Form and Meaning in the Hebrew Verb

by

Itamar Kastner

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DEDICATION

In memory of

David & Blanca Nathan

Betty & Yehoshua Kastner

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This is my favorite part! As any graduate student will tell you, the acknowledgments are the most interesting chapter of every dissertation that you read. I'm glad to report that they're also the best chapter to write.

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I won't embarrass myself or my advisor, Alec Marantz, by attempting to wax poetic about his contributions to my intellectual development or about the amazing speed with which he thinks on his feet. Instead, here's one anecdote that stuck with me. The neurolinguistics lab at NYU hosts a program in which one exceptional high school student comes in every summer to learn experimental design and develop their own project. The student is usually mentored by the research assistant managing Alec's MorphLab (of which I was a member). One of these high schoolers was sitting in the lab one day, discussing their project with Alec, and it soon became evident that this kid did not know how to conduct a basic statistical test. Instead of telling them to consult a textbook or go ask the lab manager, Alec quietly picked up a pencil and a sheet of paper and started explaining to this 17-year-old how a t-test works.

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The moment I started working on Hebrew morphology in earnest I still had no idea that I would want Michael Becker on my committee. Why would a dissertation in syntax need a product-oriented phonologist? But once the idea came up, it was a perfect match. Michael struck an incredibly difficult balance between pushing against me and going with the flow, nudging me towards different kinds of questions while allowing himself to be convinced by different arguments than those he usually works with. Or at least that's what it felt like on my end during our long, thorough, wonderfully productive phone meetings.

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ABSTRACT

This dissertation is about the basic building blocks that make up words, and how these building blocks interact with the rest of the grammar. The grammar is generally viewed as an inventory of contentful units and the rules governing their combination. One question for linguistic theory is what these units might be like. Are they different for different languages? A second question is how these pieces are put together, and again we ask whether these combinatory processes are the same in different languages. A third question is to ask what we can build. This study concentrates on building verbs, specifically how the grammar builds their structure in a way that then constrains semantic interpretation and phonological pronunciation.

The empirical domain is the verbal system of Modern Hebrew, where this work attempts to unify our treatment of concatenative and non-concatenative morphology. The hypothesis put forward is that hierarchical syntactic structure, once generated, must be interpreted according to specific locality constraints when transferred to the interfaces with semantics and phonology. At each interface additional calculations take place. These calculations are interface-particular: semantics and phonology are not identical objects of study. Yet the two have in common a locality constraint on calculations that derives directly from the syntactic structure. In addition, individual lexical items ("roots") place their own requirements on the meaning and/or the pronunciation. The theory developed here limits this influence of roots to the two interfaces, making the claim that individual roots have no syntactic features. Nevertheless, roots are active at the interfaces in ways that are predictable once the right generalizations are sought out. The phonological form of roots is relevant at the phonology and their lexical semantics is relevant at the semantics: roots have no syntactic features, only interface requirements.

Hebrew, being a contemporary Central Semitic language, shows the kind of non-concatenative, "root-and-pattern" morphology that is organized around consonantal "roots" and prosodic "templates", the latter consisting of a prosodic shape, certain vowels and an affix. The account put forward argues that Hebrew roots are abstract lexical elements which combine with discrete syntactic functional heads. The combination, once fed through the phonology of the language, results in morphophonological templates which are not primitives of the system in and of themselves. The architecture defended supports the view of constrained interpretation at the interfaces which lies at the core of this proposal, using non-hierarchical surface forms in order to mount an argument for hierarchical structure.

Chapter one of the dissertation introduces the issues at hand and the basics of the Hebrew verbal system. It also reviews a number of earlier approaches which help set the stage for the analysis that follows.

Chapter two develops the syntactic-semantic part of the proposal, defining the syntactic elements needed to derive verbal morphology both for Hebrew and crosslinguistically. It is shown that the different combinations of these elements produce the verbal system of Hebrew in a way that is constrained, in the semantics, by the lexical idiosyncrasies of individual roots.

Chapter three takes the proposed structures and manipulates them in the phonological component of the grammar. The view of linearization pursued here is shown to make correct predictions. The effect of different classes of roots is highlighted, and the point is made that verbal templates are not holistic morphemes but the spell-out of distinct functional heads.

Chapter four takes a quantitative approach, surveying previous psycholinguistic and neurolinguistic work on Semitic languages and presenting novel findings from a recent magnetoencephalography experiment. These findings support the claims made in the previous chapters regarding the organization of the system.

Chapter five considers how the child might acquire this system. Recent developmental findings are surveyed and a novel computational model is discussed. This chapter outlines a model of Semitic acquisition in which the consonantal character of roots is used as a learning cue, leading to acquisition of basic verbal templates and eventually the system as a whole.

Chapter six concludes, recapitulating the main contributions of this work: derivations in a generative grammar combine rigid grammatical principles with unstructured lexical material. This dissertation defends an explicit view of how such combination takes place.

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Chapter 1

INTRODUCTION

1.1 Words and interfaces

The present study examines the division of labor between syntax, semantics, phonology and the lexicon. Generative approaches to linguistic theorizing have so far resulted in a wealth of knowledge about how an abstract syntax generates structure which is then interpreted by the semantics and by the phonology. We also have a basic vocabulary allowing us to describe how individual lexical items might have their own idiosyncrasies in the syntax (different features), in the semantics (different meanings) and in the phonology (lexical exceptionality). What this dissertation tests is the hypothesis that the syntax feeds both interfaces in the same way.

The core idea has two parts. The first is that there is a universal set of syntactic elements which can be arranged in a hierarchical way. Once the syntax generates a chunk of structure (be it a phase or an entire utterance), it must be interpreted compositionally at the interface with the semantics and linearized in order to be interpreted at the interface with the phonology. In both cases, I argue that the same kind of locality constraints hold on interpretation. The second part has to do with how individual lexical items muddy the waters. The grammar is rigid, but lexical material can influence how functional material is interpreted. The important point here is that lexical material is separated from the syntax proper: its idiosyncrasies only kick in at the two interfaces. As such, lexical material (a root) has no syntactic features, only properties which are directly related either to meaning or to pronunciation.

In support of this claim I approach a notorious empirical landscape: the non-concatenative morphology of Modern Hebrew. In Semitic languages like Hebrew, words are famously made up of various grammatical and lexical elements interleaved in a single, short (often disyllabic or trisyllabic) phonological word. Two syllables might convey a lexical root, tense information, derivational information and agreement information all at once. It is therefore not immediately obvious that hierarchical structure is there to be found. Yet that is exactly the claim put forward here. By demonstrating that the hypothesis outlined above is a valid one for Hebrew, this dissertation entails that it is valid for natural language as a whole. Functional material (in the form of structure) and lexical material (in the form of roots) can be seen to combine in systematic, predictable ways.

Taking the verbal system as the main object of inquiry, the following chapters analyze its syntactic, semantic and phonological properties in order to address a number of Hebrew-specific, Semitic-specific and language-general questions. At its analytical core, this work asks how we might apply the theories that have been developed for other languages to Semitic: how these theories might be tested and how they should be modified to accommodate a broader range of data. I frame this question in terms of the abstract syntactic structure and the way it feeds into semantic and phonological interpretation. The resulting discussion addresses three main questions: the proper description of Hebrew morphology, the proper description of the syntax and its relation to the interfaces with the semantics and the phonology, and ultimately the way such a system is learned by the child. Let us first see what the system looks like.

1.1.1 Traditional descriptions of the Hebrew verbal system

Linguists and non-specialists who encounter a Semitic language like Hebrew for the first time often find themselves scratching their heads in an attempt to come to terms with the language's distinctive morphological system, built around "roots" and "patterns". Many early speakers of Modern Hebrew were such head-scratchers themselves: the language was revived in the late 19th century by individuals who, for the most part, were not native speakers of Semitic languages. The language nevertheless retained the Semitic morphology of its classical predecessor. On the surface, Hebrew is very different from European languages, or perhaps from any non-Semitic language. The question of how languages differ from one another is a familiar one from work in the generative tradition which often turns the question on its head, asking how languages are fundamentally similar.

As this dissertation is a study of the verbal system of Hebrew, I will make repeated reference to "roots" and "templates" (the latter also called "patterns", "measures", "forms" and *binyanim*) as the two main components of the verb. I reserve the terms "templates" for the systematic verbal forms and "patterns" for the systematic nominal and adjectival forms. These traditional terms have been used, as far as I know, for as long as the verbal systems of Hebrew and other Semitic languages have been documented. Ussishkin (2000) mentions a number of works on Hebrew which use roots and templates as integral parts of the system, including Gesenius (1813/1919)—perhaps the best-regarded grammar of Biblical Hebrew—as well as Bopp (1824), Ewald (1827), Harris (1941) and Chomsky (1951). For Arabic, he mentions de Sacy (1810) as one example among many of older works which make direct reference to roots and templates.

The nature of the root was already debated by the traditional Arabic grammarians of Basra and Kufa in the 8th Century, according to Borer (2013:563ff) who herself cites Owens (1988). Turning to more recent works, Borer (2013) also cites foundational contributions by Berman (1978), Bolozky (1978, 1999) and Ravid (1990), all relying on the root and the template as at least descriptive notions. To this list I hasten to add Rosén (1977). I cannot hope to do justice here to the vast modern-day literature on Modern Hebrew, much of which has been published in Hebrew. The interested reader may want to consult the works of Yehoshua Blau, Reuven Mirkin, Uzzi Ornan and Haim Rosén, among many others; the latter two, in particular, have authored work that may be more accessible to generative linguists. In §1.6 I discuss contemporary work on Semitic morphology in the generative tradition; for now, we simply establish that roots and patterns have been invoked throughout the ages in descriptions of the Semitic system. One goal of this dissertation is to evaluate the theoretical status of these notions for Semitic and for natural language in general.

To see how the system is traditionally conceived of, let us take as a starting point the essay by Schwarzwald (1981b) which begins with "the traditional classification" of template meanings. I have added examples of the alternations to this classification. "Y̯" marks a non-spirantized consonant, §1.4.1.

(1) A naïve classification of Hebrew templates (Schwarzwald 1981b:131):

	Active	**Passive**				
Simple	*XaYaZ*	*niXYaZ*	$\sqrt{\text{sgr}}$	*sagar*	*nisgar*	'closed'
Intensive	*XiY̯eZ*	*XuY̯aZ*	$\sqrt{\text{tpl}}$	*tipel*	*tupal*	'treated'
Causative	*heXYiZ*	*huXYaZ*	$\sqrt{\text{kns}}$	*hexnis*	*huxnas*	'inserted'
Reflexive or reciprocal	*hitXaY̯eZ*		$\sqrt{\text{xbk̯}}$	*hitxabek*		'hugged'

As Schwarzwald immediately points out herself, this classification is misleading. The relationships between the templates (the argument structure alternations) are not always predictable and most templates have additional meanings beyond those listed in (1). For example, there is little way to predict what the root $\sqrt{\text{rʃm}}$, which has to do with writing down, will mean when it is instantiated in a given template. In the "simple" template *XaYaZ* we substitute the consonants in $\sqrt{\text{rʃm}}$ for X, Y and Z and derive *raʃam* 'wrote down'. In the "middle" template *niXYaZ*, *nirʃam le-* means 'signed up for', against the characterization of *niXYaZ* as "simple passive" in (1). In the "intensive middle" *hitXaY̯eZ*, *hitraʃem me-* means 'was impressed by', challenging the characterization of *hitXaY̯eZ* as "reflexive or reciprocal" in (1).

The only cells of the table which are completely predictable are the two passive templates *XuY̯aZ* ("intensive passive") and *huXYaZ* ("causative passive"). The other templates constrain the possible meaning in ways that have eluded precise specification. For example, while it is clear that many verbs in *niXYaZ* are passive-like, not all verbs in that template are. In Chapter 2 we will see that the syntax and semantics of the system can nevertheless be analyzed within a constrained theory of morphosyntax. I will make precise what the unique contribution of each template is and how that contribution comes about in the syntax. We will then be able to identify the role of the root in selecting between different possible meanings for the verb in a given template.

The verbs in (1) are all given in the 3rd person masculine singular past tense – the citation form. Pending minor complications that will be addressed in Chapter 3, the actual conjugation of a given form across tenses and person/number/gender features is completely predictable, as (2) exemplifies for the *XiY̯eZ* template. That is to say, even though the meaning of a given verb cannot be immediately guessed in its entirety, the morphophonological form is predictable.

(2) Tense and agreement marking in *XiY̯eZ*.

	Past		Present		Future	
	M	F	M	F	M	F
1SG	XiY̯aZ-ti		me-XaY̯eZ	me-XaY̯eZ-et	je-XaY̯eZ	
1PL	XiY̯aZ-nu		me-XaY̯Z-im	me-XaY̯Z-ot	ne-XaY̯eZ	
2SG	XiY̯aZ-ta	XiY̯aZ-t	me-XaY̯eZ	me-XaY̯eZ-et	te-XaY̯eZ	te-XaY̯Z-i
2PL	XiY̯aZ-tem		me-XaY̯Z-im	me-XaY̯Z-ot	te-XaY̯Z-u	
3SG	XiY̯eZ	XiY̯Z-a	me-XaY̯eZ	me-XaY̯eZ-et	je-XaY̯eZ	te-XaY̯eZ
3PL	XiY̯Z-u		me-XaY̯Z-im	me-XaY̯Z-ot	je-XaY̯Z-u	

The system appears to be at once very regular and riddled with idiosyncrasies. Is there a method to the madness? In §1.2 I present three research questions that guide our investigation. These questions are crosscut by three themes introduced in §1.3. Section §1.4 moves on to discuss the sources of data, §1.5 provides a brief rundown of the theoretical assumptions and §1.6 touches on a number of prominent analyses from the past. Section §1.7 provides an overview of each of the following chapters.

1.2 Three problems

1.2.1 The problem of Semitic morphology

The main analytical question is how to analyze the morphology of Semitic verbs. This question can be split in two:

- What does the speaker know about the verb if they know the root?
- What does the speaker know about the verb if they know the template?

Any description of non-concatenative morphology of the Hebrew type must make some assumptions about the role of roots and templates: does meaning come from the root, from the template or from some combination of the two? How is the same root constant across different templates? How is the same template constant across different roots?

My solution is to allocate all idiosyncrasy to the roots: a root is thus an index for phonological and semantic information. Templates will then be taken to be functional material, built up from individual pieces of syntax. The pieces of syntax are invariant across constructions. Importantly, the morphophonological template can mask a distinction between different syntactic structures. The bulk of the dissertation will be devoted to developing this idea, inspired by Doron (2003).

This problem is broached through Hebrew though it is relevant to other languages. For example, Embick (2012) asks how our lexicon differentiates uses of the root $\sqrt{\text{SLUG}}$ in English: the mollusc, the ammunition, the action of gulping and so on. Affixes are roughly comparable to Semitic templates in this sense: is *-ize* in *emphasize* and *nominalize* the same element? Probably so. Is *-er* in *writer* and *stronger* the same element? Probably not. But these kinds of questions cannot be answered without a theory of what all these elements are. The need is especially evident in languages in which the interplay of root and "affix" or template is a defining property of what the system looks like.

1.2.2 The problem of syntax and the interfaces

A general theoretical question has to do with the overall architecture of the grammar: how the syntax is built up and how it interacts with the semantics and the phonology. I will argue for a specific view of morphosemantics and morphophonology, according to which the syntax generates all structures (even word-internal structures) and these structures are then interpreted at the interfaces. Dependencies between elements—which take the form of allomorphic interactions in the phonology and of special meaning in the semantics—are limited to interactions between adjacent elements that are not separated by overt material (Embick 2010; Marantz 2013a).

This brief summary may seem opaque at this point, but will be elaborated on already in §1.5 (and fleshed out in the next two chapters). The bottom line is that the syntax generates structure, after which the interfaces interpret said structure subject to similar locality constraints. We will identify the content of the locality constraints and the ways in which the syntax is built.

1.2.3 The problem of acquisition

In Hebrew as elsewhere, a major question for the linguist is to formulate a model of acquisition: how the child acquires the language by generalizing over patterns in the input data and forming a system out of them. Such models often consist of two main parts: on the one hand, the statistical patterns in the input, and on the other hand, the innate cognitive endowment which guides acquisition (the grammar). Most of the dissertation is devoted to the adult grammar but in Chapter 5 I develop a basic model of how the morphological system might be acquired.

The dissertation thus tackles three problems that are relevant to any contemporary study of language; the answers I provide are tested on an empirical domain which has received various treatments over the years but no one comprehensive analysis. This dissertation proposes such an analysis, building on the idea that the syntax generates structure which is then interpreted in particular ways. Or, to borrow a turn of phrase from Kramer (2009:2), the unifying idea across all the chapters can be pithily summed up as: attention must be paid to morphosyntax, since without an underlying morphosyntactic structure it is not possible to account for the system as a whole.

1.3 Three themes

In §1.1.1 we saw one traditional description of the Hebrew system. Just as there have been other analyses of the system, there have also been competing theoretical proposals. This work does not exist in a vacuum; as we proceed, I will repeatedly return to three dialectics that help frame the discussion. These themes pervade my approach to the issues and, if my exposition is clear enough, each analytical choice I make should pull in one direction or the other.

1.3.1 Lexical material vs functional structure

The grammar can be viewed as a machine combining lexical material with structure. In a contemporary theory of the grammar in which the semantics interprets syntactic structure (Chomsky 1995), the structure directly constrains the possible interpretations of the predicate: an unaccusative structure cannot be interpreted in the semantics as a double object construction, for instance. Nevertheless, the predicate also constrains the structure: *give* requires a specific set of arguments, (3). Similarly, a verb like *devour* is "strongly transitive" in the sense that speakers find examples without a direct object deviant, (4).

(3) *John gave the book yesterday.

(4) *The hungry caterpillar devoured last night.

Nothing in the morphosyntax of (4) would lead us to expect that a both an Agent and a Theme are required: there is no causative affix, for example. Yet it seems that the act of *devouring* necessitates an object to be consumed, a Theme.

Earlier work in the generative tradition encoded these requirements in the form of *thematic roles*, a loosely organized theory of participants in an event. Events can be seen as relationships between predicates and participants; a giving event has three such participants (typically two animate and one inanimate). Participants can be classified into various thematic roles such as Agent, Patient, Theme, Instrument and so on. In many cases, the relationship between these roles has direct implications in the grammar, such that Agents are more likely subjects than Instruments (Fillmore 1968, Baker 1988, Dowty 1991 and much related work).

These notions were originally formalized as θ-*roles* on a θ-*grid*, part of the lexical specification of every predicate (Chomsky 1981). Cases of a mismatch between a predicate and the number of arguments it expects were handled by principles such as the θ-*Criterion* and the *Projection Principle*. The problem is that θ-roles were never part of any subcomponent of the grammar, neither in the syntax proper nor in the semantics. As a mechanism regulating representations, they were by and large abandoned. And while other approaches have attempted to treat θ-roles as "regular" syntactic features (Hornstein 1999), these attempts have not held up well to close scrutiny (e.g. Landau 2003).

Even though the θ-role has been all but abandoned as a formal device, the fundamental questions that led generative grammarians to propose it have not gone away. These questions all surround the contrast between rigid syntactic structure and individual lexical items:

(5) a. What information does the grammar encode about the possible participants in an event?
b. How much of this work is done by the syntax?
c. How much of this work is done by the individual predicate?
d. What does the formal architecture regulating the two look like?

Hebrew permits us to isolate lexical material from syntactic structure in our investigation by alternating between roots and templates. Assuming that roots are the storage of lexical material and that templates convey structural information, we may test our theories of how the two constrain each other.

1.3.2 Roots vs stems

Even though I take the existence of the consonantal root for granted, not all linguists agree that such an element should have a privileged role in the theory. A number of recent proposals have suggested to discard the Semitic root as a theoretical device. I discuss some of these proposals explicitly in §§2.7, 3.5. What is at stake, I believe, is where idiosyncrasy lies. In a theory with roots, all exceptionality has a single locus (namely the root) which is limited through locality constraints imposed by the structure. In a theory without roots, lexical stems will need to do similar work.

1.3.3 Functional heads vs morphemes

Each template in Semitic can be seen either as its own morpheme or as a by-product of other elements. The latter position, not usually pursued, is the one I argue for here. Templates each have their own morphophonology and their own syntax-semantics. If we collapse the two together, we can treat a template as a morpheme. But I argue that this position is not tenable. It is not possible to hold the morphophonology constant, so to speak, and map each phonological template deterministically to certain argument structure alternations and meanings. It will also not be possible to hold the meaning constant and predict a phonological template for each possible construction (transitive, reflexive and so on). The two kinds of morphemes in our theory are functional heads and roots. The template behaves like neither, ergo it is not a morpheme. Instead, we must build the structure using individual functional heads and then understand how these heads give rise to the templates as an emergent property of the morphological system.

These three themes are highly relevant to our understanding of non-concatenative morphology but generalize across other language families. I take them to be typical of the kind of questions formal linguistics has been asking: what is the division of labor between the different parts of the grammar and how is it learned. To begin addressing them let us proceed to our subject matter. The following sections describe the data in a bit more depth and sketch the theory as it is developed over the course of the next two chapters.

1.4 Data

Most works carried out by native speaker syntacticians on their own languages rely heavily on introspection. This dissertation is no different. Yet relying on a single source of information can be problematic, even though it has been argued convincingly that linguists' judgments are a robust experimental tool (Marantz 2005; Sprouse and Almeida 2012, 2013; Sprouse et al. 2013, but see e.g. Gibson and Fedorenko

2010). In this section I would like to make explicit what sources I drew on and where they were put to use, especially given that the community of Hebrew-speaking linguists is substantially smaller than that of English-speaking linguists, leaving less opportunity for quality control; see the discussion in Linzen and Oseki (2015). Looking to the chapters ahead, the generalizations in Chapter 2, in particular, rely on native speaker judgments.

The following sources have proven fruitful for this work in providing data or corroborating my own intuitions.

- Edit Doron's papers on the morphology of Modern Hebrew, in particular the lists and generalizations in Doron (2000) and Doron (2003).
- The argument structure alternations documented in Levin (1993) for English, which I often used as a starting point when looking for similar alternations in Hebrew.
- The database of verbal forms in Hebrew compiled by Lior Ehrenfeld for Ehrenfeld (2012).
- Attested occurrences in Tal Linzen's Hebrew Blog Corpus (Linzen 2009).
- Informal online searches, both for written forms (via the internet search engine Google) and naturally occurring spoken examples (via the video website YouTube).

