pass attaches before T, unlike in an overwriting-of-stems approach. Whether passivization happens before inflection or inflection before passivization, vowel allomorphy must be constrained more than it was in Ussishkin (2005).

Even if a specific constraint were created to ensure that **jehugdal* becomes *jugdal*, the theory loses its internal consistency because active *i-a* in *XiYeZ* and *e-i* in *heXYiZ* are themselves past tense markers, so the theory must allow tense information to combine with the active stem first in order to have 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 was reacting against.

3.3 Discussion

The basic observation that can be made about passive forms is that the /u/-/a/ pattern holds throughout the system. This much is straightforward. Yet I have argued that this generalization cannot be derived using purely phonological machinery if we are to account for the system as a whole. In contrast, the morphosyntactic analysis predicts syncretism correctly, interprets passivization before tense, accounts for allomorphy as in the first case study, and requires fewer stipulations overall.

It is worth mentioning that patterns of syncretism like that discussed here also argue against an overly permissive theory of allomorphy such as Spanning, where recent work

has eschewed the strict adjacency condition (Grestenberger 2015, Merchant 2015). This weakening of the theory comes at a cost: overgeneration of allomorphic possibilities (see Božič 2015 for a similar argument).

4. Conclusion

Three different kinds of questions were brought together in this paper: the way learners might generalize over an input, the structure of non-concatenative morphology and the best way of accounting for allomorphic patterns. The same syntactic account that explained allomorphy in Case Study 1 predicted syncretism in Case Study 2. In contrast, the morphophonological analyses were shown to make incorrect predictions.

Nevertheless, the two kinds of accounts point out different generalizations. It is possible that the learner would make use of both sources of information, phonological and structural, discarding one as its grammar matures. This line of inquiry, asking whether learners privilege phonological or structural cues (and which ones), stands to benefit from further structural (syntactic) analyses of both concatenative and non-concatenative morphology.

Itamar Kastner
itamar@itamarkast.net

References

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

Arad, Maya. 2005. *Roots and Patterns: Hebrew Morpho-syntax*. Springer.

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

Becker, Michael, Nihan Ketrez, & Andrew Nevins. 2011. The surfeit of the stimulus: Analytic biases filter lexical statistics in Turkish devoicing neutralization. *Language* 87:84–125.

Bobaljik, Jonathan. 2000. The ins and outs of contextual allomorphy. In *University of Maryland working papers in linguistics*, ed. K. Grohmann & C. Struijke, volume 10, 35–71.

Borer, Hagit. 2013. *Structuring Sense*, volume 3: *Taking Form*. Oxford: Oxford University Press.

Božič, Jurij. 2015. Locality exponence in Distributed Morphology: Root suppletion in Slovenian. In *NELS 46*.

Doron, Edit. 2003. Agency and voice: The semantics of the Semitic templates. *Natural Language Semantics* 11:1–67.

Embick, David. 2010. *Localism versus Globalism in Morphology and Phonology*. Number 60 in Linguistic Inquiry Monographs. Cambridge, MA: MIT Press.

Gagliardi, Annie, & Jeffrey Lidz. 2014. Statistical insensitivity in the acquisition of Tsez noun classes. *Language* 90:58–89.

Grestenberger, Laura. 2015. More span-conditioned allomorphy: voice morphology in Classical Greek. In *NELS 46*.

Halle, Morris, & 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 & Samuel Jay Keyser, 111–176. Cambridge, MA: MIT Press.

Harley, Heidi. 2013. External arguments and the Mirror Principle: On the distinctness of Voice and v. *Lingua* 125:34–57.

Hayes, Bruce, & James White. 2013. Phonological naturalness and phonotactic learning. *Linguistic Inquiry* 44:45–75.

Hayes, Bruce, Kie Zuraw, Peter Siptar, & Zsuzsa Londe. 2009. Natural and unnatural constraints in Hungarian vowel harmony. *Language* 85:822–863.

Kastner, Itamar. 2016. Form and meaning in the Hebrew verb. Doctoral dissertation, New York University. lingbuzz/003028.

Kastner, Itamar, & Vera Zu. 2015. Blocking and paradigm gaps. Ms., NYU. lingbuzz/002394.

Kratzer, Angelika. 1996. Severing the External Argument from its Verb. In *Phrase Structure and the Lexicon*, ed. Johan Rooryck & Laurie Zaring, 109–137. Dordrecht: Kluwer.

Laks, Lior. 2011. Morpho-phonological and Morpho-thematic Relations in Hebrew and Arabic Verb Formation. Doctoral dissertation, Tel Aviv University.

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

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

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.

Tucker, Matthew A. 2015. Your roots are showing: On root-sensitive allomorphy in Arabic. In *Roots IV, New York University*.

Ussishkin, Adam. 2005. A fixed prosodic theory of nonconcatenative templatic morphology. *Natural Language and Linguistic Theory* 23:169–218.

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