Where necessary, these were supplemented with consultation with other native speakers.[1]

Since most of the investigation reported here was qualitative in nature rather than quantitative I was not able to exploit the following corpus in full, though I look forward to relying on it in future work:

- The Corpus of Spoken Israeli Hebrew curated by Shlomo Izre'el and his collaborators (Izre'el 2016).

One reason for taking the time to discuss the data is that there are some differences between my sociolect (and even idiolect) of contemporary Modern Hebrew on the one hand and Standard Hebrew on the other. These differences can be reflected in the syntactic-semantic patterns or in the morphophonology.

1. I am especially grateful to Michael Becker, Edit Doron, Tal Linzen, Yuval Pinter and Ben Lee Volk for challenging or confirming my intuitions on various occasions.

The word forms that are analyzed in this dissertation are predominantly those which I judge as being used by most native speakers of Modern Hebrew in Israel. Some forms are interesting linguistically but less frequent in everyday speech. These include the passives and certain combinations of person, number and gender. Nevertheless, in all cases I assume that native speakers recognize the forms and are able to parse and understand them with minimal effort.

The remainder of this section notes the choice points in my description of the data. I first make a few remarks on the notation, and then note a number of cases where I prefer a colloquial form to the prescriptive one. This latter part might not be of much interest to non-native speakers; §1.5 resumes with the theory.

1.4.1 Transliteration and notation

I use the variables X, Y and Z for the tri-consonantal root: $\sqrt{\text{XYZ}}$. This dissertation contains little discussion of roots with more than three consonants, but nothing in the notation hinges on it. The list in Ehrenfeld (2012) contains 311 quadrilateral roots and three quintilateral roots[2] out of 1876 roots in total.

In the Hebrew glosses, ACC is used for the direct object marker *et* and CS for the head of a Construct State nominal.

As will be discussed in Chapter 3, Hebrew has a fairly productive process of postvocalic spirantization applying to /b/, /k/ and /p/, turning them into [v], [x] and [f] respectively. This process is blocked in certain verbal templates; to note this blocking I borrow the non-syllabicity diacritic and place it under the medial root consonant: "Y̯". This notation can be found in the templates *XiY̯eZ* and *hitXaY̯eZ*, in which this blocking holds. The same notation is used for segments which never spirantize: "k̯". Again, see Chapter 3.

Transcriptions are given using the International Phonetic Alphabet with the following modifications:

2. $\sqrt{\text{xntrʃ}}$ 'bullshit', $\sqrt{\text{snxrn}}$ 'synchronize' and $\sqrt{\text{flrtt}}$ 'flirt'.

- “e” stands for /ɛ/ and /ə/.
- “g” stands for /ɡ/.
- “o” stands for /ɔ/.
- “r” stands for /ʁ/.
- “x” stands for /χ/.
- The apostrophe ’ stands for the glottal stop /ʔ/ in the example sentences in Chapter 2.

These changes were made purely for reasons of convenience. The syntactic literature has often used “š” or “S” for /ʃ/ and “c” for /ts/. In both cases I preferred to retain the IPA transcription, “ʃ” and “ts”. Stress is marked with an acute accent, “á”. Deleted vowels are enclosed in angle brackets, “<>”.

Underlining and **boldface** are used only for emphasis, never as diacritics or notation.

1.4.2 Deviations from the standard forms

The template *heXYiZ* usually appears in the literature as *hiXYiZ*, with the first vowel an /i/. In my experience, speakers of my generation and at least one generation older use the /e/ form, and so I use /e/ throughout.

In contrast, the initial /h/ in *hiXYiZ* is usually dropped in speech. Nevertheless, I retain the segment in my transcription for two reasons. First, the /h/ is still pronounced by some older speakers and certain sociolinguistic groups, especially marginalized ones (Schwarzwald 1981a; see Gafter 2014b for related discussion). Second, the initial *h-* should help the non-Semitist reader distinguish this template from others.

Glottal stops are often dropped in speech (Faust 2005, 2015). I usually omit them, but at times retain an apostrophe in order to distinguish between otherwise homophonous forms, for example *hefria* ‘he disturbed’ ∼ *hefri’a* ‘she disturbed’.

When presenting verbal paradigms I use two substandard forms. The first person singular future is normally prefixed with a low vowel, e.g. *a-daber* ‘I will talk’ (in $\sqrt{\text{dbr}}$). Contemporary usage, however, syncretizes the first person singular future with the third person masculine singular future: *je-daber* 'I/he will talk'. As far as I can tell, nothing important in the analysis depends on this distinction (or lack thereof). I do not use a dedicated 1SG form in my transcription.

Finally, Modern Hebrew does not make a distinction between masculine and feminine plural forms in past and future tense verbs. The traditional feminine plural endings have been discarded, syncretizing instead with the masculine plural forms.

When building on existing work I modify the original transcriptions for consistency. With this housekeeping out of the way, we return to the theoretical approach.

1.5 The basics of the theory

My analysis subscribes to the view that there is one generative engine in the grammar, namely the syntax. We will eschew the traditional distinction between syntactic and lexical operations, maintaining instead one syntactic engine that manipulates morphemes to form both (phonological) words and (syntactic) phrases within the framework of Distributed Morphology (Halle and Marantz 1993).

The lexicon consists of lists of functional morphemes, characterized by their morphosyntactic features (e.g. [Past], [3SG], etc.), and of abstract lexical entries, the $\sqrt{\text{roots}}$. Syntactic structure is built from the ground up, as is assumed in Minimalist syntax (Chomsky 1995). At certain points in the derivation the structure is "sent off" to be interpreted at the two interfaces with the rest of the grammar, Logical Form (semantics, LF) and Phonetic Form (morphophonology and phonetics, PF). The identity of these "certain points" is a focus of much work in contemporary syntactic theory; such "phases" are often taken to be CP and VoiceP.

This is an approach in which the syntax limits possible interpretations of the verb, leaving the lexical semantics to the root (Schäfer 2008; Alexiadou et al. 2014a; Myler 2014; Wood 2015). In Hebrew as in English, there is no difference between the functional heads that make up the verb *buy* and those that make up the verb *dance*. The former is transitive simply because the root $\sqrt{\text{BUY}}$ is compatible with Voice (default, active Voice) and an internal argument, and the latter is intransitive simply because $\sqrt{\text{DANCE}}$ is incompatible with most types of internal arguments (save for cognate objects).

In general, a root carries meanings associated with a general semantic field though the interpretation of a root in a template is idiosyncratic, as seen already in §1.1.1. What the syntax does in this approach is to constrain the possible interpretations. For instance, verbs in the "middle" template *niXYaZ* are never transitive and verbs in the "intensive" template *XiY̯eZ* are active. Chapter 2 is devoted to explaining how these alternations arise.

At PF, the abstract morphemes are replaced with phonologically contentful Vocabulary Items via a process of Vocabulary Insertion. Vocabulary Insertion proceeds outwards from the most deeply embedded element (Bobaljik 2000). It has been argued that this process must be constrained by locality considerations; I will adopt the Strict Linear Adjacency Hypothesis (Embick 2010; Marantz 2013a), elaborated on in Chapter 3. In essence, its predictions for contextual allomorphy are as follows. Given two elements X and Y, X may condition allomorphy on Y (and Y on X) if the two are adjacent and in the same local domain (say a syntactic phase). However, if an *overt* element Z intervenes between the two, X can no longer condition allomorphy on Y; [X **Z** Y]. It is predicted that Y will show *syncretism* across different values of X when overt Z intervenes. On the other hand, if Z is *silent*, X may still condition allomorphy on Y.

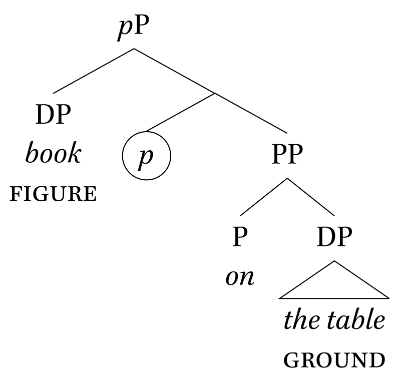
1.5.1 Some specifics

Let us flesh out a few of the functional heads relevant to the analysis. We are interested in the difference between roots and functional morphemes as a way of getting at the loci of idiosyncrasy and systematicity in the grammar. A root is an acategorial morpheme: the verb *walk*, for example, consists under my assumptions of a root $\sqrt{\text{WALK}}$ and a verbalizing categorizer, little v. There are three such categorizers: a, n, and v, which serve to categorize roots as adjectives, nouns or verbs (Marantz 2001; Arad 2005; Wood and Marantz To appear).

The functional head v introduces an event variable and categorizes a root as a verb. A higher functional head, Voice, introduces the external argument (Kratzer 1996; Pylkkänen 2008; Marantz 2013b). The functional head *p* introduces the external argument of a preposition, also called its Figure (Svenonius 2003, 2007; Wood 2014). To derive the full range of verbs in Hebrew, I use a number of overt variants of these heads. The breakdown is as follows.

Voice and *p* heads introduce a DP in their specifier. In a regular, unmarked active clause, default (silent) Voice introduces the external argument. The head *p* was proposed by Svenonius (2003, 2007) to act in similar fashion to Voice or Chomskyan little *v*: it merges above the PP, introducing the Figure (subject) of the preposition. I will not attempt to motivate this structure but will simply assume it; it is meant to capture the predicative relationship between the two DPs, similarly to the PredP of Bowers (1993, 2001) and *ann*-XP of McCloskey (2014). In (6), the Figure is the DP *book* and *p* is circled for ease of reference.

(6)



To these heads I add nonactive counterparts, namely **$\text{Voice}_{\emptyset}$** and $p_{\emptyset}$. These two heads dictate that nothing may be merged in their specifiers. $\text{Voice}_{\emptyset}$ blocks the introduction of an external argument (Doron 2003; Alexiadou and Doron 2012; Bruening 2013; Wood 2015; Spathas et al. 2015) and $p_{\emptyset}$ blocks merger of a DP in the specifier of pP (Wood 2015). The different kinds of Voice/*p* only manipulate the syntax: they dictate whether a DP may or may not be merged in their specifier. As mentioned above, default Voice and p are silent. But Voice$_{\emptyset}$ and $p_{\emptyset}$ are spelled out by the placeholder Vocabulary Item MID, which adds a prefix and triggers insertion of certain vowels.

Voice also has the strongly active counterpart **Voice$_{\{D\}}$**. This head requires that a DP be merged in its specifier, behaving the opposite of Voice$_{\emptyset}$. This definition will be refined in §2.3.2.

Alongside these functional heads and standard lexical roots I posit $\sqrt{\textbf{ACTION}}$. In the semantics, this element types the event as an Action (Doron 2003) or "self-propelled" (Folli and Harley 2008). In the phonology, $\sqrt{\text{ACTION}}$ is spelled out as a predictable set of vowels slotting between the root consonants. $\sqrt{\text{ACTION}}$ also blocks intervocalic spirantization of the middle consonant as mentioned above. I assume for now that $\sqrt{\text{ACTION}}$ is spelled out by the Vocabulary Item INTNS, which is used as a placeholder for the phonological output. The semantics of this element emerge again in §§2.2.4.1, 2.2.4.2, 2.3.3, its phonology in §3.2.2, and its crosslinguistic equivalents in §2.4.1.

The spell-out of these heads produces templates as an epiphenomenon and is as follows:

Voice and v are underspecified, but when combining they result in the *XaYaZ* template as explained in Chapter 3.

Voice$_{\{D\}}$ provides the prefix *he-*. Recall that templates differ from each other also in the vowels that appear between the root consonants, so I assume that each of the overt functional heads used in this theory inserts the right vowels, with the full implementation as in Chapter 3. For the time being, one may think of these vocalic changes as readjustment rules (Embick and Halle 2005). These are rules that "fix" the phonology of a form. Informally, for English, irregular past tense verbs do not take a suffix but undergo readjustment of the stem:

(7) *sang* = *sing* + T[Past]

The exact processes giving rise to vowel alternations are explored in Chapter 3.

Voice$_{\emptyset}$ provides the prefix *ni-* or its allomorph *hit-* in the environment of $\sqrt{\text{ACTION}}$:

(8) a. Voice$_{\emptyset}$ $\leftrightarrow$ *hit-* + READJUSTMENT / ___ $\sqrt{\text{ACTION}}$
   b. Voice$_{\emptyset}$ $\leftrightarrow$ *ni-* + READJUSTMENT

The root $\sqrt{\text{ACTION}}$ triggers readjustment rules and blocks postvocalic spirantization of the medial root consonant. This phonological effect is formalized as a floating feature [−continuant] docking onto a particular consonant. See Wallace (2013) for an analysis of gemination in Akkadian and Arabic using a similar mechanism.

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

Table 1.1 summarizes the syntactic, semantic and morphophonological effects of these heads, deriving a subset of the verbal system of Modern Hebrew. Special Voice/*p* heads affect their specifier; see for the external argument (EA) under "Syntax" and as a prefix under "Phonology." The effects of the special root $\sqrt{\text{ACTION}}$ can be seen under "Semantics" and as de-spirantization under "Phonology." Note in particular that the *hitXaY̯eZ* template is morphologically complex. It is prefixed, indicating the existence of an overt Voice/*p* head, and de-spirantized, indicating the existence of $\sqrt{\text{ACTION}}$. Each of these elements is motivated in Chapter 2, and the table expanded on there.

Heads			Syntax	Semantics	Phonology	Mnemonic
Voice			(underspecified)	(underspecified)	*XaYaZ*	"simple"
Voice	$\sqrt{\text{ACTION}}$		(underspecified)	Action	*XiY̯eZ*	"intensive"
$\text{Voice}_{\{D\}}$			EA	(underspecified)	*he-XYiZ*	"causative"
$\text{Voice}_{\emptyset}$			No EA	(underspecified)	*ni-XYaZ*	"middle"
$\text{Voice}_{\emptyset}$	$\sqrt{\text{ACTION}}$		No EA	Action	*hit-XaY̯eZ*	"intensive middle"
Voice		$p_{\emptyset}$	EA = Figure	(underspecified)	*ni-XYaZ*	"middle"
Voice	$\sqrt{\text{ACTION}}$	$p_{\emptyset}$	EA = Figure	Action	*hit-XaY̯eZ*	"intensive middle"

Table 1.1: The requirements of functional heads in the Hebrew verb.

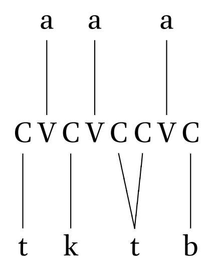
1.6 Traditional generative treatments of the system

Before we get to the meat of the dissertation, I would like to acknowledge some of the earlier work on Semitic morphology in an attempt to illustrate what we do and do not know yet. I focus here on the seminal series of works by McCarthy (McCarthy 1979, 1981, 1989; McCarthy and Prince 1990) in order to bring out the inadequacies of a purely phonological account of Semitic morphology. Comparisons with more recent analyses will be presented in the next two chapters, where appropriate.

1.6.1 Tiers

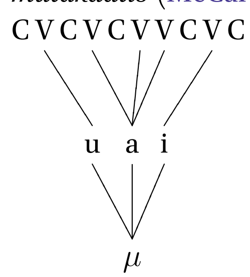
McCarthy's original contribution lay in dividing the Semitic (Arabic) verb into three "planes" or "tiers": the CV skeleton (C and V slots), the root (consonants) and the melody (individual vowels). For example, the verb *takattab* 'got written' was analyzed as follows, with a default verbal vowel -*a*-.

(10) *takattab* (McCarthy 1981:392):



By including the vocalism on a separate tier, McCarthy's theory allowed vowels to be manipulated independently of the roots or the skeleton. The melody *u-a-i* is taken to derive the active participle, for instance:

(11) *mutakaatib* (McCarthy 1981:401)



The beauty of this theory is that it allowed for a separation of three morphological elements on three phonological tiers: the root (identity of the consonants), the template (the form of the CV skeleton) and additional inflectional or derivational information (the identity of the vowels). Important extensions were proposed in McCarthy and Prince (1990) to account for denominal forms, specifically plurals and diminutives.

The current work shifts the focus to the nature of the CV skeleton and the melody. McCarthy's approach did not attempt to model the relationships between the semantics of the different templates – the alternations in argument structure. Yet as we have seen in §1.1.1, some templates are related to others in ways that remain to be explicated. McCarthy's work, as well as work inspired by it, leaves us in prime position to ask the following interrelated questions:

(12) **Questions on the nature of Semitic addressed in this study**

a. What is the syntax behind the CV skeleton?

b. What is the syntax behind the melody?

c. What is the relationship between different templates, that is, how are argument structure alternations derived?

My answers to these questions lead us to make different assumptions than McCarthy. Like him, I believe that the consonantal root lies at the core of the lexicon. Unlike his theory, I do not postulate independent CV skeletons and do not accord the prosody morphemic status. The skeletons will be a by-product of how functional heads are pronounced and regulated by the general phonology of the language. There is no skeleton CVCVCCVC as in (10) giving *takattab*, for example: there would be a prefix *ta-*, a number of vowels spelling out Voice, gemination spelling out an additional head, and the organization of these different segments will proceed in a way that satisfies the phonology without making reference to prosodic primitives like skeletons. Furthermore, each morpheme will have an explicit syntax and semantics associated with it. Chapter 2 develops the morphosyntactic system and Chapter 3 returns to the morphophonological side of the morphology, making a number of additional contributions to our understanding of how the syntax and the phonology interact.

1.6.2 Related work

A few more pieces of research that capture generalizations important to this dissertation deserve mention. The seminal work by Berman (1978) underscored the semi-predictable nature of the templates. Berman (1978:Ch. 3) made the point that the combination of root and template is neither fully regular nor completely idiosyncratic. Instead, Berman proposed a principle of *lexical redundancy* to regulate the system. According to this theory, each root has a "basic form" in some template from which other forms are derived. Yet this theory did not formalize the relations between the templates, arbitrarily selecting one as the "basic form" and the others as derived from it, for each root. Nevertheless, Berman's clear description of the regularities and irregularities in the morphology of Hebrew laid the groundwork for later works such as Doron (2003), Arad (2005), Borer (2013) and the current contribution.

Alongside work that analyzed the syntactic and semantic features of roots and templates, other researchers have focused on the morphophonological properties of the system. The research program developed in a series of works by Bat-El (1989, 1994) and Ussishkin (2000, 2005)—credited by Ussishkin (2000) at least in part to Horvath (1981)—denies the existence of the root as an independent morpheme. Instead, all verbs are derived via phonological manipulation of surface forms from each other, rather than from an underlying root. I refer to this idea as the "stem-based approach". We return to it in §3.5, discussing it more in depth there.

Even before the stem-based approach took form, other Semitists explored the idea of a Semitic system which diverged from the traditional descriptions. Schwarzwald (1973) doubted the productivity of both the root and the templates, making an early argument for frequency effects in the interpretation of different templates. On that view, it is only the high frequency verbs of the language that show reliable alternations between templates. These verbs lead us as analysts to postulate relationships between templates, though when one looks at less frequent verbs, transparent alternations are less likely to hold. Unlike the stem-based hypothesis, which eschewed roots and relied on the template as a morphological primitive, the proposal in Schwarzwald (1973) kept the root but relegated the template to morphophonological limbo: salient in the grammar but not operative in the syntax. While this early formulation of a template-less idea is intriguing, it cannot hold up to wug studies in which speakers generate argument structure alternations between templates using nonce words (Berman 1993; Moore-Cantwell 2013).

To pick out a few studies on Arabic (as gleaned from the helpful overview in Ussishkin 2000), Darden (1992) offered an analysis of Egyptian Arabic that attempted to do without verbal templates; McOmber (1995) developed an infixation-based system similar to that of McCarthy (1981) which makes crucial reference to morpheme edges; and Ratcliffe (1997, 1998) attempted to improve on McCarthy and Prince (1990) by restricting the CV skeleton and treating more phenomena as cases of infixation. But let us return to the current study.

1.7 Overview of the dissertation

The dissertation is organized in six chapters, each of which can be read independently.

Chapter 1 has provided an overview of the theoretical issues, empirical issues and general approach.

Chapter 2 consists of the bulk of the dissertation. In it, a syntactic analysis of the Hebrew verbal system is proposed. The chapter makes the following points: argument structure alternations are derived using distinct functional heads, not holistic templatic morphemes; the first contentful head merging with the root, normally v or Voice, selects the meaning of the root; and individual roots may place restrictions on the kinds of structures they are merged in. The result is a theory that captures argument structure alternations, the meanings associated with each template and an initial lexical-semantic categorization of roots.

Chapter 3 shows how the system from Chapter 2 is interpreted by the phonological component, deriving the templates as morphophonological epiphenomena rather than as morphemic primitives.

The chapter also makes the point that allomorph selection is local under linear adjacency, meaning that structure must be taken into account if we are to understand the full phonological behavior of the system.

Chapter 4 segues into experimental work, describing a neurolinguistic experiment that tested whether the Hebrew lexicon is processed similarly to that of languages like English. In a masked priming experiment, subjects saw word forms that were or were not related to a masked prime. The results show priming both for roots and for templates, in line with the general theoretical claims.

Chapter 5 sketches a model of acquisition, highlighting some developmental findings and proposing a way in which the infant can go from the phonetic input string to the full-fledged morphosyntactic system by focusing on the consonants in the input.

Chapter 6 concludes with a summary of the dissertation and its contributions.

Chapter 2

MORPHOSYNTAX

2.1 Templates as functional heads

Modern Hebrew makes use of seven distinct morphophonological verbal forms in which a given root may or may not be instantiated. The root $\sqrt{\text{ktb}}$ which has a general meaning associated with writing can give rise to the verb *katav* 'wrote' in the *XaYaZ* template and *hextiv* 'dictated' in the *heXYiZ* template. "Causative" *hextiv* can then be passivized to yield *huxtav* 'was dictated' in the passive template *huXYaZ*. We can also get a passive reading of 'was written' using the *niXYaZ* template, *nixtav*. So far, the argument structure alternations seem easy enough to pin down, as the first approximation in (13) shows. We begin with a subset of four verbal templates out of the seven.

(13) A naïve view of argument structure alternations, based on $\sqrt{\text{ktb}}$.

a. *XaYaZ*: unmarked/transitive.

b. *niXYaZ*: passive of *XaYaZ* (13a).

c. *heXYiZ*: causative of *XaYaZ* (13a).

d. *huXYaZ*: passive of *heXYiZ* (13c).

Traditional descriptions of the templates fall along these lines. However, if the characterization in (13) were correct then this would be a very short dissertation. In reality, neither the templates nor the roots play by such simple rules. A number of counterexamples are presented in (14).

(14) Counterexamples to the generalizations in (13).

a. *XaYaZ*: does not exist in a large number of roots ($\sqrt{\text{kns}}$, $\sqrt{\text{'lm}}$, $\sqrt{\text{tsmtsm}}$, $\sqrt{\text{tlfn}}$).

b. *niXYaZ*: *nixnas* 'entered', *ne'elam* 'disappeared', *nilxam* 'fought'; are not derived from a form in *XaYaZ* nor are they passive.

c. *heXYiZ*: *hexmits* 'grew sour', *he'edim* 'reddened'. Change-of-state verbs, not derived from a form in *XaYaZ*.

d. *huXYaZ*: (no counterexamples – robust generalization)

This brief rundown omits further complications introduced by two additional templates, namely *hitXaY̯eZ* and *XiY̯eZ*, and by *XuY̯aZ* which is the passive counterpart of the latter. The seven templates, then, do not provide us with deterministic mappings from phonological form (the template) to syntax (argument structure), except in the case of the two passive templates. One goal of this chapter—and of the dissertation in general—is to argue for an analysis which treats templates not as morphosyntactic atoms (morphemes or features) but as an epiphenomenon of distinct functional heads merging in the structure. Both the regularities in (13) and the exceptions in (14) will need to be covered by our theory of morphosyntax.

Consider next the roots. In a "clean" system, placing the same root in different templates would at least result in predictable changes in meaning; the alternations of $\sqrt{\text{ktb}}$ mentioned above all maintain the same basic notion of writing, modified in different ways. Yet the alternations, too, are not an open-and-shut case, as can be seen for $\sqrt{\text{pkd}}$ in (15).

(15) a. *XaYaZ*: *pakad* 'ordered'.

b. *niXYaZ*: *nifkad* 'was absent'.

c. *XiY̯eZ*: *piked* 'commanded' (and a passive *XuY̯aZ* form).

d. *heXYiZ*: *hefkid* 'deposited' (and a passive *huXYaZ* form).

e. *hitXaY̯eZ*: *hitpaked* 'allied himself', 'conscripted'.

One could find a general semantic field of "counting" or "surveying" running through the use of this root but the alternations are in no way obvious. The problem is exacerbated when considering nominal forms as well: *pakid* 'clerk', *mifkada* 'headquarters', *pikadon* 'deposit'. Templates, then, do not provide us with deterministic mappings from phonological form (the template) to semantics (interpretation of a root), again with the exception of the passive templates.

We have seen that a template cannot definitively clue us in onto the argument structure or interpretation of the verb. It is equally true that a given argument structure alternation or interpretation cannot be deterministically assigned to a certain template: we have already seen transitive verbs at least in *XaYaZ*, *XiY̯eZ* and *heXYiZ*. Where does this lead us? This dissertation attempts to balance two angles on the morphological phenomena: an empiricist-Semitist one, in which I ask what the templates are and what they tell us; and a theoretical one, in which I take the conceptual issue of locality domains in argument structure alternations and search for relevant evidence. But it is worth pausing to consider what is at stake. To the extent that the utterances of different languages are generated by similar grammars, the task of the linguist is to identify those parts of the grammar that cannot be learned from simple exposure to input, as well as how the parts that do get learned are encoded. Semitic languages are interesting because they seem to defy a linear account of structure building, at least in one well-circumscribed domain: prosodically strict morphology (McCarthy 1981). Any structure that the grammar generates, and any locality conditions or other constraints that hold in said structure, must produce output that can be linearized according to phonological requirements. Theories of locality and allomorphy are especially sensitive to ordering, be it linear or hierarchical. It follows that a satisfactory account of Semitic morphology is necessary in order to test hypotheses of how morphemes are arranged, how they combine, and how they might be learned.

Before continuing there is an important question regarding whether verbs such as those in (13) or in (15) do in fact share the same root. For example, it could be argued that (15a,b,c,e) as well as the noun 'headquarters' share one root that has to do with military concepts, and that (15d) as well as the nouns 'clerk' and 'deposit' stem from a homophonous root that has to do with financial concepts. There are a number of reasons to reject this claim. First, there are no "doublets"; if we were dealing with two roots, call them $\sqrt{\text{pkd}_1}$ and $\sqrt{\text{pkd}_2}$, then each should be able to instantiate any of the templates. But *hefkid* can only mean 'deposited', never something like 'installed into command'. The choice of verb for that root in that template has already been made. Second, experimental studies have found roots to behave uniformly across their different meanings (though this conclusion has been challenged – see the overview in §4.1). We will sidestep this issue for the bulk of the discussion, returning to it in §5.3.1.

In the remainder of this dissertation I will be forced into the not-unwelcome position of claiming that templates are *emergent*, arising from the combination of roots and functional heads in the syntax. Unlike much traditional work that took both roots and templates to be primitives in the system (i.e. morphemes), and unlike some recent work which takes templates to be morphemic but denies the existence of the root, our primitives will be the root and a collection of hierarchically arranged syntactic heads.

Each of these heads will be assigned an explicit syntax, semantics and phonology. This chapter is devoted to describing the syntax and semantics of the different pieces, evaluating the model's fit to the data and testing additional predictions that are made. The goal is to identify (a) the syntactic features relevant to each morpheme and (b) which rules of interpretation operate on them. Table 2.1 summarizes the combinations of functional material that I will discuss.

Heads				Syntax	Semantics	Phonology	Section
	Voice			(underspecified)	(underspecified)	*XaYaZ*	§2.3.1
	Voice	$\sqrt{\text{ACTION}}$		(underspecified)	Action	*XiYeZ*	§2.3.3
Pass	Voice	$\sqrt{\text{ACTION}}$		Passive	Action	*XuYaZ*	§2.3.4
	$\text{Voice}_{\{D\}}$			EA	(underspecified)	*he-XYiZ*	§2.3.2
Pass	$\text{Voice}_{\{D\}}$			Passive, EA	(underspecified)	*hu-XYaZ*	§2.3.4
	$\text{Voice}_{\emptyset}$			No EA	(underspecified)	*ni-XYaZ*	§2.2.1
	Voice		$p_{\emptyset}$	EA = Figure	(underspecified)		§2.2.2
	$\text{Voice}_{\emptyset}$	$\sqrt{\text{ACTION}}$		No EA	Action	*hit-XaYeZ*	§2.2.1
	Voice	$\sqrt{\text{ACTION}}$	$p_{\emptyset}$	EA = Figure	Action		§2.2.2

Table 2.1: The requirements of functional heads in the Hebrew verb.

Explaining briefly, Pass is a passivizing head. Voice is a functional head introducing the external argument of the verb. $\text{Voice}_{\emptyset}$ is a variant which does not allow anything in its specifier and $\text{Voice}_{\{D\}}$ is a variant requiring a DP in its specifier. p introduces the subject of a preposition, and $p_{\emptyset}$ is a variant which does not allow anything in its specifier. $\sqrt{\textsc{action}}$ is an agentive modifier. These elements will be introduced as the discussion progresses; the combinatorial possibilities are addressed in §2.4.1.1.

Table 2.2 summarizes the requirements of root classes in different configurations.

Morphology	Section	Verb type	Root type
hitXaY̯eZ	§§2.2.1.1, 2.2.4.1, 2.2.6	Reflexive Inchoative	Self-oriented Other-oriented
hitXaY̯eZ	§§2.2.4.2, 2.2.6	Reciprocal Figure reflexive	Naturally reciprocal Naturally disjoint (Other-oriented)
heXYiZ	§2.3.2	Alternating unaccusative Alternating unergative	Change of color Emission
XiY̯eZ	§2.3.3	Pluractional object Pluractional event	Other-oriented Self-oriented (activity)
Passive participle	§2.3.5	Resultative adjective	Change of state
XaYaZ	§2.3.1	Underspecified	(all)

Table 2.2: The requirements of root classes in the Hebrew verb.

The chapter is organized as follows. We begin in §2.2 by examining the two "middle" templates, *niXYaZ* and *hitXaY̯eZ*. Focusing on two templates first will present us with plenty of puzzles to tackle while avoiding the unwelcome task of having to introduce the entire system at once. Section §2.3 examines each of the other templates in turn, showcasing their peculiarities, how they are accounted for in our theory and what their consequences are for the overarching questions raised in Chapter 1. We then broaden the scope a bit, considering in §2.4 what this system entails for our understanding of argument structure in general. Section §2.5 addresses a number of potential counterexamples to the claims I make here. Alternative analyses are discussed in §2.6 (root-based approaches) and §2.7 (stem-based lexicalist approaches).

2.2 The "middle" templates

In this section I begin to make the case for templates as emergent from the combination of distinct functional heads. A central distinction in studies of argument structure is made between internal and external arguments. This contrast has proven crucial for analyses of various issues relating to subject/object asymmetries (Marantz 1984; Kratzer 1996), case assignment (Burzio 1986; Marantz 1991) and analyses of unaccusativity and unergativity (Perlmutter 1978), among many related topics. Generalizing over external arguments vs internal arguments has in effect taken over the traditional distinction between transitive and intransitive verbs or between subjects and objects (though see Legate 2014 or the vast literature on ergativity).

Hebrew has traditionally been viewed as a language distinguishing transitive from intransitive verbs. Two "intransitive" templates are examined in this section. For convenience, I use the term "active" for structures containing an external argument in the canonical subject position (i.e. transitives and unergatives), and "nonactive" for structures without an external argument (i.e. unaccusatives). This section discusses two verbal templates in Hebrew which exhibit "middle" morphology, meaning morphology that is traditionally taken to indicate nonactive syntax (roughly on a par with Romance SE, Latin *-r*, Russian *-sja* and Icelandic *-st*). The claim is that this morphology should be distinguished from the underlying syntactic structure: "middle" marking in Hebrew does not necessarily entail that the verb is nonactive. Instead, the affix indicates the presence of a functional head which manipulates arguments in a systematic way. Once the behavior of this functional head is properly understood, the different readings of "middle" verbs fall out, as does the fact that their morphophonology is uniform.

The empirical domain departs from the well-studied affixes and clitics of the European languages mentioned above and focuses on the two Hebrew verbal templates ***niXYaZ*** and ***hitXaY̯eZ***. Verbs in these templates are never transitive, in that they do not have a subject paired with a direct object. But it is not the case that all verbs in these templates are nonactive: some are agentive. We will see how the interpretations of different Hebrew roots result under this morphology when merged in different syntactic structures. Theoretically, the implications will be explored for a system in which different argument structure alternations arise without recourse to specialized operators such as a decausativizer or reflexivizer. As a result, "middle" morphology will be dissociated from nonactive syntax and there will be two ways of getting to each of the two templates under discussion.

The analysis of these two templates will also serve to explain why "intensive middle" *hitXaY̯eZ* is the only Hebrew template that houses reflexive and reciprocal verbs, even though "middle" *niXYaZ* would have been an equally likely candidate. The analysis of reflexives and reciprocals will use the same functional head embedded in different contexts, obviating the need for distinct reflexivizers and reciprocalizers. One consequence of the theory developed here is that reflexive and reciprocal verbs need not be considered "special" in any way, but arise simply by compositional interpretation of roots and functional heads, at least in Hebrew. This analysis ties in to the overarching issue of Semitic morphology: there is no direct mapping between the phonology (the template) and the semantics, in either direction. Instead, the syntax builds up a hierarchical structure which is then interpreted at the interfaces.

We will now delve deeper into the middle templates, suggesting two main structures for middle verbs. In §2.2.1 I propose that nonactive middle verbs are unaccusative, built using the functional head Voice$_{\emptyset}$. I then argue in §2.2.2 that active middle verbs always take a prepositional phrase complement, built using the functional head $p_{\emptyset}$. This kind of structure permits an external argument in Spec,VoiceP, rendering the verb active. I develop this idea in what follows, arguing for identical morphophonological forms for separate underlying structures. The basic intuition behind this analysis is that some middle verbs seem more volitional than others, just like in English unaccusative *arrive* is more volitional than unaccusative *break*, a matter I return to in §2.2.6.

2.2.1 Nonactive structures

2.2.1.1 Anticausatives

We will discuss two kinds of nonactive verbs, treating them as different types though their underlying structure will be argued to be identical. The basic intuition behind middle verbs as nonactive is that they are the anticausative counterparts of a causative verb in another template, as in the English causative alternation in (16).

(16) a. John broke the vase. (causative)

b. The vase broke. (anticausative)

In Hebrew it is often the case that an unaccusative change-of-state verb in *hitXaY̯eZ* is derived from an active counterpart in the "intensive" *XiY̯eZ* template, as in (17a). Similarly, some *niXYaZ* verbs are derived from active counterparts in the "simple" *XaYaZ* template, (17b). In these cases, the middle version is a detransitivized form of the active version and shares the same root as the active verb. The derived verbs in (17) are all intransitive and their bases transitive. Call these derived middle verbs *anticausatives*.

(17) Examples of anticausatives:

Templates	Root	Causative		Anticausative	
a. *XiY̯eZ* ∼ *hitXaY̯eZ*	√prk̯	pirek	'dismantled'	hitparek	'fell apart'
	√ptsts	potsets	'detonated'	hitpotsets	'exploded'
	√bʃl	biʃel	'cooked'	hitbaʃel	'got cooked'
b. *XaYaZ* ∼ *niXYaZ*	√ʃbr	ʃavar	'broke'	niʃbar	'got broken'
	√k̯ra	kara	'tore'	nikra	'got torn'
	√mtx	matax	'stretched'	nimtax	'got stretched'

The unprefixed base forms are active, (18a), whereas tests such as incompatibility with *by*-phrases or agent-oriented adverbs show that the derived middle verbs are indeed unaccusative and allow no agents, (18b–c).

(18) a. *ha-tsoref* *pirek* *et* *ha-tsamid*
the-jeweler dismantled.INTNS ACC the-bracelet
'The jeweler took the bracelet apart.'

b. *ha-tsamid* ***hit**parek* *me-atsmo*
the-bracelet dismantled.INTNS.**MID** from-itself
'The bracelet fell apart of its own accord.'

c. * *ha-tsamid* ***hit**parek* { *al-jedej* *ha-tsoref* / *be-mejomanut* }
the-bracelet dismantled.INTNS.**MID** by the-jeweler in-skill
(int. 'The bracelet was dismantled by the jeweler/skillfully')

Unaccusativity diagnostics confirm that these structures are nonactive. I make use of the two standard diagnostics in the literature, possessive datives and Verb-Subject order.

Possessive datives, a type of possessor raising, have been claimed to only be possible with internal arguments by Borer and Grodzinsky (1986), though see Gafter (2014a) and Linzen (To appear) for critiques of this diagnostic, to be returned to in §2.2.5. A simple unaccusative like *nafal* 'fell' in the underspecified *XaYaZ* template is compatible with a possessive dative, (19a), as is a transitive construction, (19b), whereas an unergative verb leads to a deviant, affected interpretation, (19c). Anticausatives are compatible with possessive datives, (20).

(19) a. *nafal l-i* ***ha-ʃa'on*** ✓ INTERNAL ARGUMENT
fell to-me the-watch
'My watch fell.'

b. *dani ʃavar l-i et* ***ha-ʃa'on*** ✓ INTERNAL ARGUMENT
dani broke to-me ACC the-watch
'Danny broke my watch.'

c. # *navax l-i ha-kelev* ✗ EXTERNAL ARGUMENT
barked to-me the-dog
'The dog barked and I was adversely affected' (int. 'My dog barked')

(20) *niʃbar l-i* ***ha-ʃa'on*** ✓ INTERNAL ARGUMENT
broke.MID to-me the-watch
'My watch broke.'

The other diagnostic is **Verb-Subject order**. The word order of Modern Hebrew is typically SVO, but unaccusatives allow the verb to appear before the underlying object, (21a). Unergatives do not allow VS order except for specific emphasis, (21b); see Shlonsky (1987), Shlonsky and Doron (1991) and Borer (1995). Anticausatives allow VS order, (22).

(21) a. *nafl-u* ***ʃaloʃ kosot*** *be-mahalax ha-nesi'a* ✓ INTERNAL ARGUMENT
fell-3PL three glasses in-duration the-ride
'Three glasses fell during the trip.'

b. # *navx-u ʃloʃa klavim be-mahalax ha-nesi'a* ✗ EXTERNAL ARGUMENT
barked-3PL three dogs in-duration the-ride
(Marked variant; sounds literary)

(22) *niʃber-u* ***ʃaloʃ kosot*** *be-mahalax ha-nesi'a* ✓ INTERNAL ARGUMENT
broke.MID-3PL three glasses in-duration the-ride
'Three glasses broke during the trip.'

The analysis utilizes a special Voice head, namely **Voice$_{\emptyset}$**, proposed by Schäfer (2008) for German and utilized by Bruening (2014) for English, Alexiadou and Doron (2012) and Spathas et al. (2015) for Greek, Alexiadou and Doron (2012) for Hebrew, Wood (2015) for Icelandic, and Kastner and Zu (2015) for Latin. This head bans the merger of a DP in its specifier, leaving the structure without a canonical subject.

(23) a. **Voice$_{\emptyset}$**:
Voice$_{\emptyset}$ (pronounced "voice zero" or "voice minus dee") is a Voice head with a [–D] feature, prohibiting anything with a [D] feature from merging in its specifier.

b. $[\![\text{Voice}_{\emptyset}]\!] = \lambda P_{<s,t>}.P$

For the time being, let us assume that this head is spelled out as the placeholder vocabulary item MID, which is shorthand for the prefix (*ni-*/*hit-* in the past, *ji*(*t*)-/*ti*(*t*)- in the future) and the relevant vowels. The PF component of the system is fleshed out in Chapter 3.

(24) Voice$_{\emptyset}$ ↔ MID (First pass)

Anticausatives are derived by taking an existing transitive vP (one that has a direct object) and merging Voice$_{\emptyset}$, thereby detransitivizing the verb. This results in causative-inchoative alternations as in (25)–(26).

(25) a. "Simple" *XaYaZ*, $\boxed{[\text{v } [\text{v } \sqrt{\text{ʃbr}}] \text{ DP}]}$: *ʃavar* 'broke' (transitive)

b. "Middle" *niXYaZ*, [$\boxed{\textbf{Voice}_{\emptyset}}$ $\boxed{[\text{v } [\text{v } \sqrt{\text{ʃbr}}] \text{ DP}]}$] : *niʃbar* 'got broken'

(26) a. "Intensive" *XiYeZ*, [Voice $\boxed{\sqrt{\text{ACTION}}\ [\text{v } [\text{v } \sqrt{\text{prk̯}}] \text{ DP}]]}$: *pirek* 'dismantled' (transitive)

b. "Intensive middle" *hitXaYeZ*, [$\boxed{\textbf{Voice}_{\emptyset}}$ $\boxed{\sqrt{\text{ACTION}}\ [\text{v } [\text{v } \sqrt{\text{prk̯}}] \text{ DP}]}$] : *hitparek* 'fell apart'

The theory of locality on which I am relying predicts the possibility of a situation in which v does not choose an interpretation of the root. In that case, its combination with the root does not result in a licit verb, and a higher Voice head might select the *alloseme* of the root instead (cf. Marantz 2013a). Nonactive middles bear this idea out, as in the following discussion of inchoatives.

2.2.1.2 Inchoatives

Unlike with anticausative verbs, it is not always the case that an active version of a middle verb exists in another template. Some middle verbs could not have been derived from a counterpart in *XaYaZ* or *XiY̯eZ* because the root was never instantiated in the active template in the first place. For example, *hit'alef* is not derived from active **ilef*. Call these middle verbs *inchoatives*.

(27) Examples of inchoatives:

Templates		Root	Causative	Inchoative	
a.	*XiY̯eZ* ∼ *hitXaY̯eZ*	$\sqrt{\text{'lf}}$	—	hit'alef	'fainted'
		$\sqrt{\text{'tʃ}}$	—	hit'ateʃ	'sneezed'
		$\sqrt{\text{'rk}}$	—	hit'arex	'grew longer'
b.	*XaYaZ* ∼ *niXYaZ*	$\sqrt{\text{rdm}}$	—	nirdam	'fell asleep'
		$\sqrt{\text{'lm}}$	—	ne'elam	'disappeared'
		$\sqrt{\text{kxd}}$	—	nikxad	'went extinct'

That inchoatives like those in (27) are nonactive as well can be shown by their incompatibility with *by*-phrases and agent-oriented adverbs, where no external cause is possible, as well as by the standard unaccusativity diagnostics.

(28) *By*-phrases and agent-oriented adverbs.

a. *ha-klavlav* *nirdam* *me-atsmo*
the-puppy fell.asleep.MID from-itself
'The puppy fell asleep of his own accord.'

b. **josi* *hit'alef* / *nirdam* { *al-jedej ha-xom* / *al-jedej ha-kosem* / *be-xavana* }
Yossi passed.out.INTNS.MID / fell.asleep.MID by the-heat by the-magician on-purpose
(int. 'Yossi fainted/fell asleep due to the heat/due to the magician/on purpose')

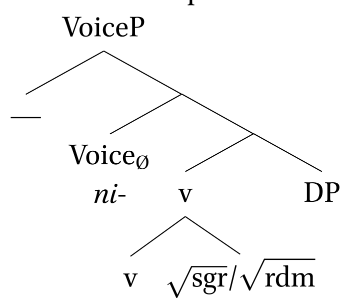
(29) Possessive datives:
nirdam *l-i* *ha-kelev* *al* *ha-regel,* *ma* *la'asot?*
fell.asleep.MID to-me the-dog on the-leg what to.do
'My dog fell asleep on my lap, what should I do?'

(30) VS order:

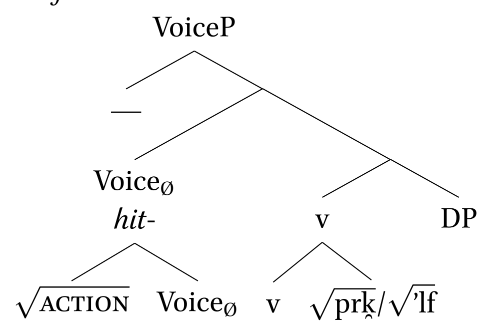
<u>*hit'alf-u*</u> *ʃloʃa* *xajalim* *ba-hafgana*
fainted.INTNS.MID-3PL three soldiers in.the-protest
'Three soldiers fainted during the protest.' (Reinhart and Siloni 2005:397)

The full structures for both kinds of verbs are as follows. Nonactive middles are derived using the head $\text{Voice}_{\emptyset}$. As this head does not allow anything to be merged in its specifier, no external argument can be introduced into the structure. The difference between *niXYaZ* in (31a) and *hitXaY̯eZ* in (31b) is that *hitXaY̯eZ* is the result of adjoining $\sqrt{\text{ACTION}}$ to $\text{Voice}_{\emptyset}$. This morpheme is an additional root which I discuss at more length in §§2.2.4, 2.3.3. For now, let us assume that this root has the phonological realization of added vowels and blocked spirantization (Y̯ in *hitXaY̯eZ*). When it is adjoined to default Voice it derives the "intensive" template *XiY̯eZ*.

(31) a. ***niXYaZ*** *nisgar* 'closed', *nirdam* 'fell asleep':



b. ***hitXaY̯eZ*** *hitparek* 'fell apart', *hit'alef* 'fainted':



Before proceeding to active middles, it is worth exploring in more detail the implications of semantically inert elements.

2.2.1.3 Null allosemy in inchoatives

I have assumed that certain configurations allow for interpretations of the root conditioned by a high functional head (e.g. Voice) over a lower functional head (e.g. v). The theory involved is one in which allosemy is calculated over semantically contentful elements only, just as allomorphy is calculated over phonologically contentful (overt) elements only. The *niXYaZ* template will serve as a case in point.

In (32a), the combination of v and $\sqrt{\text{root}}$ results in a contentful combination, the verb *sagar* 'closed'. This root can have various related meanings, but at this point in the derivation its meaning has been fixed. As a consequence, any higher material will only be able to manipulate this meaning (Arad 2003), not select another meaning of the root. Voice$_{\emptyset}$ has a syntactic function: it blocks merger of a DP in its specifier. As a result, the VoiceP will be interpreted as a detransitivized version of the vP, (32b). These are the anticausatives discussed above.

(32) Locality in interpretation: anticausatives.

a. $\boxed{[\text{v}\ \sqrt{\text{sgr}}]}$ = *sagar* 'closed'

b. [$\boxed{\textbf{Voice}_{\emptyset}}$ $\boxed{[\textit{close}]}$] = *nisgar* 'got closed'

If a given root combines with v to be verbalized, it is possible that v introduces an event but carries no additional semantic content when combined with this root. No verb results in this configuration, (33a). As a result, the next functional head will have a chance to select the interpretation of the root, as with Voice$_{\emptyset}$ in (33b). These are the inchoatives discussed above.

(33) Locality in interpretation: inchoatives.

a. $\boxed{[\text{v}\ \sqrt{\text{rdm}}]}$ – does not exist

b. [$\boxed{\textbf{Voice}_{\emptyset}}$ $\boxed{[(\text{v})\ \sqrt{\text{rdm}}]}$] = 'fell asleep'

In a sense, the root selects for a specific additional functional head; similar constructions can be found in Romance languages. Burzio (1986) observes what he calls an "inherently reflexive" verb which requires the nonactive clitic *si* (Italian SE). Glosses are his.

(34) Burzio (1986:39), Italian:

a. *Giovanni* ***si*** *sbaglia*
Giovanni himself mistakes
'Giovanni is mistaken.'

b. **Giovanni sbaglia Piero*
Giovanni mistakes Piero
(int. 'Giovanni mistakes Piero')

(35) Burzio (1986:70), Italian:
Giovanni ***se*** *ne pentirá*
Giovanni himself of.it will.repent
'Giovanni will be sorry for it.'

(36) *Giovanni ci* ***si*** *é arrangiato*
Giovanni there himself is managed
'Giovanni has managed it.'

The forms **sbaglia* and **pentirá* are not possible without SE; some verbs simply require SE or the equivalent nonactive marker in their language, however encoded.[1] The famous case of deponents in Latin is similar: as discussed by grammarians and by contemporary authors such as Aronoff (1994), deponents are verbs with nonactive morphology but active syntax. Although they appear with a nonactive suffix, the verbs themselves are unergative or transitive. The deponent verb *sequor* 'to follow' is syntactically transitive but has no morphologically active forms:

(37) a. Regular Latin alternation:
amo-r 'I am loved' $<$ *amō* 'I love'

b. Deponent Latin verb:
sequo-r 'I follow' $\not<$ **sequō* 'I follow'

Similar patterns are discussed for Latin, German, Greek and Icelandic by Embick (2004b), Kallulli (2013), Kastner and Zu (2015) and Wood (2015). I do not have anything theoretically impactful to say about how individual roots implement their requirement for nonactive morphology. We simply note that the theory allows such a selectional requirement to be interpreted.

2.2.1.4 Null allosemy in *hitXaY̯eZ*

I have presented inchoatives in *niXYaZ* which are not derived from underlying active verbs. Similar examples can be found in *hitXaY̯eZ*, where $\sqrt{\text{ACTION}}$ is doing its regular morphophonological work but is not available to create "intensive" verbs in *XiY̯eZ*.

1. The facts are slightly more complicated: *sbaglia* 'mistake' is possible in certain contexts but I believe that the generalization about *pentirsi* 'repent' is robust (Burzio 1986:40).

(38) *hit'alef* 'fainted' ($\not<$ **ilef* 'int. made someone faint')

$\sqrt{\text{ACTION}}$ contributes general agentive meaning. In this case, I require that the root "turn off" the semantic contribution of $\sqrt{\text{ACTION}}$, and with it the ability of $\sqrt{\text{ACTION}}$ to choose an alloseme of the root itself. Yet $\sqrt{\text{ACTION}}$ still contributes morphophonological information, as expected. This state of affairs is true for nonactive verbs such as inchoatives:

(39) a. *dani* <u>*hit'atef*</u> {*me-ha-avak* / *??be-xavana*}
Danny sneezed.INTNS.MID from-the-dust on-purpose
'Danny sneezed because of the dust/??on purpose'

b. *josi* <u>*hit'alef*</u> {*me-ha-xom* / *??be-xavana*}
Yossi fainted.INTNS.MID from-the-heat on-purpose
'Yossi fainted due to the heat/??on purpose'

Impoverishment of $\sqrt{\text{ACTION}}$ for these roots proceeds as in (40). Note that this is a case of Impoverishment in the semantics (Nevins 2015)—which operates at a distance—rather than local allomorphy or allosemy: $\sqrt{\text{ACTION}}$ is rendered null in the context of certain roots. The rule of impoverishment is given in (40a) and its effect in the semantics is shown in (40b).

(40) a. $[\![\sqrt{\text{ACTION}}]\!] \rightarrow \emptyset$ / ___ $\{\sqrt{\text{XYZ}} \mid \sqrt{\text{XYZ}} \in \sqrt{\text{prk̯}}$ 'DISMANTLE', $\sqrt{\text{bʃl}}$ 'COOK', ...$\}$

b. $[\![\sqrt{\text{ACTION}}]\!] = \lambda P.P$ / ___ $\{\sqrt{\text{XYZ}} \mid \sqrt{\text{XYZ}} \in \sqrt{\text{prk̯}}$ 'DISMANTLE', $\sqrt{\text{bʃl}}$ 'COOK', ...$\}$

There is an intuition captured by (40), namely that these roots are understood to be active (by convention). This list of roots could be simply called "Class 1", but keeping with our overarching theme of lexical and functional material, I will call them Other–Oriented roots: dismantling, cooking and so on are usually activities carried out on something else. By making this division we are able to see how the requirements of different roots are imposed at the interfaces. In this case, semantic information is relevant at Transfer to LF. I return to the derivation of other root classes in *hitXaY̯eZ* in §2.2.4, and to the question of different root classes in different structures in §2.2.6.

Turning to a possible crosslinguistic parallel, it has recently been pointed out that in some languages, verbalizing suffixes do not contribute eventive semantics in certain environments. That is, they are phonologically overt but semantically null, a slightly different situation than ours. Anagnostopoulou and Samioti (2013, 2014) document a pattern in Greek in which certain adjectives can only be derived if a verbalizing suffix is added to the root first. Crucially, there is no eventive semantics (unlike with our inchoatives); no weaving is entailed for (41) nor planting for (42). The authors suggest that *-tos* requires an eventive vP as its base, which is not possible with nominal roots like 'weave' and 'plant'.

(41) *if-an-tos* weave-VBLZ-ADJ 'woven'

(42) *fit-ef-tos* plant-VBLZ-ADJ 'planted' (Anagnostopoulou and Samioti 2014:97)

In fact, the part of the structure consisting of the root and verbalizer might not even result in an acceptable verb (Anagnostopoulou and Samioti 2014:100):

(43) *kamban-a* 'bell' ∼ ??*kamban-iz-o* 'bell (v)' ∼ *kamban-is-tos* 'sounding like a bell'

In a similar vein, Marantz (2013a) argues that an *atomized individual* need not have undergone atomization, and analyzes a similar phenomenon in Japanese "continuative" forms that must be vacuously verbalized first before being nominalized (Volpe 2005). Anagnostopoulou (2014) extends this idea of a semantically null exponent to cases like *-ify-* in *the classifieds* (but see Borer 2014 for a dissenting view).

Returning to Hebrew, we have some evidence that v and $\sqrt{\text{ACTION}}$ can be active in the phonology without selecting an alloseme of the root, deriving nonactive verbs directly from the root rather than from an existing verb. Crucially here, though, little v still introduces an event variable. This analysis leaves open the possibility of the unattested form *'ilef* in *XiY̯eZ* arising as an innovation. This does seem to be the case: although *hit'alef* 'fainted' is not derived from active **'ilef* in standard usage, for some younger speakers it is possible to say *%'ilef* to mean 'amazed' figuratively (Laks 2014).

To summarize, the nonactive structure involving $\text{Voice}_{\emptyset}$ derives anticausative verbs. In §2.2.4 I argue that this structure can also give rise to reflexive verbs, but first we will turn to active structures.

2.2.2 Active structures

The empirical puzzle of the "middle" templates *niXYaZ* and *hitXaY̯eZ* is that they allow for nonactive verbs, as seen above, as well as for active verbs. The theoretical point of interest is that these active verbs are reflexive-like in meaning, leading us to ask how different structures result in similar semantics (Myler 2014; Wood and Marantz To appear).

I first observe that these active verbs are of a very specific kind, namely volitional verbs that take a prepositional phrase as their complement. Call these verbs *figure reflexives*, following Wood (2014). Berman (1978:87) uses the term "ingression".

(44) **Figure reflexives**

a. *hitXaY̯eZ*: *hitparets le-* 'stormed into', *histare'a al-* 'stretched out over', *hit'akeʃ al-* 'insisted on', *hitnageʃ be-* 'collided with', *hitmared neged-* 'rebelled against', *hit'atsben al-* 'got mad at'.

b. *niXYaZ*: *nixnas le-* 'entered (into)', *nidxaf derex/le-* 'pushed his way through/into', *nirʃam le-* 'signed up for', *nilxam be-* 'fought (with)', *ne'exaz be-* 'held on to'.

Figure reflexives might denote an action (*hitmared neged* 'rebelled against'), motion (*histare'a al-* 'sprawled over') or psych-verb (*hit'atsben al-* 'got mad at'), but in all cases, a prepositional phrase is the obligatory complement of the verb. The structure for these constructions will involve an agent in Spec,VoiceP and a prepositional phrase complement. First, let us confirm that these verbs are active (not unaccusative).

(45) Agent-oriented adverbs are possible:

a. *ha-kelev* <u>*hitnapel*</u> *al* *ha-davar* ***be-za'am***
the-dog laid.into.INTNS.MID on the-mailman in-rage
'The dog attacked the mailman in a fit of rage.'

b. *dani* <u>*nixnas*</u> *la-kita* ***be-bitaxon***
Danny entered.MID to.the-classroom in-confidence
'Danny confidently entered the classroom.'

Figure reflexives fail the unaccusativity diagnostics.

(46) Possessive dative:
\# *ha-xatul* <u>*nixnas*</u> ***l-i*** *la-bait,* *ma* *la'asot?*
the-cat entered.MID to-me to.the-house what to.do
(int. 'My cat came into the house, what should I do?')

These examples involve somewhat delicate judgments. Hebrew allows for a dative in both possessive and "ethical dative" affected uses (Ariel et al. 2015). Example (46) is infelicitous on a reading where the cat is the speaker's. I return to the possessive dative in §2.2.5.

(47) VS order:
 # <u>*nixnes-u*</u> *ʃloʃa* *xajalim* *la-kita*
 entered.MID.3PL three soldiers to.the-classroom
 (int. 'Three soldiers entered the classroom.')

Example (47) can be interpreted as a case of "untriggered stylistic inversion", which is generally taken to be ungrammatical but can be coerced given enough prosodic work. See Shlonsky (1987) and Borer (1995).

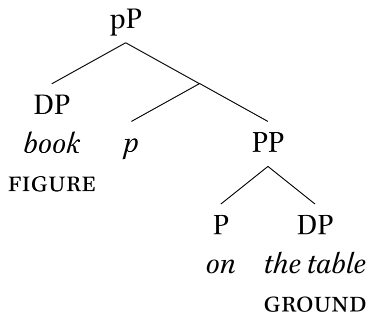
Now that we've convinced ourselves of the fact that figure reflexives are active verbs, we turn to their complements. The idea that subjects of prepositional phrases are introduced by a separate functional head was floated in one way or another by a number of authors in order to account for different phenomena (van Riemsdijk 1990; Rooryck 1996; Koopman 1997; Gehrke 2008; Den Dikken 2003, 2010). Svenonius (2003, 2007, 2010) implemented this idea with the functional head *p* (akin to Chomskyan "little v", which introduces the VP). Borrowing terminology from Talmy (2000) and earlier work, Wood (2014) calls the subject of *p* the Figure and the object of P the Ground.

The configuration of figure reflexives is one in which the head *p* introduces the subject of the prepositional phrase in its specifier, the Figure, and takes a PP consisting of the preposition P and Ground DP as its complement. It is to Wood (2014) that we also owe the term "figure reflexive", coined in his study of Icelandic *-st*. The terminology is meant to capture the Figure-like, reflexive-like interpretation of a Figure in a prepositional phrase when it is the complement of certain verbs.

I follow Wood (2015) in proposing the head $p_{\emptyset}$ which does not allow a DP to be merged in its specifier (similarly to how Voice$_{\emptyset}$ does not allow a DP in its own specifier).

(48) a. ***p*:**

p (pronounced “little p”) is the functional head licensing prepositions:



b. $[\![p]\!] = \lambda s \lambda x.\text{Figure}(x,s)$

c. $p_{\emptyset}$**:**

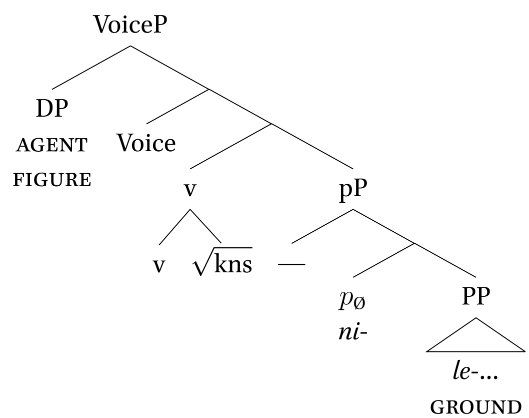
$p_{\emptyset}$ (pronounced “little p zero” or “little p minus dee”) is a *p* head with a [–D] feature, prohibiting anything with a [D] feature from merging in its specifier.

d. $[\![p_{\emptyset}]\!] = [\![p]\!] = \lambda s \lambda x.\text{Figure}(x,s)$

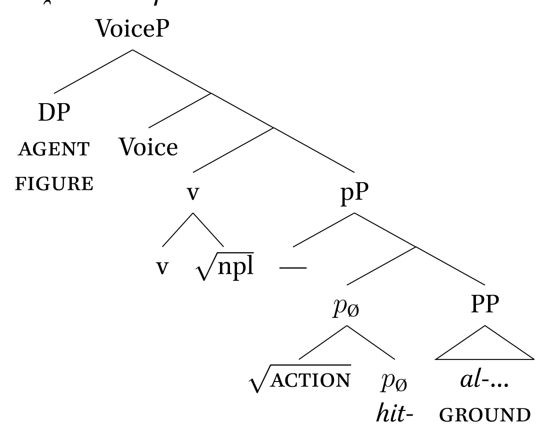
The functional head $p_{\emptyset}$ licenses the prepositional phrase which is the complement of all Hebrew figure reflexives. Since no direct objects are allowed, this functional head must head a projection that is the complement to the verb; in other words, these verbs select for an indirect, prepositional (*p*P) object but not for a direct (DP) object, (49).

As with the nonactive structures, the sole difference between *niXYaZ* in (49a) and *hitXaY̭eZ* in (49b) is that *hitXaY̭eZ* utilizes $\sqrt{\text{ACTION}}$. No DP can be merged in the specifier of $p_{\emptyset}$.

(49) a. *niXYaZ nixnas le-* ‘entered’:



b. *hitXaY̭eZ hitnapel al-* ‘laid into’:



The two main consequences of this configuration are that an external argument may be merged in Spec,VoiceP and that the obligatory prepositional phrase does not have a subject of its own. Since $p_\emptyset$ does not allow anything to be merged in its specifier, the preposition introduced by $p_\emptyset$ does not have an immediate subject. Instead, the predicate $p_\emptyset$ "waits" until the external argument is merged in Spec,VoiceP and this DP is then interpreted as the subject of the preposition. A similar phenomenon in Icelandic is analyzed by Wood (2014, 2015). Under his analysis, $p_\emptyset$ needs to assign a semantic role (Figure) to a DP, but there is no DP in its specifier. The predicate remains unsaturated, and the denotation passed on up in the derivation, until a DP is merged in Spec,VoiceP and saturates Voice and $p_\emptyset$ at the same time. See Myler (2014) and Wood and Marantz (To appear) for additional examples of this mechanism in action, which Myler terms "delayed gratification".

A semantics for (45b) is given in (50); see Wood (2014:1405) for the original derivation of figure reflexives in Icelandic. Note that $p_\emptyset$ expects a Figure semantically but does not introduce one in the syntax (Wood 2015:158). In this $p_\emptyset$ is different than Voice$_\emptyset$.

(50) a. $[\![\text{PP}]\!] = \lambda$s.in(s,room)

b. $[\![p_\emptyset]\!] = \lambda$s$\lambda$y.Figure(y,s)

c. $[\![p\text{P}]\!] = \lambda$s$\lambda$y.Figure(y,s) & in(s,room)
Via Event Identification

d. $[\![\text{v}]\!] = \lambda$e$\lambda$y$\lambda$P$\exists$s.P(y,s) & enter(e) & Cause(e,s)

e. $[\![\text{vP}]\!] = \lambda$e$\lambda$y$\exists$s.Figure(y,s) & in(s,room) & enter(e) & Cause(e,s)
Via Function Composition

f. $[\![\text{Voice}]\!] = \lambda$e$\lambda$y.Agent(y,e)

g. $[\![\text{Voice'}]\!] = \lambda$e$\lambda$y$\exists$s.Agent(y,e) & Figure(y,s) & in(s,room) & enter(e) & Cause(e,s)

h. $[\![\text{VoiceP}]\!] = [\![\text{Voice'}]\!]$(Danny) =
λe$\exists$s.Agent(Danny,e) & Figure(Danny,s) & in(s,room) & enter(e) & Cause(e,s)
"The set of entering events, for which Danny is the Agent, and which cause Danny to be in the room"

Icelandic figure reflexives also appear to be non-active in their morphophonology; see Wood (2014) for discussion of the middle-like *-st* clitic. In both languages we can account for the active semantics and the non-transitive syntax of these constructions by teasing apart the syntactic and semantic contribution of each element in the structure.

In the case of Icelandic discussed by Wood (2014), figure reflexives are introduced by $p_{\{D\}}$, a strong version of *p* requiring a DP in its specifier (compare Voice$_{\{D\}}$ in §2.3.2), with an expletive filling Spec,*p*P. Yet I have used $p_{\emptyset}$ for figure reflexives in Hebrew. The main question for these theories is whether *p* should have "active" and "non-active" variants like Voice does (in Voice$_{\emptyset}$ and Voice$_{\{D\}}$). If the Hebrew case were treated similarly to the Icelandic one, with $p_{\{D\}}$ rather than $p_{\emptyset}$, then a null expletive would be needed in the specifier of $p_{\{D\}}$. Additionally, we would lose the intuitive connection between $p_{\emptyset}$ and Voice$_{\emptyset}$ which both have the same syntax and morphophonology, a point I return to in §2.4.1.

(51) $p_{\emptyset} \leftrightarrow$ MID (First pass)

2.2.3 Interim summary: Actives and nonactives

A number of puzzles have now been addressed. These are the inability of verbs in *niXYaZ* and *hitXaY̭eZ* to take direct objects, and the fact that in their active use they must take a prepositional complement. I have observed that verbs in the "middle" templates *niXYaZ* and *hitXaY̭eZ* come in two types, one nonactive and one active.

In terms of the theory developed, we have decomposed these templates into hierarchically arranged functional heads. Anticausatives and inchoatives are nonactive (unaccusative): the sole argument is the internal argument and there is no agentive external argument. Figure reflexives are active verbs which have an agentive external argument and must take a prepositional complement. This analysis supports a specific view of argument structure which distinguishes between syntactic features, such as the requirement for a specifier, and semantic roles, such as the requirement for an Agent or a Figure.

In terms of the questions outlined in Chapter 1, I have given a formalism for the components of the template and modeled how syntax feeds into the interfaces. Reflecting on the theoretical juxtapositions, I emphasized the role of functional structure and how lexical material feeds into it. We have also begun to amass evidence against a morphemic analysis of templates: what morpheme could have as its meaning both anticausativization and figure reflexivity?

We now proceed with §2.2.4 which sketches an analysis of reflexive and reciprocal verbs. I derive these verbs based on combinations of $\text{Voice}_{\emptyset}$, $p_{\emptyset}$ and $\sqrt{\text{ACTION}}$. Additional theoretical implications are highlighted in §§2.2.5–2.2.6.

2.2.4 Reflexives and reciprocals

In what follows I turn to reflexives and reciprocals in *hitXaY̯eZ*. Closer examination of $\sqrt{\text{ACTION}}$ shows that it can be used to derive three different kinds of constructions: in active sentences with default Voice it produces agentive entailments. But it can also be used to derive reflexive and reciprocal verbs, combining with other pieces of the grammar, namely reflexives with $\text{Voice}_{\emptyset}$ and reciprocals with $p_{\emptyset}$. It has recently been proposed that dedicated reflexivizers are not necessary in order to derive reflexives in certain languages. I take this claim one step further based on Hebrew, arguing that neither dedicated reflexivizers nor dedicated reciprocalizers are necessary and that the same functional head can be used to derive both, at least in this language.

The phenomenon is as follows. The verbal template *hitXaY̯eZ* shows the same morphological marking for reflexives and reciprocals. Unlike in languages like French where *se* might be ambiguous between a reflexive and reciprocal meaning (Labelle 2008), this morphology is not ambiguous in Hebrew.

(52) French, after Labelle (2008:834):
Luc et Pierre ***se*** *<u>regardent</u>*
Luc and Pierre SE look.at-3PL
'Luc is looking at Pierre and Pierre is looking at Luc' [reciprocal]
'Luc and Pierre are looking at themselves (in a mirror)' [reflexive]

(53) French, after Labelle (2008:839):
les enfants ***se*** *sont tous soigneusement* <u>*lavés*</u>
the children SE are all carefully washed-3PL
'The children all washed each other carefully' [reciprocal]
'The children all washed themselves carefully' [reflexive]

(54) Hebrew:

a. *luk ve-pier* <u>*hitxabk-u*</u>
Luc and-Pierre hugged.INTNS.MID-3PL
'Luc and Pierre hugged each other' [reciprocal only]

b. *luk ve-pier* <u>*hitlabʃ-u*</u>
Luc and-Pierre got.dressed.INTNS.MID-3PL
'Luc and Pierre got dressed' [reflexive only]

A kissing event is typically carried out on someone else, while a dressing event is often done to oneself. So the lexical semantics of the root constrains the meaning of the resulting verb in Hebrew. But recall that a root can appear in a number of templates. The two roots in (54) can appear in other templates with non-reflexive and non-reciprocal meanings.

(55) a. $\sqrt{\text{nʃk̭}}$: *niʃek* 'kissed', *noʃak* 'was kissed', *heʃik* 'launched, interfaced with'

b. $\sqrt{\text{lbʃ}}$: *lavaʃ* 'wore', *helbiʃ* 'dressed someone up'

Having a root that is compatible with a reflexive or a reciprocal reading is not enough for the verb to be reflexive or reciprocal; both the root and the template combine to decide the meaning and argument structure of the verb. What's more, on my analysis *hitXaY̭eZ* is complex, made up of two separate morphemes plus the root. The challenge is to see whether basic syntactic-semantic elements can be combined in ways that lead to the assumed readings. And if so, the proposal should extend crosslinguistically.

I discuss reflexives in §2.2.4.1 and reciprocals in §2.2.4.2, moving on to issues of unaccusativity in §2.2.5 and the contribution of the roots in §2.2.6.

2.2.4.1 Reflexives

The argument structure of reflexive verbs has posed a long-standing puzzle: one DP seems to have two thematic roles. One part of the debate has to do with whether reflexives are unaccusative or unergative. Another has to do with whether there exist dedicated reflexivizers, operators whose sole job is to reduce the arity of a predicate. The answer may well vary by language. On the question of reflexivizers, Reinhart and Siloni (2005) answer in the affirmative for Hebrew, Lidz (2001) in the negative for Kannada. There are no dedicated reflexivizers for many other languages, including French (Labelle 2008), Greek (Spathas et al. 2015) and Latin (Kastner and Zu 2015). I present a novel analysis of Hebrew reflexives here, one that does not make use of a reflexivizer as such and that treats reflexives as unaccusative.

By "reflexive verb" I mean the following:

(56) **Canonical reflexive verb**: (i) A monovalent verb whose argument X is interpreted as both Agent and Theme, **and** (ii) where no other argument Y (implicit or explicit) can be interpreted as Agent or Theme, **and** (iii) where the structure involves no pronominal elements such as *himself*.

Hebrew reflexives are only attested in *hitXaY̯eZ*, never in *niXYaZ*.

(57) *hitXaY̯eZ*: *hitgaleax* 'shaved', *hitraxec* 'washed', *hitnagev* 'toweled down', *hit'aper* 'applied makeup', *hitnadev* 'volunteered'.

The internal argument is interpreted as coreferential with the external argument. The analysis has three components: Voice$_{\emptyset}$, $\sqrt{\text{ACTION}}$ and the root. Whatever makes *hitXaY̯eZ* different from *niXYaZ* will also need to explain why only *hitXaY̯eZ* verbs can be reflexive. I claim that this is due to added agentive semantics which *hitXaY̯eZ* has but *niXYaZ* lacks. This agentive semantics is the result of the additional root $\sqrt{\text{ACTION}}$ merging in *hitXaY̯eZ*, which also brings about the morphophonological difference between the two templates.

The root $\sqrt{\text{ACTION}}$ is attested elsewhere in the verbal system, namely in the "intensive" template *XiY̯eZ*. In (58a) both agent and cause are possible with the "simple" *XaYaZ* verb *ʃavru*, but in (58b) only the agent is available with the "intensive" *ʃibru* (in *XiY̯eZ* and analyzed as containing $\sqrt{\text{ACTION}}$). Note also the lack of spirantization ([v]∼[b]) and the different vowel patterns in the latter example. These facts are repeated in my treatment of *XiY̯eZ* in §2.3.3.

(58) a. {✓ *ha-jeladim* / ✓ *ha-tiltulim* *ba-argaz*} ***ʃav̲r-u*** *et* *ha-kosot*
the-children the-shaking in.the-box **broke.SMPL-PL** ACC the-glasses
'{The children / Shaking around in the box} broke the glasses.'

b. {✓ *ha-jeladim* / ✗ *ha-tiltulim* *ba-argaz*} ***ʃib̲r-u*** *et* *ha-kosot*
the-children the-shaking in.the-box **broke.INTNS-PL** ACC the-glasses
'{The children / *Shaking around in the box} broke the glasses to bits.' (Doron 2003:20)

The intuition for reflexives, then, is that a construction in which there is only an internal argument, but in which there is also agentive semantics, leads to an interpretation in which the internal argument is also the agent. The relevant morphemes have the following denotations:

(59) a. $[\![\text{Voice}]\!] \leftrightarrow \lambda e \lambda x.\text{Agent}(x,e)$ / ___ $\sqrt{\text{ACTION}}$

b. $[\![\text{Voice}]\!] \leftrightarrow \lambda e \lambda x.\text{Cause}(x,e)$

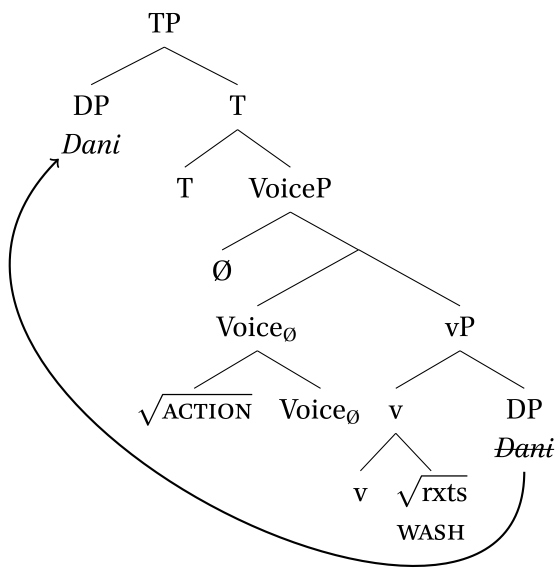
c. $[\![\text{Voice}_{\emptyset}]\!] \leftrightarrow \lambda e \lambda x.\text{Agent}(x,e)$ / ___ $\sqrt{\text{ACTION}}$

d. $[\![\text{Voice}_{\emptyset}]\!] \leftrightarrow \lambda P_{<s,t>}.P$

I propose that reflexive verbs in *hitXaY̯eZ* are the result of compatible roots merging in a nonactive structure with an action affix. Specifically, *Self-Oriented* roots combine with $\text{Voice}_{\emptyset}$ and $\sqrt{\text{ACTION}}$. In so doing I derive a constraint on what structures the syntax may generate by specifying the relevant functional heads, and explain how different roots fit into the derivation.

(60) *dani* *hitraxets*
Danny washed.INTNS.MID
'Danny washed (himself).'

(61)



(62) a. $[\![\text{v}]\!] = [\![\text{v}+\sqrt{\text{rxts}}]\!] = \lambda y \lambda e.\textit{wash}(e)$ & Theme(e,y)

b. $[\![\text{vP}]\!] = [\![\text{v}+\sqrt{\text{rxts}}]\!]$(Danny) = $\lambda e.\textit{wash}(e)$ & Theme(e,Danny)

c. $[\![\text{Voice}_Ø]\!] = [\![\text{Voice}_Ø+\sqrt{\text{ACTION}}]\!] = \lambda e \lambda x$.Agent(x,e)

d. $[\![\text{Voice}_Ø\text{'}]\!] = \lambda e \lambda x.\textit{wash}(e)$ & Theme(e,Danny) & Agent(x,e)
via Event Identification

e. *Since no argument may be merged in the specifier of Voice$_Ø$, the function is passed up:*
$[\![\text{Voice}_Ø\text{P}]\!] = \lambda e \lambda x.\textit{wash}(e)$ & Theme(e,Danny) & Agent(x,e)

f. *Using a placeholder semantics for* $[\![\text{T}]\!]$*:*
$[\![\text{T'}]\!] = \lambda x \lambda e$.wash(e) & Theme(e,Danny) & Agent(x,e) & Past(e)

g. *The internal argument raises to the specifier of T and saturates the open predicate:*
$[\![\text{TP}]\!] = [\![\text{T'}]\!]$(Danny) = $\lambda e.\textit{wash}(e)$ & Theme(e,Danny) & Agent(Danny,e) & Past(e)

The crucial points in this derivation are (62e) and (62g): when the internal argument raises to Spec,TP, say to satisfy the EPP, the derivation converges. This is a similar mechanism to that employed in the analysis of figure reflexives in §2.2.2.

In the remainder of this section on reflexives I address three issues. First, we will recall how inchoatives are derived in *hitXaYeZ* , comparing that analysis with the account of reflexives. Two conclusions will be drawn, one regarding the role of roots in the derivation and the other regarding how the syntax manipulates arguments. Second, we will address the proposed semantics of (62g) more in depth.

Third, we will consider the crosslinguistic implications of this analysis through a similar proposal made recently for Greek. With these issues behind us we will move on to reciprocals in *hitXaY̯eZ*.

Reflexives and inchoatives. As argued in §2.2.1.3, *hitXaY̯eZ* inchoatives are built using $\sqrt{\text{ACTION}}$, hence their morphophonological form. But this root cannot do its regular semantic work, otherwise we would expect an agent for inchoatives, contrary to fact. I proposed that the rule of Impoverishment in (40), repeated in (63), removes the agentivity requirement of $\sqrt{\text{ACTION}}$ for Other-Oriented roots such as $\sqrt{\text{prk̯}}$. This change renders the resulting verb *hitparek* 'fell apart' inchoative, rather than a potential reflexive 'tore himself to pieces'.

(63) $[\![\sqrt{\text{ACTION}}]\!] = \lambda P.P$ / ___ $\{\sqrt{\text{XYZ}} \mid \sqrt{\text{XYZ}} \in \sqrt{\text{prk̯}}$ 'DISMANTLE', $\sqrt{\text{bʃl}}$ 'COOK', ...$\}$

I suggested that roots like $\sqrt{\text{prk̯}}$ and $\sqrt{\text{bʃl}}$ are Other-Oriented in their lexical semantics while the complement set is Self-Oriented: showering, shaving and so on are normally actions that one performs on oneself (Alexiadou 2014b). Importantly, the influence of these roots only holds at the interface with semantics; (63) is a rule operating on semantic interpretation, not syntax. To the extent that the semantics of roots influences the structures they may appear in—as I have now argued for *hitXaY̯eZ*—this proposal allows us to constrain the power of roots and where they may exert it. This type of argument will be found throughout the chapter, recapitulated in §2.2.6.

Next, what of the syntactic difference? The derivation of inchoatives and reflexives in *hitXaY̯eZ* is not identical. For inchoatives, the internal argument may either stay low or raise to Spec,TP, as is usually the case with unaccusatives in Hebrew (the details are given in §2.2.5 below). But the reflexive internal argument must raise if the derivation is to converge; if it does not, no argument satisfies the Agent role and the derivation crashes at the interface with LF.

I have not given an explicit account of the optionality of movement for inchoative arguments. This, I believe, is a challenge for all research on unaccusativity. In some languages the argument of an unaccusative may either stay low or raise, with no apparent difference in interpretation. How does one account for this optionality? I return to examples like (64) in §2.2.5.

(64) a. [*Molti esperti*]$_i$ *saranno invitati* __$_i$
many experts will.be invited
'Many experts will be invited.' ITALIAN

b. *Saranno invitati* [*molti esperti*]
will.be invited many experts
'Many experts will be invited.' (=a)

Reflexive semantics. In the derivation in (61)–(62), the internal argument raises to Spec,TP in order to be interpreted twice: once as Theme and once as Agent. I contend that this is a better way of deriving reflexives than the traditional mechanisms. This analysis is contrasted with the silent anaphor approach (Heim and Kratzer 1998), though the same problems arise for other alternatives such as arity reducers (Szabolcsi 1992; Reinhart and Siloni 2005) and the **z**-Combinator (Jacobson 1999).

My analysis faces a potential weakness when considering quantificational subjects. Assuming that bound variables are interpreted in their base-generated positions, the semantics of (65) wrongly generates the possibility that each boy shaved another boy, such that in total every boy shaved one other boy.

(65) *kol ha-ne'arim hitgalx-u* ~~*kol ha-ne'arim*~~
all the-youngsters shaved-3PL
'All the boys shaved.' $\forall x[boy(x) \rightarrow shaved(x,x)]$
*'All the boys shaved all the boys.' $\forall x \forall y[boy(x) \& boy(y) \rightarrow shaved(x,y)]$

It seems, then, that my semantics requires an additional amendment. Perhaps it will be possible to QR the quantifier independently of the restrictor, as suggested to me by Adrian Brasoveanu and Dylan Bumford (p.c); I will not develop the intuition here.

On the silent anaphor approach (Heim and Kratzer 1998), a silent *pro* (or similar reflexive pronoun) is the internal argument of a reflexive verb and the problem of quantifiers does not arise. The high quantifier simply binds its lower variable. Yet this approach fails already with non-quantified reflexives:

it assumes a covert object but the direct object marker *et* does not appear after the verb. Furthermore, it is unclear why this silent pronoun should be possible only in reflexive environments. Why can it not be used as an object in other templates, for example in *XaYaZ* and *heXYiZ*?

(66) a. *ha-jeladim*$_i$ <u>*axl-u*</u> (***pro***$_i$)
the-children ate.SMPL-3PL
'The children ate.'
(*'The children ate themselves')

b. *ha-jeladim*$_i$ <u>*hexmits-u*</u> (***pro***$_i$)
the-children missed.CAUS-3PL
'The children missed.'
(*'The children missed themselves')

Something special would have to be said about Voice$_{\emptyset}$ and $\sqrt{\text{ACTION}}$, i.e. about *hitXaYeZ*, where my account strives for compositionality across templates: the syntax, semantics and phonology of both Voice$_{\emptyset}$ and $\sqrt{\text{ACTION}}$ are consistent in different derivations. There is one choice point at which a root-specific interpretation applies in order to distinguish inchoatives from reflexives, but otherwise the system proceeds as expected.

Another alternative would be to suggest that *hitXaYeZ* is a reflexivizer (Reinhart and Siloni 2005). As alluded to at the beginning of this section, such a proposal would give up on any attempt to explain why it is precisely *hitXaYeZ* (and not any other template) in which reflexive verbs appear: why is the reflexivizer the same form as a reciprocalizer and an anticausativizer, and why the form with a prefix and non-spirantization? Importantly, this template is morphophonologically complex (prefix and de-spirantization) and also semantically complex. I have tied the two together by implicating two functional heads in the structure.

The differences between the semantic approaches are summarized in (67). On balance, it appears that *something* special needs to be said about reflexives within the VoiceP domain, but at least for the Hebrew case my proposal requires fewer stipulations.

(67) Reflexivity in *hitXaɌeZ*: strengths and weaknesses of different frameworks.

	Current system	Traditional approaches (Szabolcsi 1992; Heim and Kratzer 1998; Jacobson 1999)
Mechanism	Movement	Silent reflexive anaphor Arity reduction (reflexivizer) z-Combinator (reflexivizer)
Pros	No reflexivizers Compositional heads	Standard
Cons	Quantifiers	Stipulated reflexivizers Cross-templatic overgeneration Additional assumptions required

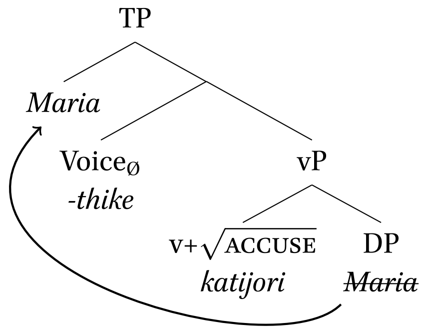
Synthesizing these different approaches is a goal for the next stage of this project. It has been suggested to me by a number of semanticists working within the Continuations framework (Barker and Shan 2015) that Continuations should be able to capture the necessary semantic conditions for these derivations. The implementation remains to be worked out.[2]

Greek reflexives. This analysis of *hitXaɌeZ* reflexives is similar to a recent analysis of reflexive verbs in Greek; the overall inventory of functional heads in fact predicts that such cases should exist. In work on this construction, Alexiadou and Schäfer (2013), Alexiadou (2014b) and Spathas et al. (2015) argue that these reflexives are the result of combining two morphemes with the root: a Middle Voice head and the bound anti-assistive intensifier *afto-*. Greek Middle Voice is typical of anticausative, passive and middle verbs in the language, similar to Voice$_{\emptyset}$ (Alexiadou and Doron 2012).

(68) Medio-passive:

a. *I* *Maria* *katijori-**thike***
the Maria accused-NACT.3SG
'Maria got accused', 'Maria was accused.' GREEK

2. For their insightful comments on this issue and for their patience I am grateful to Dylan Bumford and Lucas Champollion.

b. 

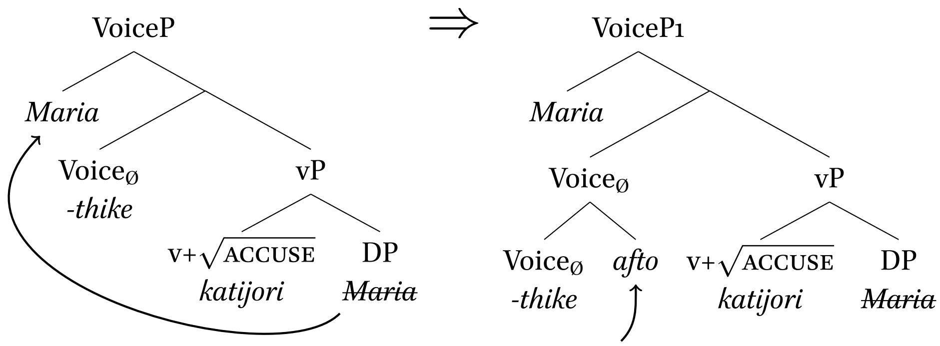
For certain roots, a reflexive can be built on the basis of medio-passives like (68). The reflexive construction is derived using *afto*-, an "anti-assistive intensifier" similar to √ACTION and to English non-reflexive *herself*, as in (69).

(69) She built the house **herself**$_{\text{anti-assistive}}$.

According to Spathas et al. (2015), the Greek equivalent of $\text{Voice}_{\varnothing}$ blocks an external argument from being merged in its specifier, but the internal argument is allowed to undergo A-movement to Spec,Middle VoiceP. The prefix *afto*- then "tucks in" and adjoins to Middle Voice.

(70) Reflexive:

a. *I* *Maria* ***afto**-katijori-thike*
the Maria self-accused-NACT.3SG
'Maria accused herself.' GREEK

b. 

In the semantics, *afto* states that its associate (the internal argument, the only argument DP in the structure) is the only Agent in every sub-event of the event, so that Agent and Theme end up being coreferential. The thematic roles are invoked in the interpretation but are not part of the lexical specification of the predicate like θ-roles were. The denotations in (71) are adapted from Spathas et al. (2015:1330,1332,1335).

(71) a. $[\![\text{VoiceP}]\!] = \lambda e.\exists x.accuse(e)\ \&\ \underline{\text{Theme}(\textbf{Mary},e)}\ \&\ \text{Agent}(x,e)$ (124c)

b. *The internal argument undergoes A-movement. Important assumption: A-movement creates a derived predicate, inserting the variable binder λy. Attributed to Heim and Kratzer (1998) and Nissenbaum (2000).*
$[\![\text{VoiceP1}]\!] = \underline{\lambda y}\lambda e.\exists x.accuse(e)\ \&\ \underline{\text{Theme}(y,e)}\ \&\ \text{Agent}(x,e)$ (126)

c. $[\![afto_{\text{anti-assistive}}]\!] = \lambda f\lambda y\lambda e.f(y,e)\ \&\ \forall e'\forall x.(e'\leq e\ \&\ \text{Agent}(x,e')) \rightarrow x{=}y$ (147)

d. $[\![\text{VoiceP1} + afto]\!] = \lambda y\lambda e.\exists x.accuse(e)\ \&\ \text{Theme}(y,e)\ \&\ \text{Agent}(x,e)\ \&$
$\forall e'\forall x.(e'\leq e\ \&\ \text{Agent}(x,e')) \rightarrow x{=}y$ (128)

e. $[\![\text{VoiceP1} + afto]\!]\underline{(\text{Mary})} = \lambda e.\exists x.accuse(e)\ \&\ \underline{\text{Theme}(\text{Mary},e)}\ \&\ \text{Agent}(x,e)\ \&$
$\forall e'\forall y.(e'\leq e\ \&\ \overline{\text{Agent}(y,e')}) \rightarrow y{=}\text{Mary}$ (135)
"[A] description of events of someone accusing Mary such that Mary is the agent in all subevents of that event. This is a reflexive interpretation."

To reiterate, there is no dedicated reflexivizer in this structure, though as the authors show, these verbs are reflexive. The two affixes NACT (Middle Voice ≈ $\text{Voice}_{\emptyset}$) and *afto-* (anti-assistive ≈ $\sqrt{\text{ACTION}}$) achieve this result: the former by restricting the number of arguments in the clause and the latter by specifying that the existing argument is the only Agent.

Nevertheless, this kind of derivation also depends on the lexical semantics of the root. *Afto-*reflexives are only possible with *Other-Oriented* roots like $\sqrt{\text{ACCUSE}}$. Nonactive verbs derived from these roots using $\text{Voice}_{\emptyset}$ receive some non-reflexive interpretation consistent with the root (anticausative, passive, etc). It is only in combination with *afto-* that the internal and external arguments are forced to be coreferential, leading to a reflexive interpretation. With Self-Oriented roots like $\sqrt{\text{WASH}}$, on the other hand, it suffices to merge Middle Voice for a reflexive reading to arise (Alexiadou 2014b).

Let us highlight a number of differences between the analysis of Greek and the analysis of Hebrew. In all cases, the differences are expressed in terms that are by now familiar in the current framework: the vocabulary we have developed for discussing functional heads and their interaction with roots allows us to pinpoint the differences between the languages.

- Greek *afto- only* attaches to Middle Voice, whereas Hebrew $\sqrt{\text{ACTION}}$ attaches to Voice or $\text{Voice}_{\emptyset}$.

- Greek Middle Voice is *only* compatible with Other-Oriented roots, whereas Hebrew Voice$_{\emptyset}$ combines with all roots.
- Greek *afto-* uses counter-cyclic attachment.

The last difference is a matter of technical preference, I believe. The first two will be revisited in §2.4.1, where we consider the resulting typology of heads and constructions.

In this section we applied similar logic to Greek and to Hebrew in order to explain why *hitXaY̯eZ* is the only template that allows reflexive verbs and why *afto-* combines with a nonactive suffix to derive reflexives: these are the structures which combine a head preventing the merger of a disjoint external argument (Voice$_{\emptyset}$), on the one hand, with an agentive modifier ($\sqrt{\text{ACTION}}$) on the other. Nonactive verbs in *niXYaZ*, for example, only have Voice$_{\emptyset}$ and so receive different nonactive interpretations (anticausative, inchoative) but do not have a functional head forcing its associate to be the agent, as is true of reflexives.

No other analysis of Hebrew that I know of goes beyond stipulating that *hitXaY̯eZ* is the template for reflexive verbs and *niXYaZ* is not (Reinhart and Siloni 2005; Siloni 2012; Bar-Asher Siegal 2015b). If the current approach is on the right track we will be in a better position to understand how syntactic structure feeds the semantics and how these combinations are signaled by the morphology. The claim would be even more forceful if a parallel analysis using similar building blocks can be given for reciprocals, as I attempt to do next.

2.2.4.2 Reciprocals

In this section I sketch an analysis of reciprocals which proceeds in similar fashion to the analysis of reflexives just given. I will stop short of a comprehensive account, though, leaving the final tweaks to future work. The empirical issue is similar to that of reflexives. Namely, the *hitXaY̯eZ* template—but not *niXYaZ* or any other—allows for reciprocal verbs, where by "reciprocal" I mean the following:

(72) **Canonical reciprocal verb:** (i) A verb whose arguments are interpreted as both Agents and Themes of the event, (ii) **and** where each such event is symmetric, i.e. all arguments are simultaneously Agents and Themes, (iii) **and** where the construction involves no pronominal elements such as *each other*.

Dimitriadis (2008:378) puts it as follows: "*A predicate is irreducibly symmetric if* (*a*) *it expresses a binary relationship, but* (*b*) *its two arguments have necessarily identical participation in any event described by the predicate*".

Like reflexives, reciprocals are found in *hitXaY̭eZ*.

(73) *hitnašek im-* 'kissed (with)', *hitxabek im-* 'hugged (with)', *hitkatev im-* 'corresponded (with)', *hitvakeax im-* 'argued (with)'.

Reciprocal constructions clearly require two distinct arguments; this cannot be achieved in a nonactive structure but only in an active one and reciprocals do appear to be active crosslinguistically (Siloni 2012).

The syntactic analysis is essentially the same as with figure reflexives: the internal argument is merged as the complement of P and the external argument in Spec,VoiceP, then interpreted as coreferential with the specifier of $p_{\emptyset}$. This analysis captures the fact that arguments of reciprocal verbs can be introduced by a preposition in Hebrew, namely *im-* 'with'. This construction has been called the "discontinuous reciprocal".

But discontinuous reciprocals are not the only kind. Dimitriadis (2008), Rubinstein (2009) and others have distinguished group reciprocals, (74a), from discontinuous reciprocals, (74b).

(74) a. **Group:** *John <u>and</u> Bill kissed.*
b. **Discontinuous:** *John corresponded <u>with</u> Bill.*

The two constructions are not equivalent, (75)–(76), but in Hebrew virtually any reciprocal predicate can be used in both constructions, (77).

(75) a. *John **and** Bill married.*
b. **John married **with** Bill.*

(76) a. *John **and** Bill kissed.*

b. ?*John hugged **with** Bill.*

(77) The two constructions appear interchangeable in Hebrew:

a. *dan* ***ve**-josi* <u>*hitnaʃku*</u>
Dan and-Yossi kissed.RECIP

b. *dan* <u>*hitnaʃek*</u> ***im*** *josi*
Dan kissed.RECIP with Yossi
'Dan and Yossi kissed.'

Both constructions are **symmetric** (Dimitriadis 2008; Siloni 2012) in that the two participants are both agents, (72i–ii), but group reciprocals more strongly so. In group reciprocals both participants appear to be equally volitional or agentive, (78). Discontinuous reciprocals allow for one participant to be more agentive than the other, (79). Similar claims are put forward by Bar-Asher Siegal (2015a,b), supported by a wealth of naturally occurring online data in Hebrew.

(78) Group reciprocals require strong symmetry:
maradona* ***ve-ha-kir* <u>*hitmasru*</u> (*exad im ha-ʃeni*)
Maradona and-the-wall passed.RECIP one with the-other
(int. 'Maradona and the wall passed the ball to each other')

(79) Discontinuous reciprocals allow weaker symmetry:

a. *dani* <u>*hitvakeax*</u> (*be-je'uʃ* / *ka'as*) ***im*** *josi*
Danny argued.RECIP in-despair anger with Yossi
'Danny$_i$ argued with Yossi$_j$ full of despair/anger$_{i/?j}$.'

b. *maradona* <u>*hitmaser*</u> ***im*** *ha-kir*
Maradona passed.RECIP with the-wall
'Maradona passed the ball to himself off the wall'

As Bar-Asher Siegal (2015a) puts it: "*The reciprocal reading is merely when all members of the set denoted by the subject are understood to participate in the same event and that all participants in that event are of the same set.*" This brings us back to our original question: does reciprocality come from the root, from the structure or from *im* 'with'?

A full paradigm serves to illustrate. The prepositional object is obligatory with reciprocal verbs, (80)–(81). Group reciprocals are allowed, (82). A direct object is not licensed, (83).

(80) *dani* *hitnaʃek* ***im*** *josi*
Dani kissed.INTNS.MID with Yossi
'Danny and Yossi kissed'

(81) * *dani* *hitnaʃek*
Dani kissed.INTNS.MID
'Danny kissed'

(82) *dani* *ve-josi* *hitnaʃk-u*
Dani and-Yossi kissed.INTNS.MID-3PL
'Danny and Yossi kissed'

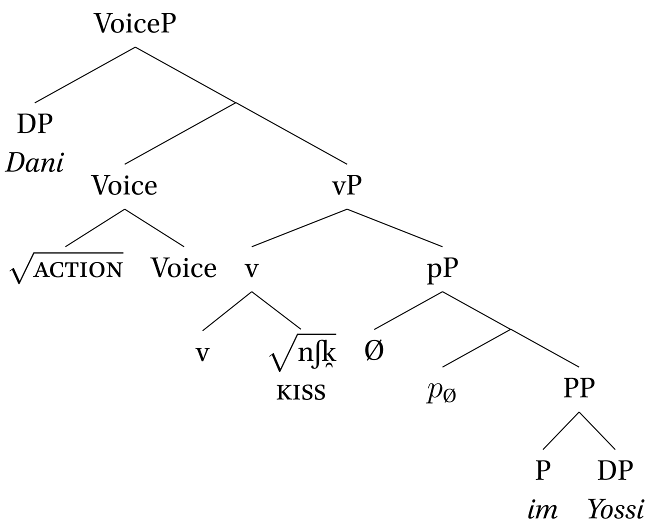
(83) * *dani* *ve-josi* *hitnaʃk-u* ***et*** {*dina* / *ha-klavlav*}
Dani and-Yossi kissed.INTNS.MID-3PL ACC Dina the-puppy
(int. 'Danny and Yossi kissed each other and also Dina/the puppy')

We start with **discontinuous reciprocals**. An analysis of reciprocal *hitXaY̯eZ* verbs as a kind of figure reflexive captures two fundamental facts about them: that they are volitional (agentive external argument with $\sqrt{\text{ACTION}}$) and that they require a prepositional object (complement of $p_{\emptyset}$). Recall our discussion of the roots that can take part in these constructions: the reciprocal reading comes about as a result of the root being naturally reciprocal rather than naturally disjoint, taking another actor as its complement. For instance, both the agent and another participant are usually required for acts of meeting and kissing. In contrast, figure reflexives have roots which are naturally disjoint: attacking (45a) and entering (45b) are not things that one usually does on oneself.

In the discussion of reflexive verbs in §2.2.4.1 I provided an explanation for why reflexives are licensed in *hitXaY̯eZ* but not in *niXYaZ* or any other template. This generalization turned out to be the result of the interaction of Voice$_{\emptyset}$ and $\sqrt{\text{ACTION}}$. We are now in a position to apply similar logic to reciprocals, with $p_{\emptyset}$ taking the place of Voice$_{\emptyset}$. The derivation is as follows, with the resulting VoiceP being reciprocal.

(84) *dani* *hitnaʃek* *im* *josi*
Danny kissed.INTNS.MID with Yossi
'Danny kissed Yossi', 'Danny was kissing with Yossi.'

(85)



(86) a. $[\![p_{\varnothing}]\!] = \lambda s\lambda y.\text{Figure}(y,s)$

b. $[\![p\text{P}]\!] = \lambda s\lambda y.\text{Figure}(y,s)\ \&\ \text{with}(s,\text{Yossi})$ *Via Event Identification*

c. $[\![\text{v}]\!] = [\![\text{v}+\sqrt{\text{nʃk̯}}]\!] = \lambda e\lambda y\lambda P\exists s.P(y,s)\ \&\ \textit{kiss}(e)\ \&\ \text{Cause}(e,s)$

d. $[\![\text{vP}]\!] = [\![\text{v}+\sqrt{\text{nʃk̯}}]\!](\text{with Danny}) = \lambda e\lambda y\exists s.\text{Figure}(y,s)\ \&\ \text{with}(s,\text{Yossi})\ \&\ \textit{kiss}(e)\ \&\ \text{Cause}(e,s)$
Via Function Composition

e. $[\![\text{Voice} + \sqrt{\text{ACTION}}]\!] = \lambda e\lambda x.\text{Agent}(x,e)$

f. $[\![\text{Voice'}]\!] = \lambda x\lambda y\lambda e\exists s.\text{Agent}(x,e)\ \&\ \text{Figure}(y,s)\ \&\ \text{with}(s,\text{Yossi})\ \&\ \text{kiss}(e)\ \&\ \text{Cause}(e,s)$

g. $[\![\text{VoiceP}]\!] = [\![\text{Voice'}]\!](\text{Danny}) =$
$\lambda e\exists s.\text{Agent}(\text{Danny},e)\ \&\ \text{Figure}(\text{Danny},s)\ \&\ \text{with}(s,\text{Yossi})\ \&\ \text{kiss}(e)\ \&\ \text{Cause}(e,s)$

This kind of analysis is meant to bring out the intuition that in discontinuous reciprocals the external argument is more strongly volitional than the prepositional object. The semantics of the *with*-phrase remains to be cashed out.

Group reciprocals will require a slightly different account since there is no *with*-phrase. It remains to be seen whether the semantics previously proposed for English examples like (75)–(76) can be carried over to Hebrew.

(87) *dani* *ve-josi* *hitnaʃk-u*
Danny and-Yossi kissed.INTNS.MID-3PL
'Danny and Yossi kissed.'

Returning one last time to the comparison between *hitXaY̯eZ* and *niXYaZ*, we predict that there will not be a reciprocal reading for *niXYaZ*, regardless of prepositions. This is correct: singular objects in *niXYaZ* do not entail reciprocality, (88), and plural subjects must have reciprocality brought about by another element such as *exad la-ʃeni* 'to each other', (89).

(88) *dani nikʃar **le**-josi (aval le-josi lo haya expat)*
Danny tie.MID to-Yossi but to-Yossi NEG was care
'Danny grew attached to Yossi (but Yossi didn't care about Danny).'

(89) a. *dani **ve**-josi nikʃer-u*
Danny and-Yossi tie.MID-3PL
'Danny and Yossi were tied up.' [literal, nonactive]

b. *dani **ve**-josi nikʃer-u **exad la-ʃeni***
Danny and-Yossi tie.MID-3PL one to.the-other
'Danny and Yossi grew attached to each other' [reciprocal]
'Danny and Yossi were tied up together' [literal]

In this section and in §2.2.4.1 I have described what a compositional semantics for reflexives and reciprocals should look like, based on the syntactic structures proposed earlier on in this chapter. The empirical puzzle revolves around the same morphological marking appearing on both reflexives and reciprocals (and certain unaccusatives). I took this pattern to indicate syntactic commonalities and divergences, cashed out using the functional heads Voice$_{\emptyset}$ and $p_{\emptyset}$ and the root $\sqrt{\text{ACTION}}$. We now turn to some additional theoretical considerations that this kind of analysis raises.

2.2.5 Between unaccusativity and agentivity

The analysis of reflexive verbs in this chapter treats them as unaccusative, although I have not shown whether they pass unaccusativity diagnostics. They do not:

(90) Possessive dative:
#ʃloʃa xatulim hitkalx-u l-i mitaxat la-xalon
three cats showered.INTNS.MID-3PL to-me under to.the-window
(int. 'My three cats washed themselves under the window.')

(91) Verb-Subject order:

# *hitkalx-u*	*ʃloʃa*	*xatulim*	*mitaxat*	*la-xalon*
showered.INTNS.MID-3PL	three	cats	under	to.the-window

(int. 'Three cats washed themselves under the window.')

On the face of it, the analysis of reflexives as underlying unaccusatives cannot be correct if reflexives fail unaccusativity diagnostics. But this conclusion is not necessary. My plan of attack consists of two parts: first, to revisit the diagnostics themselves and question whether they can deliver a decisive verdict on the unaccusativity of a construction. Then, to consider what the argument structure of reflexives is like and argue for a difference between deep unaccusativity and surface unaccusativity which ultimately supports my analysis.

The **possessive dative** has recently been re-characterized by Gafter (2014a) and Linzen (2014, To appear) as a diagnostic of saliency or animacy rather than unaccusativity. Gafter (2014a) gives the following contrast by way of example:

(92) a.

ha-karborator	*neheras*	*le-dan*
the-carburetor	ruined.MID	to-Dan

'Dan's carburetor got ruined.'

b.

* *ha-karborator*	*neheras*	*la-mexonit*
the-carburetor	ruined.MID	to.the-car

(int. 'The car's carburetor got ruined.')

The animate possessor in (92a) is acceptable, but the inanimate possessor in (92b) is not. Taking these kinds of data as his point of departure, Gafter conducted a rating study to test whether the prominence of the possessor was the crucial factor driving grammaticality in the possessive dative, where prominence is defined both in terms of animacy and definiteness. The experiment bore out this prediction.

In a reflexive construction such as that in (90), the to-be-possessed argument ('cats') is animate since it is the agent of a reflexive predicate. As Gafter shows, this is a case where acceptability of possessive datives suffers when both possessor and possessee are animate and salient in the discourse.

A prediction made by this account is that a 3rd person possessive dative should not be possible with a 1st person possessee (as pointed out to me by Stephanie Harves). This seems to be correct:

(93) * *niftsa-ti* *la-kvutsa*
injured-1SG to.the-team
(int. 'I got injured, and I was part of the team.')

These findings provide us with an out by denying the applicability of the diagnostic: if the possessive dative is not really an unaccusativity diagnostic, then the fact that reflexives do not pass it may be interesting in its own right but does not argue against an unaccusative analysis.

Verb-Subject order has gone unchallenged as a diagnostic and, as just mentioned, it is not possible with reflexives, (91). As with the possessive dative, however, we should ask what the diagnostic is actually diagnosing. In the analysis of reflexives proposed here the internal argument undergoes A-movement to Spec,TP and ends up higher than its base-generated position, as in (61). It is likely that VS order only diagnoses surface unaccusativity, that is, a structure in which the internal argument remains in its base-generated position.

Let us take a moment to recall the difference between the two (Levin and Rappaport Hovav 1995). It has been proposed that the subjects of "deep" unaccusatives originated as internal arguments but have moved to subject position, while "surface" unaccusatives remain in their low, base-generated position.

(94) The internal argument in unaccusative structures:

	Surface position	Base-generated ("deep") position
Surface unaccusative	Complement of v	Complement of v
Deep unaccusative	Spec,TP	Complement of v

Italian *ne*-cliticization (Burzio 1986) is a surface diagnostic since the object out of which the clitic *ne* 'of them' is extracted must remain in its original position:

(95) a. Baseline example:
[*Molti* *esperti*] *saranno* *invitati* ___
many experts will.be invited
'Many experts will be invited.'

b. *Ne*-cliticization allowed out of a surface object:
<u>*Ne*</u> *saranno* *invitati* [*molti* ___]
of.them will.be invited many
'Many of them will be invited.'

c. * *Ne*-cliticization disallowed out of a moved, "deep" object:

[*Molti* ___] *ne* *saranno* *invitati*
many of.them will.be invited
(int. 'Many of them will be invited.')

See Burzio (1986:23) and Irwin (2012:32) for additional discussion.

In English, the resultative construction is taken to be a canonical "deep" unaccusativity diagnostic (Levin and Rappaport Hovav 1995; Irwin 2012:64). Only change-of-state verbs may participate (96a), the argument may raise to subject position (96b), but it cannot remain low if it is the only argument in the clause (96c):

(96) a. John froze/*moved the matcha ice cream solid.
b. [The matcha ice cream] froze ___ solid.
c. * Froze [the matcha ice cream] solid.

The subject in (96b) started off as the internal argument. Example (96c) shows a "surface" unaccusative object failing a "deep" unaccusativity diagnostic.

Here is what is at stake: if VS order in Hebrew is a "surface" unaccusativity diagnostic, then this would explain why reflexives do not pass it – the internal argument has moved out of the VP and into subject position. Unfortunately, there is little additional evidence for or against the claim that VS order in Hebrew is a "surface" unaccusativity diagnostic. Instead, we must leave this as a conjecture and explore whether it opens up a fruitful line of inquiry. To do this, we move away from Hebrew once more.[3]

In their discussion of Greek, Alexiadou and Schäfer (2013) and Alexiadou (2014b) apply various unaccusativity diagnostics to reflexives and conclude that these verbs do not unambiguously pass or fail them. That is, reflexives pass some unergativity diagnostics and some unaccusativity diagnostics. The authors interpret these results as indicating that Greek reflexives do have an internal argument that undergoes some change of state. As Embick (2004b:142) put it in his own discussion, "[*T*]*he unaccusative analysis of reflexives holds that reflexives and unaccusatives have some properties in common; not that they are identical.*"

3. Word order cannot be used as a diagnostic for height in this case since adverbs follow the verb in Hebrew.

It could thus be the case that the broad notion of "unaccusativity" is not enough to describe reflexives in Hebrew and Greek (and is too broad in general for other phenomena: Irwin 2012; Alexiadou 2014a). If unaccusativity means that the surface subject started off as the internal argument, then surface unaccusativity diagnostics might not identify reflexive structures in which the internal argument raised to subject. The debate on unaccusativity of reflexives goes back at least to Kayne (1975) and Marantz (1984); see Chierchia (2004), Doron and Rappaport Hovav (2009) and Sportiche (2014) for recent contrasting views.

To test the possibility that reflexivity has been misdiagnosed, one would need to examine languages such as Russian and Icelandic which mark reflexivity using a morpheme akin to $\text{Voice}_{\emptyset}$—as Greek does—in order to see if reflexives in these languages fail surface unaccusativity tests as well.

2.2.6 The right root in the right place

Before concluding this discussion of middle morphology I address the question of which roots can be embedded in different contexts: if root A can be embedded in an anticausative structure and root B in a figure reflexive, is it necessary to postulate different structures or would it be simpler to adopt a lexicalist notion in which each verb projects its own argument structure?

Put differently, the structures I provided above are not enough in and of themselves to derive the exact typology of verbs in *niXYaZ* and *hitXaY̯eZ*. We must also know which root goes in which structure. The functional heads interact with the lexical semantics of the root, constraining the meaning of the resulting verb but not dictating it. For example, the difference between a reciprocal verb and a figure reflexive is not in the structure but in the type of root: there is something inherently reciprocal about kissing (*hitnaʃek* 'kissed') whereas rebelling against someone is inherently disjoint (*hitmared neged* 'rebelled against'). Similarly, not every root can give rise to a reflexive interpretation when combined with $\sqrt{\text{ACTION}}$ and $\text{Voice}_{\emptyset}$.

Conceptual distinctions must be made between different kinds of roots (as with the ontologies proposed by Anagnostopoulou and Samioti 2014 and Levinson 2014). Following Alexiadou (2014b), I make a distinction between *naturally reflexive* roots and *naturally disjoint* roots. These are not syntactic notions but semantic ones, and their purpose is to give us tools with which to discuss different interpretations of verbal structures. Table 2.3 summarizes the different readings that emerge in *hitXaY̭eZ*.[4]

	Naturally reflexive root	Naturally disjoint root
Nonactive, $\sqrt{\text{ACTION}}$ + Voice$_{\emptyset}$	Reflexive	Anticausative / inchoative
Active, $p_{\emptyset}$ + $\sqrt{\text{ACTION}}$	Reciprocal	Figure reflexive

Table 2.3: A typology of verbs in *hitXaY̭eZ*.

There are two dimensions to Table 2.3: rows distinguish the two structures. Columns distinguish the conceptual kinds of roots just discussed. We ask whether a given root can participate in either or both rows, and in either or both columns. The theory predicts that roots can be in the same column (different structures for the same root) but not in the same row (different root classes are not possible for the same root).

The division of rows is syntactic: active and nonactive structures are different. That being the case, we expect that a root should be able to participate in either structure (but not that it must). For example, *break* in English can be part of a causative construction or an inchoative construction (regardless of whether one employs a theory in which the two are underlyingly the same structure). Since the root is a syntactic element, it can in principle be merged in the appropriate place in the syntax. This view predicts that we should find alternations within a given template: one root might be nonactive in one context and active in another context. This appears to be correct: we have discussed the behavior

4. Alexiadou (2014b) actually suggests a tripartite division based mostly on Dutch, in which some roots are inherently reflexive (e.g. $\sqrt{\text{SHAME}}$), some naturally reflexive/reciprocal (e.g. $\sqrt{\text{WASH}}$) and some naturally disjoint (e.g. $\sqrt{\text{HATE}}$). I will make do with a binary distinction.

of a figure reflexive like *nixnas le-* 'entered'. Figure reflexives are active constructions, (97a). However, the same root in the same template can be derived as a nonactive verb in the right context, (97b).

(97) a. *gilad nixnas la-bait ha-xadaʃ be-ga'ava / be-bitaxon*
Gilad entered.MID to.the-house the-new in-pride in-confidence
'Gilad entered the new house with pride/confidence.'

b. *nixnas l-i maʃeu la-ain* (**be-xavana*)
entered.MID to-me something to.the-eye in-purpose
'I got something in my eye.'

The construction in (97b) is nonactive: note the verb-initial order and the disallowed agent-oriented adverb.

To take another example, *hitpotsets* 'exploded' is the anticausative variant of *potsets* 'detonated'. In an active (figure reflexive) context it takes on the figurative meaning of 'lash out at' or, often in sports contexts, 'let loose against', (98a). This construction resists the unmarked VS order typical of nonactives, (98b).

(98) a. *katan hitpotsets al hapoel ba-misxak etmol* (*kmo ʃe-hu tamid xalam*)
Katan exploded.INTNS.MID on Hapoel in.the-game yesterday like COMP-he always dreamed
'Katan demolished the Hapoel team in yesterday's match (just like he always dreamed about)'.

b. # *hitpotsets katan al hapoel ba-misxak etmol*
exploded.INTNS.MID Katan on Hapoel in.the-game yesterday
(int. 'Katan demolished the Hapoel team in yesterday's match')

Regardless of the identity of the root, then, it can be inserted in different syntactic contexts, as predicted. The question of rows in Table 2.3 has been addressed.

Now to the question of columns and to the claim that roots belong to different ontological types. Compare $\sqrt{\text{ptsts}}$ EXPLODE with $\sqrt{\text{lbʃ}}$ WEAR: inserted into the nonactive context in (99), the former gives rise to anticausative *hitpotsets* and the latter to reflexive *hitlabeʃ*.

(99) $[_{\text{VoiceP}} \sqrt{\text{ACTION}}\ \text{Voice}_{\emptyset}\ [_{\text{vP}}\ \text{v}\ [\ \text{v} \sqrt{\text{root}}\ ]\ \text{DP}]]]$

As discussed earlier, there is little syntactic difference between the two. Canonical reflexives in Hebrew have the same structure as canonical anticausatives, save for obligatory A-movement. The only reason to even give these constructions different names is that they do not behave the same with respect to certain diagnostics due to the fact that their meanings are different, a fact which implicates semantic rather than syntactic differences.

Interestingly, the resulting generalization is one-way (and compare the discussion in Alexiadou 2014b): naturally disjoint roots can be treated as reflexive in the right context, (100), but naturally reflexive roots cannot be interpreted as disjoint, (101).

(100) Naturally disjoint $\sqrt{\text{ptsts}}$ in a reflexive context, licit:

le-marbe	*ha-mazal,*	*ha-mexabel*	*ha-mitabed*	*hitpotsets*	*be-migraʃ*	*rek*
to-much	the-luck,	the-terrorist	the-suiciding	exploded.INTNS.MID	in-lot	empty

'Luckily, the suicide bomber blew himself up in an empty lot'

(101) Naturally reflexive $\sqrt{\text{lbʃ}}$ in a disjoint context, illicit:

'The king was still in his underwear minutes before the ceremony. His assistants rushed to dress him up in expensive clothes, a robe and a crown. …

* *lifnei*	*ʃe-hu*	*hevin*	*ma*	*kara*	*hu*	*kvar*	*hitlabeʃ*
before	COMP-he	understood.CAUS	what	happened	he	already	dressed.INTNS.MID

(…'Before he could understand what had happened, he had already dressed up.)'

Reciprocals and figure reflexives were already discussed in §2.2.4 where it was shown that a reciprocal verb must have symmetrical entailments. In other words, a naturally disjoint root cannot be made into a reciprocal.

(102)

josi	*ve-dani*	*hitlabʃ-u*
Yossi	and-Danny	dressed.INTNS.MID

'Yossi and Danny got dressed.' (not: 'Yossi and Danny dressed each other')

The system described here leaves room for investigation. Importantly, the notion of volitionality or agentivity is still not defined precisely enough. For example, the verbs *hitmaker le-* 'got addicted to' and *hitahev be-* 'fell in love with' would be analyzed as figure reflexives in *hitXaY̯eZ*. Yet it is arguable to what extent they denote agentive events. Similar considerations will arise again in §2.3.2 on *heXYiZ*.

2.2.7 Summary

To summarize this section, I have laid out a theory of middle morphology as it interfaces with active and nonactive syntax. Consequences were discussed for anticausatives, reflexives and reciprocals, and for lexical semantics within the language and crosslinguistically. It was shown that fine-grained distinctions between meanings can be derived by treating verbal templates as complex entities, formed using specific functional heads. It was also shown that this approach can explain why the same morphology might signal different syntactic derivations. The structures which remain to be addressed are highlighted in Table 2.4.

Heads				Syntax	Semantics	Phonology	Section
	Voice			(underspecified)	(underspecified)	*XaYaZ*	§2.3.1
	Voice	$\sqrt{\text{ACTION}}$		(underspecified)	Action	*XiY̭eZ*	§2.3.3
Pass	Voice	$\sqrt{\text{ACTION}}$		Passive	Action	*XuY̭aZ*	§2.3.4
	$\text{Voice}_{\{D\}}$			EA	(underspecified)	*he-XYiZ*	§2.3.2
Pass	$\text{Voice}_{\{D\}}$			Passive, EA	(underspecified)	*hu-XYaZ*	§2.3.4
	$\text{Voice}_{\emptyset}$			No EA	(underspecified)	*ni-XYaZ*	§2.2.1
	Voice		$p_{\emptyset}$	EA = Figure	(underspecified)		§2.2.2
	$\text{Voice}_{\emptyset}$	$\sqrt{\text{ACTION}}$		No EA	Action	*hit-XaY̭eZ*	§2.2.1
	Voice	$\sqrt{\text{ACTION}}$	$p_{\emptyset}$	EA = Figure	Action		§2.2.2

Table 2.4: Functional heads: interim summary.

So far we have been answering a number of the questions we started off with. I have made the case that roots are a primitive of the system and that functional heads make up the morphological templates, not holistic morphemes. I have also set up a framework in which the mapping from syntax to semantics proceeds in regular fashion, imposing a locality constraint on the interpretation of the root by adjacent, contentful heads in the syntax. The next section fleshes out the rest of the system for Hebrew, furthering the theoretical claims.

2.3 The morphosyntactic system in full

This section describes the system for the rest of the templates, focusing on the theoretical issues they raise. The templates include the "simple" *XaYaZ*, which is underspecified for its syntax/semantics, in §2.3.1; the "causative" *heXYiZ*, which is active save for a small number of exceptions, in §2.3.2; the "intensive" *XiY̯eZ* in §2.3.3; and the two passive templates in §2.3.4. We then turn to some consideration of adjectival passives in §2.3.5 and nominalizations in §2.3.6.

2.3.1 *XaYaZ*: Underspecification

In the "simple" template *XaYaZ* there are no restrictions on argument structure alternations; the root is free to require any interpretation from v and Voice (save for reflexive and reciprocal which have been argued to be syntactically complex).

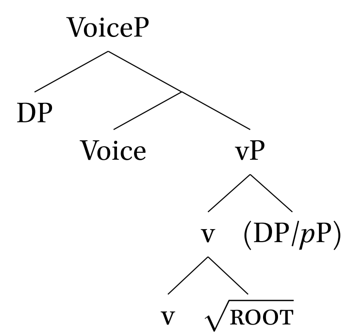
(103) a. Unaccusative:
nafal 'fell', *kara* 'happened', *halax* 'vanished'.

b. Unergative:
rakad 'danced', *kafats* 'jumped', *halax* 'walked'.

c. Figure reflexive:
ala al- 'climbed', *xana be-* 'parked'.

d. Transitive:
axal 'ate', *ʃata* 'drank', *haras* 'destroyed', *tafas* 'caught'.

e. Ditransitive:
natan 'gave', *lakax* 'took'.

(104)


The underspecification of this template—and of the underlying structure—can be likened to the lack of morphological marking on forms such as *break* in English. These forms participate in the causative alternation (*John broke the vase* ∼ *The vase broke*.) Assuming that there is no special syntactic head deriving one form from the other, the analysis can make reference to different allosemes of Voice: causative when adjacent to an external argument, an identity function if not.

(105) a. $[\![\text{Voice}]\!] = \lambda x \lambda e.\text{Agent}(x,e)$ / DP ___ $\sqrt{\text{BREAK}}$

b. $[\![\text{Voice}]\!] = \lambda P.P$ / ___ $\sqrt{\text{BREAK}}$

While this template is underspecified in the syntax and semantics, the lack of overt heads constraining the structure means that it can be marked in the phonology. The intuition is that if there are no overt affixes, the root will have free reign in the phonology. For example, verbal stems are normally longer than one syllable except for some roots in *XaYaZ*:

(106) *ba* 'came', *fav* 'returned', *tsats* 'appeared'.

The phonological markedness of this template has been discussed in contemporary work by Ussishkin (2000, 2005) and Laks (2011). I will not have much to add on this point here, but it is consistent with the theory developed in Chapter 3.

Borer (2013, 2015) takes *XaYaZ* to be a verbalized root, without functional material attaching to it. The two main reasons for this are the wide range of nominalizations possible in this template (see §2.3.6) and the idiosyncratic phonology. We will revisit this point in §3.4.4 after discussing the phonology in more depth. For now, suffice it to say that because of the way Borer's system is constructed, our account and hers are compatible: both allow for *XaYaZ* to be as idiosyncratic as it needs to be.

2.3.2 *heXYiZ*: Limited alternations

The "causative" template *heXYiZ* is so called because verbs in it are often transitive and almost always active. I suggest a straightforward analysis for the majority of cases, tweaking it to account for a set of exceptions while acknowledging that they might tell us more about argument structure than we have been able to uncover so far.

2.3.2.1 The basics

As noted above, verbs in this template are generally active. If it is true that there is an external argument regardless of the root, the presence of this argument should be encoded in the syntax. This goal is achieved using the functional head **Voice$_{\{D\}}$** (Schäfer 2008; Wood 2015), the active counterpart of Voice/Voice$_{\varnothing}$: it requires that a DP be merged in its specifier, guaranteeing that an external argument appear.

(107) a. **Voice$_{\{D\}}$:**
Voice$_{\{D\}}$ (pronounced "voice dee" or "voice plus dee") is a Voice head with a [+D] feature, requiring that some element with a [D] feature merge in its specifier.

b. $[\![\text{Voice}_{\{D\}}]\!] = \lambda x \lambda e.\text{Cause}(x,e)$

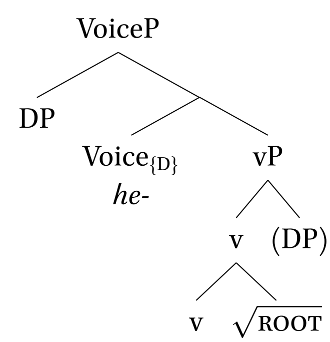
This definition of Voice$_{\{D\}}$ will be amended in §2.3.2.4, to a feature valuation operation (Agree) that probes first upwards and then downwards, so that we can account for a number of exceptions.

(108) a. Unergative:
hedrim 'went southwards', *hegzim* 'exaggerated'.

b. Transitive:
hefmid 'destroyed', *hergiz* 'angered'.

c. Ditransitive:
hexnis 'inserted', *hetsmid* 'attached'.

(109)



A small class of unaccusative verbs appear in *heXYiZ*, most of which are de-adjectival. Of these, many are ambiguous with a true causative, (110).

(110) a. *helbin*
'whitened' (became/made white)

b. *he'edim*
'reddened' (became/made red)

c. *heffir*
'thawed, defrosted' (became/made thawed)

I begin by describing the data more fully, before presenting my analysis and surveying a number of possible alternatives.

2.3.2.2 Data

I will take care to use **"inchoative"** as a descriptive term, not a theoretical one: an inchoative verb in *heXYiZ* is one in which the sole argument has undergone the change of state (or changed on a scale). **"Causative"** is likewise a descriptive term, but is identical in use to "transitive" here, denoting a structure with an external argument and an internal argument (complement to the verb). The two kinds will receive different analyses once we consider the data in full. **"Alternating verbs"** are those which can be used in either causative or inchoative constructions, like *heffir* 'thawed' in (111).

(111) a. *ha-jaxasim ben ʃtej ha-medinot heffir-u axarej bikur roʃ ha-memʃala*
the-relations between both the-states thawed.CAUS-3PL after visit head.CS the-government
'The relations between the two countries thawed after the Prime Minister's visit.'

b. *bikur roʃ ha-memʃala heffir et ha-jaxasim ben ʃtej ha-medinot*
visit head.CS the-government thawed.CAUS ACC the-relations between both the-states
'The Prime Minister's visit thawed the relations between the two countries.'

The corpus from Ehrenfeld (2012) lists a total of 639 verbs in *heXYiZ*. Of these, approximately 550–600 are part of my own vocabulary. Out of these verbs, 37 show the causative-inchoative alternation by my own estimate.[5] The 37 alternating verbs are broken down as follows: 19 transitive-unaccusative and 18 transitive-unergative. The full list of alternating verbs in *heXYiZ* is given below in (113)–(114).

Unaccusativity judgments are difficult with intransitive verbs in *heXYiZ* due to the confounding factors already addressed in §2.2.5. Nevertheless, it is possible to find unaccusative verbs in *heXYiZ* which perform satisfactorily on the Verb-Subject order diagnostic, as the following examples show. Borer (1991:149) argues that inchoatives in *heXYiZ* can be either unergative or unaccusative.

5. Arad (2005) counts 11 such verbs in her corpus, a figure that seems too low. Laks (2011) counts 34. Lev (2013) found 84 in a survey taking into account many naturally attested, but perhaps spurious, forms.

(112) VS order with unaccusative inchoatives in *heXYiZ*. No *by*-phrase possible.

a. *heffir-a* (*l-i*) *kol ha-glida* (**al jedej ha-xom*)
thawed-F to-me all the-ice.cream by the-heat
'All (my) ice cream defrosted completely (*by the heat).'

b. *hevʃil-u ha-tna'im le-haffara ba-jaxasim* (**al jedej ha-bikur*)
ripened-3PL the-conditions to-thawing in.the-relations by the-visit
'The conditions matured for the relations to thaw (*by the visit).'

Accordingly, I will assume that all three constructions (transitive, unergative and unaccusative) are possible in this template in principle.

I have classified the alternating verbs by the alternations they participate in. Barring a judgment survey, and given that I know of no comparable lists, the following lists reflect my own intuitions. Some verbs are equally acceptable in both alternations, as with *heffir* 'thawed' in (111). Others are predominantly used as inchoatives, though causative uses have been attested. This procedure is repeated separately for unaccusatives in (113) and for unergatives in (114).

(113) Alternating unaccusatives in *heXYiZ*:

a. **Full alternation:** *hekʃiax* 'stiffened', *heffir* 'thawed', *heʃmin* 'fattened', *herza* 'grew thin', *hezkin* 'grew old', *hekriax* 'became bald', *hevʃil* 'ripened', *hekrim* 'crusted', *hetsliax* 'succeeded'.

b. **Inchoative preferred but causative innovation attested:** *he'edim* 'reddened', *helbin* 'whitened', *hekxil* 'became blue', *hetshiv* 'yellowed', *heʃxir* 'blackened', *hezhiv* 'became golden', *hevri* 'got healthy', *hexmir* 'deteriorated', *hertsin* 'became serious', *hexvir* 'grew pale'.[6]

I have not yet found, or at least not yet noticed, any alternations in which the causative is preferred and the inchoative is a recent innovation; or inchoatives in *heXYiZ* which have no causative counterpart. I take these findings to be emblematic of the causative meaning inherent in *heXYiZ*: even if inchoative verbs have arisen, contemporary usage overwhelmingly tends to coin causatives in this template rather

6. Attested example for causative "palen":

(i) "The girl looked as though someone wrapped her up in massive metallic toilet paper. …*afilu ha-tseva ha-meanjen* […] *hexvir et hofa'a-ta ʃel danst*
even the-color the-interesting paled ACC appearence-hers of Dunst
'Even the interesting color … made Dunst's appearance pale.'
http://www.mako.co.il/women-fashion/whats_in/Article-174f70ed642f121004.htm

than another kind of verb (Laks 2014). A similar phenomenon is reported by Harley (2009) for the English verbalizers *-ify*, *-en*, *-ize* and *-ate*. We return to the similarity between *-en* and $\text{Voice}_{\{D\}}$/*heXYiZ* in §2.3.2.7.

The following list presents alternating verbs which do not convincingly pass unaccusativity diagnostics. I refer to these as causative-unergative alternations. Here, too, the tendency is to coin new causatives rather than new (unergative) inchoatives.

(114) Alternating unergatives in *heXYiZ*:

a. **Full alternation:** *he'its* 'sped up', *he'emik* 'deepened', *he'erix* 'lengthened', *hetser* 'narrowed', *her'iʃ* 'made loud', *hektsin* 'escalated', *he'et* 'slowed down', *hexriʃ* 'became silent'.

b. **Unergative preferred but innovation causative attested:** *heki* 'threw up', *hesriax* 'stank', *hezia* 'sweat',[7] *heflits* 'farted', *hesmil* 'went to the left',[8] *hesmik* 'blushed', *hev'iʃ* 'became putrid', *hetsxin* 'smelled pungent', *hexmits* 'soured', *herkiv* 'rotted'.

For the sake of comparison, the following list—which is not meant to be comprehensive—presents a small number of verbs that do not participate in the alternation at all. Recall that this is the unmarked case in *heXYiZ*: over 500 of the 550–600 verbs in this template would fit in this list.

(115) a. **Causative (transitive) only:** *hefmid* 'destroyed', *hexnis* 'inserted', *hekpi* 'froze', ...

b. **Unergative only:** *hetspin* 'went north', *hedrim* 'went south', *hejmin* 'went to the right', *hetsbia* 'pointed', *he'emin* 'believed', *hegzim* 'exaggerated', *hemtin* 'awaited', *heflig* 'set sail', *hebit* 'looked', *heria* 'cheered', ...

A satisfying analysis of these patterns must address two questions: why these roots and why this template. I take these questions up in turn.

---

7. Attested example for causative "sweaten":

(i) *mazkir l-i ta-perek ʃe-b-o al bandi* <u>*hezia*</u> *et elvis presli*
reminds to-me the.ACC-episode COMP-in-it Al Bundy sweat ACC Elvis Presley
'Reminds me of the episode where Al Bundy had a sweat mark in the shape of Elvis Presley.'
http://www.ynet.co.il/Ext/App/TalkBack/CdaViewOpenTalkBack/0,11382,L-3605065-2,00.html

8. Attested example for causative "leften":

(i) *kol ha-kavod le-barak.* <u>*hesmil*</u> *et netanjahu*
all the-respect to-Barak. made.left ACC Netanyahu
'Well done to [Ehud] Barak. He made [Benjamin] Netanyahu look like a leftist.'
http://www.ynet.co.il/Ext/App/TalkBack/CdaViewOpenTalkBack/0,11382,L-4010352,00.html

2.3.2.3 Roots

What distinguishes the active verbs in (108) and (115) from the alternating verbs in (113) and (114)? There is no phonological generalization to be made. The following lexical semantic classes can be identified in Table 2.5, however. The first two columns categorize the unaccusative and unergative verbs listed above. The third column lists some active (non-alternating) verbs in *heXYiZ* which also fall under these headers. The lists in the third column are non-exhaustive. Where I do not believe any verbs to be found, a cell is marked "—".

	Unaccusative	Unergative	Transitive
Change of color	*he'edim* 'reddened', *helbin* 'whitened', *hekxil* 'became blue', *hetshiv* 'yellowed', *heʃxir* 'blackened', *hezhiv* 'goldened',	—	—
Change of bodily function, shape or appearance	*heʃmin* 'fattened', *herza* 'thinned', *hezkin* 'grew old', *hekriax* 'became bald', *hevri* 'became healthy', *hertsin* 'became serious', *hexvir* 'grew pale'	*he'emik* 'deepened', *he'erix* 'lengthened', *hetser* 'narrowed', *hesmik* 'blushed'	*heffit* 'undressed', *henmix* 'lowered', *hextim* 'stained', ...
Change of consistency, taste or smell	*hekʃiax* 'stiffened', *heffir* 'thawed', *hevʃil* 'ripened', *hekrim* 'crusted'	*hexmits* 'soured', *herkiv* 'rotted'	*hetsis* 'fermented', *heriax* 'smelled', *hetpil* 'desalinated', *heflir* 'flouridated', ...
Emission	—	*heki* 'threw up', *hesriax* 'stank', *hezia* 'sweat', *heflits* 'farted', *hev'iʃ* 'became putrid', *hetsxin* 'smelled pungent'	—
Change of speed or direction	—	*he'its* 'sped up', *he'et* 'slowed down', *hesmil* 'went left'	*heziz* 'moved', *hotsi* 'removed', ...
Change of sound	—	*her'iʃ* 'made loud noise', *hexriʃ* 'quieted down'	*heftik* 'shut up'
Other	*hetsliax* 'succeeded', *hexmir* 'deteriorated'	*hektsin* 'escalated'	

Table 2.5: Lexical semantic classes for alternating verbs in *heXYiZ* and transitive foils.

Clearly, the semantic criteria are not enough to draw a distinct line through the entire list of roots. We might also have expected the following forms to exist, contrary to fact:

(116) a. Change of speed: **hemhir* ($\not<$ *mahir* 'quick'), **hel'it* ($\not<$ *iti* 'slow')
b. Change of color: **hesgil* ($\not<$ *sagol* 'purple'), **hektim*/*hextim* ($\not<$ *katom* 'orange').

Are there any generalizations to be made about the interaction of lexical material (the root) and functional material ($\text{Voice}_{\{D\}}$) in this case? It seems clear that change of color is strongly unaccusative, whereas verbs of emission, change of speed and direction, and change of sound are unergative. All classes can alternate. I suspect that the way forward will be to examine in more detail which of these verbs describe change on a scale and which entail reaching a result state. Many of the alternating verbs are de-adjectival, and so the correct generalization might have to do with an inherent scale in adjectives, corresponding to a change-of-state verbal analysis. The answer might lie in how adjectives are verbalized as change-of-state verbs (Dowty 1991; Hay et al. 1999; Rotstein and Winter 2004; Kennedy and Levin 2008; Bobaljik 2012),[9] but for the time being I leave this table as is, in the hope that it will prove useful for future work.

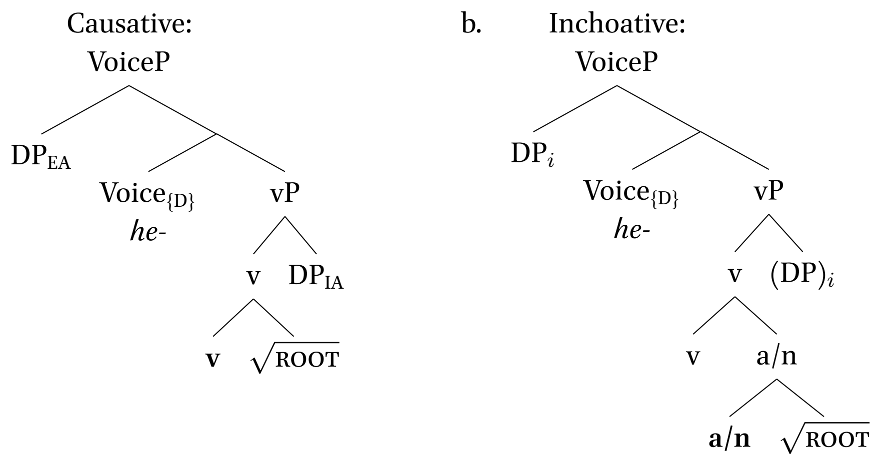
2.3.2.4 Template

In this part of the analysis I argue that inchoatives have different structure than causatives, echoing claims made by Borer (1991). Causatives will be argued to be derived from the root, whereas inchoatives will be argued to be derived from an existing adjective or noun.

The structure in (117a) is repeated from (109). This is how causatives are built. For inchoatives, the structure in (117b) will be motivated.

9. In a cross-Semitic perspective, Arabic "Form 9" *iXYaZZ* verbs show some parallels with *heXYiZ*, though the Arabic forms are exclusively nonactive.

(117) a. b.



If we assume that the [D] feature on Voice$_{\{D\}}$ is an EPP feature, we can capture the simple (causative) cases as explained above: both an external argument (EA) and an internal argument (IA) are merged in the structure. The EA satisfies [D] on Voice$_{\{D\}}$ and the derivation converges. Similarly for an unergative construction without the IA. But what of the inchoatives?

It has been suggested by Borer (1991) that in *heXYiZ*, causatives are derived directly from the root while inchoatives are derived from an underlying adjective. We will return to her argumentation in §2.3.2.7 but let us assume that this is correct. First, a minor modification is in order: inchoatives are derived either from an underlying adjective or from an underlying noun:

(118) a. Underlying adjective: *he'edim* < *adom* 'red', *heʃmin* < *ʃamen* 'fat'.
b. Underlying noun: *heki* < *ki* 'vomit', *hetsxin* < *tsaxana* 'stench'.

My theory of morphosemantics adopts the so-called Arad/Marantz hypothesis, according to which the first categorizing head selects the alloseme of the root (Anagnostopoulou and Samioti 2014).[10] If (117b) is the right structure for inchoatives, it is predicted that for roots which participate in the alternation, the causative might have a meaning that the inchoative does not share. This is because in causatives Voice$_{\{D\}}$ is local enough to the root to select a special meaning, whereas in inchoatives little a or little n will have already chosen an alloseme. A number of idioms confirm this prediction.[11]

10. In §2.2.1.3 we saw one amendment to this hypothesis: if the first categorizing head does not select an alloseme, the alloseme will be selected by the next head.
11. I thank Ruth Kramer for pushing me on this point.

(119) a. Causative, literal meaning:
ha-sid *helbin* *et* *ha-kir*
the-lime.plaster whitened ACC the-wall
'The lime plaster made the wall white.'

b. Causative, non-transparent meaning:
sar *ha-xuts* *helbin* *ksafim*
minister the-exterior whitened moneys
'The Minister of Foreign Affairs took part in money laundering.'

c. Passive of causative, non-transparent meaning retained:
nit'an *ʃe-ha-ksafim* *hulben-u* *al jedej* *sar* *ha-xuts*
was.claimed COMP-the-moneys whitened.PASS-3PL by minister the-exterior
'It was claimed that the money was laundered by the Minister of Foreign Affairs.'

d. Inchoative, only literal meaning:
ha-ʃtarot *helbin-u*
the-bills whitened-3PL
'The bills became white.'
(not: 'The bills got laundered.')

(120) a. Causative, literal meaning:
ha-piax *heʃxir* *et* *ha-avir*
the-soot blackened ACC the-air
'The air grew black with soot.'

b. Causative, non-transparent meaning:
son'e-j *israel* *menas-im* *lehaʃxir* *et* *pane-ha* *ʃel* *medina-t* *israel* *ba-zira* *ha-benleumit*
haters-CS Israel try.PTCP-M.PL to.blacken ACC faces-3F of state-CS Israel in.the-arena the-international
'Israel's haters are trying to make the State of Israel look bad on the international stage.'
http://www.ynet.co.il/articles/0,7340,L-4781034,00.html

c. Inchoative, only literal meaning:
??*pane-ha* *ʃel* *ha-medina* *heʃxir-u* *axarej* *ha-ʃaarurija* *ha-axrona*
faces-3F of the-state blackened-3PL after the-scandal the-last
(int. 'The country was made to look bad after the latest scandal')

The full semantics for $\text{Voice}_{\{D\}}$ looks as in (121), without introducing a causer for inchoative events in (121a–b):

(121) a. $[\![\text{Voice}_{\{D\}}]\!] = \lambda e.e$ / ___ (v) a (v does not select an alloseme)

b. $[\![\text{Voice}_{\{D\}}]\!] = \lambda e.e$ / ___ (v) n (v does not select an alloseme)

c. $[\![\text{Voice}_{\{D\}}]\!] = \lambda e \lambda x.\text{Cause}(x,e)$

The last piece of the puzzle is the syntax of inchoatives: we must allow for unaccusative verbs as in (113) and (117b). Our definition of Voice$_{\{D\}}$, however, states that its EPP feature requires its specifier to be filled; this definition is not compatible with an unaccusative argument remaining low.

To account for these exceptions, assume instead that the EPP feature on Voice$_{\{D\}}$ requires valuation of ϕ-features (Schäfer 2015). This valuation proceeds straightforwardly under Spec-Head Agreement but something else needs to be said if the argument in the phase is the IA. In this case, I propose that the feature [D] can be checked by the IA *in situ*: Voice$_{\{D\}}$ probes into its specifier upwards, finds no target, and so it probes downwards and is valued by the IA.

Here is what this means for an inchoative example like (122). Voice$_{\{D\}}$ has nothing in its specifier, so it probes downward and checks its unvalued ϕ-features with the IA *ha-xatul* 'the cat'. The derivation converges in the syntax. The interpretation is as in (121a): no Cause is introduced.

(122) *ha-xatul* *<u>heʃmin</u>*
the-cat fattened
'The cat grew fat.'

In developing a theory of features such as [+D] and [−D], I have assumed that their work is syntactic-configurational: either there is a DP in their specifier or there is not. Cases in which active morphophonology appears on non-active syntax and semantics, like the inchoatives in *heXYiZ* or the "adversity causative" in Japanese discussed most recently by Wood and Marantz (To appear), highlight what still needs to be developed: a unified framework for EPP effects, the interpretation of external arguments, and the role of A-movement in argument structure alternations.

Finally, let us ensure that ungrammatical cases like (123) are ruled out.

(123) a. **ha-xatul* *<u>hexnis</u>*
the-cat inserted
(int. 'The cat got inserted')

b. **ha-oto* *<u>hemhir</u>*
the-car FAST.CAUS
(int. 'The car grew fast')

For (123a) there is no adjective ‘inserted’ that could be verbalized and no inchoative can be generated, (121). In (123b) an adjective *mahir* ‘quick’ does exist, but it cannot be instantiated in *heXYiZ* as already discussed in §2.3.2.3. This analysis does not explain why this generalization holds. It is however reminiscent of a similar observation made by Oseki (2016) for Japanese, where $\text{Voice}_{\{D\}}$ cannot combine with denominal or de-adjectival bases.

It can now be seen why this template allows for certain alternations while privileging active constructions: the template is productively causative, as in (117a), but must make synchronic allowances for individual de-adjectival and de-nominal forms, as in (121). A number of possible alternatives will now be surveyed.

2.3.2.5 Alternative: Existential closure

One alternative analysis would posit a silent, generic Cause in $\text{Spec,Voice}_{\{D\}}$. The analysis in Doron (2003:61)—which in many ways is a precursor to the theory presented in this work—assumes that a Causative head γ gives rise to *heXYiZ*. The problem for the system in Doron (2003) is that if these verbs are derived using a Causative head rather than a Middle head, we have no explanation for their unaccusativity.

As a result, Doron must conclude that “*x reddened* is equivalent to *Something caused x to redden*” (Doron 2003:62), with the Causative head γ introducing a Causer that is existentially quantified over. This kind of account is more in line with a passive analysis than a causative one.

Assume for the sake of the argument that a silent element fills $\text{Spec,Voice}_{\{D\}}$ in inchoatives. One would need to specify the exact featural makeup of this element, for example a null subject *pro*. The result would be a transitive structure where *pro* should be assigned Nominative case and the IA should be assigned Accusative case. Definite accusative objects in Hebrew take the direct object marker *et*, so we would predict that *et* appears before inchoatives in *heXYiZ*. But this is incorrect: the generic Cause cannot be a silent pronoun in a transitive relationship with the internal argument.

(124) a. * *heʃmin* ***et*** *ha-xatul*
fattened ACC the-cat

b. * ***et*** *ha-xatul* *heʃmin*
ACC the-cat fattened
(int. 'The cat grew fat')

Another tack would be to say that instead of *pro*, the silent external argument is a Weak Implicit Argument in the sense of Landau (2010a): a bundle of ϕ-features with no [D] feature, distinguishing it from a Strong Implicit Argument such as *pro*. If there is no [D] feature on the weak EA, it does not participate in the calculus of case and the IA will receive unmarked case, i.e. Nominative.

But note that this analysis ends up being very similar to ours: the EA is not taking part in any relevant syntactic process, and whatever requirements $\text{Voice}_{\{D\}}$ has still need to be satisfied. Furthermore, the exact characterization of Weak Implicit Arguments is not fully fleshed out; Landau (2010a:380) concludes that they may not be direct objects, only oblique objects, and that they may not be subjects of predication, but his system makes no claims as to whether they can function as the generic kind of EA we would need here. In the absence of a convincing account for implied causers, I reject this analysis.

2.3.2.6 Alternative: Contextual allomorphy

Another possible analysis is strictly morphological in nature. Under this account, unaccusative inchoatives are true unaccusatives derived with the $\text{Voice}_{\emptyset}$ morpheme of §2.2.1, except that the allomorphic rule in (125a) causes $\text{Voice}_{\emptyset}$ to be pronounced like CAUS (which is a placeholder for of the morphology of *heXYiZ*) rather than MID (which is a placeholder for the morphology of *niXYaZ* and *hitXaY̯eZ*).

(125) a. $\text{Voice}_{\emptyset} \leftrightarrow$ CAUS / ___ {$\sqrt{\text{lbn}}$, $\sqrt{\text{'dm}}$, $\sqrt{\text{xlk̯}}$, $\sqrt{\text{xvr}}$, $\sqrt{\text{ʃmn}}$, ...}

b. $\text{Voice}_{\emptyset} \leftrightarrow$ MID

Since the number of unaccusative verbs in *heXYiZ* is fairly small, or at the very least non-productive, it is plausible that an arbitrary list of roots conditioning this allomorphy can be learned. Still, the mystery remains why it is specifically *heXYiZ* that houses inchoatives: why doesn't the rule in (125a) insert the form of any other template, such as *XaYaZ*, *niXYaZ* or *XiY̯eZ*? This solution is technically possible but conceptually unenlightening.

2.3.2.7 Alternative: Verbalizing affix

Borer (1991) presents an analysis of *heXYiZ* alternations couched in Parallel Morphology, which I will translate into comparable terms in the current theory. Her account consists of two main parts. In the first, she argues that inchoative forms are derived from adjectives while causative forms are derived from a root/verb. In the second, she presents an analysis showing why it must be the case—given certain assumptions—that causatives are formed in the lexicon and inchoatives in the syntax. Our analysis is similar to hers in adopting separate structures for causatives and inchoatives, albeit using different argumentation. The content of the analysis is different, though, since for Borer (1991) *heXYiZ* is a single verbalizing morpheme which subcategorizes for an adjectival element.

In her analysis, Borer (1991:136) takes Hebrew *heXYiZ* and English *-en* to be verbalizers subcategorizing for an adjectival stem, be it a property root or an adjective. When this is done in the "lexicon" by verbalizing a root, the result is a causative verb:

(126) $[_{\text{v}}\ \sqrt{\text{WIDE}}$ *-en*$]$

When this is done in the syntax by verbalizing an adjective, the result is an inchoative verb:

(127) $[_{\text{v}}\ [_{\text{a}}\ \sqrt{\text{WIDE}}\ \text{a}]$ *-en*$]$

Crucially for us, the analysis does not answer the questions posed at the beginning of the discussion: why this template and why these roots. *heXYiZ* is assumed to be a de-adjectival verbalizer, just like *-en*, without discussion of this template's role in the overall morphosyntax of the language. While it is stipulated that *heXYiZ* as a verbalizer subcategorizes for an adjective, this is not always the case: as alluded to above, the run-of-the-mill causatives *hexnis* 'inserted', *he'exil* 'fed' and *helbiʃ* 'dressed' are not derived from underlying adjectives.

hexnis 'inserted' is derived from $\sqrt{\text{kns}}$, but without a simple adjective *$[_a \sqrt{\text{kns}}\ \text{a}]$. One could posit an abstract adjective that is never lexicalized, but it is unclear what this non-existent adjective would be like or what its phonological form would have been (**kanus*?).

(128) *ha-nasix* *hexnis* *et* *ha-sefer* *la-tik*
the-prince inserted.CAUS ACC the-book to.the-bag
'The prince put the book in the bag.'

he'exil 'fed' is derived from $\sqrt{\text{'kl}}$, but probably not from *axul* 'consumed', a rare adjectival passive of *axal* 'ate'.

(129) a. *ha-nasix* *he'exil* *et* *ha-kivsa*
the-prince fed.CAUS ACC the-sheep
'The prince fed the sheep'

b. ≠ *ha-nasix* *garam* *la-kivsa* *lihiot* ***axula***
the-prince caused to.the-sheep to.be consumed
'The prince caused the sheep to be consumed (e.g. by worms)'

helbiʃ 'dressed' is derived from $\sqrt{\text{lbʃ}}$, but probably not from *lavuʃ* 'dressed up', the adjectival passive of *lavaʃ* 'wore', which seems to be reserved for descriptions of a full costume.

(130) a. *ha-ima* *helbiʃ-a* *et* *ha-jeled* *(be-)xalifa* *jafa*
the-mom dressed.CAUS-F.SG ACC the-boy in-suit pretty
'The mother put the boy's pretty suit on (him).

b. "On making his discovery, the astronomer had presented it to the International Astronomical Congress, in a great demonstration, ...
aval iʃ *lo* *he'ezin* *le-dvara-v,* *miʃum* *ʃe-haja* *lavuʃ* *be-tilobʃet* *turkit.*
but nobody NEG listened to-words-his, since COMP-was dressed.up in-outfit Turkish
ka'ele *hem* *ha-mevugarim*
such 3PL the-grown.ups
But he was in Turkish costume, and so nobody would believe what he said. Grown-ups are like that." (Antoine de Saint-Exupéry, *The Little Prince*, Chapter 4. Hebrew by Jude Shva[12])

Borer (1991) did not claim that the sole function of *heXYiZ* is to verbalize adjectives. But even if this is one of its functions, we have seen that not all verbs in *heXYiZ* show the alternation. As her system stands, it is not clear how it could allow for a certain root to be instantiated only in a "syntactic"

12. http://www.oocities.org/sant_exupery/c4.htm

(inchoative) derivation but not in a "lexical" (causative) one. Similarly, and as shown above, not all inchoatives in this template are de-adjectival: *heki* 'threw up' comes from the noun *ki* 'vomit', *hekrim* 'clotted' from the noun *krem* 'cream', and *hetsxin* 'smelled pungent' from the noun *tsaxana* 'pungent smell'.

The analysis in Borer (1991) does not aim to find an underlying reason for why *heXYiZ* is used for both causatives and inchoatives, as well as for general causativization in the rest of the system. Nevertheless, it remains the only in-depth study of this alternation that I know of. Recall, for the last part of this discussion, that this analysis also postulates a structural difference between *heXYiZ* causatives, (126), and inchoatives, (127). I review this distinction next.

The logic works as follows: if an adjective passes certain diagnostics, and the inchoative does but the causative does not, then the adjective must be embedded in the inchoative (Borer 1991:130). Starting with an English example, the adjective *wide* is said to license comparisons with *as*/*like* and comparative forms, whereas the inchoative *widen* does not. Borer's claim is that comparison adverbials and the comparative must be licensed by an adjective (judgments hers).

(131) a. The canal is {as <u>wide</u> as a river / <u>wider</u> than a river.}
b. The canal <u>widened</u> {like a river / more than a river}.
(int. 'The canal became as wide as a river is wide / became more wide than a river is wide')
c. *The flood <u>widened</u> the canal {like a river / more than a river}.
(int. 'The flood made the canal as wide as a river is wide / made the canal wider than a river is wide')

I suspect that there is much more variation in acceptability for the utterances in (131), and that an adverbial reading normally overpowers the scalar one ('The flood widened the canal like a river widens it'). Three native speaker linguists I have consulted do not share these contrasts but I leave a judgment survey for future work. Let us return to the novel claims about Hebrew instead.

Taking the adjective *ʃmen-a* 'fat-F.SG', it is claimed to license comparatives, (132a). Inchoatives license comparatives too, (132b), but causatives do not, (132c). Judgments are as in Borer (1991); example (132c) does not sound as degraded to me, but it does to another speaker whom I consulted informally.

(132) a. Adjective:
ha-xatula ***ʃmena*** {*kmo xazir / joter mi-xazir*}
the-cat fat like pig more than-pig
'The cat is fat as a pig / fatter than a pig.'

b. Inchoative:
ha-xatula *heʃmina* {*kmo xazir / joter mi-xazir*}
the-cat fattened like pig more than-pig
'The cat grew as fast as a pig / fatter than a pig.'

c. Causative:
* ***ha-zrika*** *heʃmina et ha-xatula* {**kmo xazir / *joter me-xazir*}
the-injection fattened OM the-cat.F like pig more than-pig
(int. 'The injection made the cat fat as a pig / more than a pig is fat.')

Similarly, some adverbs (*haxi ʃe-efʃar* 'as much as possible') must be licensed by an adjective and accordingly only appear with inchoatives, not causatives.

It seems to me that the success of this diagnostic depends to a large extent on the lexical items chosen. For example, using the antonym *herza* 'grew thin', my judgments are slightly different:

(133) a. Adjective:
ha-xatula raza {*kmo makel / ?joter mi-makel*}
the-cat thin like stick more than-stick
'The cat is as thin as a rail / skinnier than a rail.'

b. Inchoative:
? ***ha-xatula*** *herzeta* {*kmo makel / ??joter mi-makel*}
the-cat thinned like stick more than-stick
(int. 'The cat became as thin as a rail / skinnier than a rail.')

c. Causative:
?? ***ha-zrika*** *herzeta et ha-xatula* {*kmo makel / joter me-makel*}
the-injection thinned OM the-cat like stick more than-stick
(int. 'The injection made the cat as thin as a rail / skinnier than a rail.')

With *he'et* 'slowed down' I judge inchoatives unacceptable and causatives slightly better though still degraded. These judgments are meant to highlight the variance, not to be taken as categorical for all alternations or all speakers.

(134) a. Adjective:
ha-mexonit ha-zo ***itit*** {*kmo tsav / joter mi-tsav*}
the-car the-this slow like turtle more than-turtle
'This car is as slow as a turtle / slower than a turtle.'

b. Inchoative:
* *ha-mexonit ha-zo <u>he'eta</u> {kmo tsav / joter mi-tsav}*
the-car the-this slowed like turtle more than-turtle
(int. 'This car slowed down to turtle speed / to sub-turtle speed.')
(More acceptable on a reading of 'The car slowed down like a turtle slowed down'.)

c. Causative:
?? ***ha-ba'aja ba-hiluxim*** *<u>he'eta</u> et ha-mexonit {kmo tsav / joter mi-tsav}*
the-problem in.the-gears slowed ACC the-car like turtle more than-turtle
(int. 'The problem with the gear box slowed the car down to turtle speed / to sub-turtle speed.')

It is also left vague what precisely this diagnostic is probing. In (135), for instance, there is no underlying adjective 'beloved' but the utterance is completely acceptable:[13]

(135) *ani <u>ohev</u> otxa* ***kmo ax***
I love.SMPL.PTCP you.M like brother
'I love you like a brother.'

The remainder of Borer's article is devoted to working through the different possible structures that her framework generates and discussing whether they are licit or not. The final few pages (Borer 1991:150) raise the issue of whether these verbs give comparative (change on a scale) or absolute (result) readings, concluding that both are in principle possible but are constrained by the root. That is to say, both English *reddened* and Hebrew *he'edim* 'reddened' are as compatible with a 'became redder' meaning as with a 'became red' meaning, but some verbs like *quicken* are only compatible with a 'became quicker' meaning (see Bobaljik 2012:ch. 5 for some relevant recent discussion).

Since I am not sure that the argument from comparatives generalizes, and given that no explicit syntax or semantics for this modification was put forward, I do not endorse at this point the arguments for distinct structures put forward in Borer (1991). Nevertheless, I have recast the original intuition in contemporary terms and supported it using different arguments. In any case, the original proposal should serve as a stepping stone in the next stage of investigation into these kinds of alternations. Future experimental studies could test the predictions that these theories of *heXYiZ* make for speakers' usage of nonce verbs in this template, as sketched in §5.3.2.

13. Thanks to Idan Landau for pointing this out to me.

2.3.2.8 Summary

The template *heXYiZ* predominantly instantiates active verbs, usually causatives. It is also reasonably productive. Yet a number of roots derive inchoative verbs in this template. Our analysis showed how the limited influence of a small class of verbs can be accommodated in the grammar, while keeping constant the overall behavior of the head Voice$_{\{D\}}$ which derives this template morphophonologically. In so doing, I have motivated a certain view of feature valuation (Agree) that may probe downward after probing its specifier.

I have also provided anecdotal evidence that this template is productive, able to take existing inchoatives and causativize them via zero-derivation (*hezi'a* 'sweat', *hexmits* 'soured'). The structure allows the template to be causative by default with an allowance for exceptions. These exceptions, once they are better understood, stand to reveal the kind of lexical-semantic generalizations that might be relevant at the interface with LF.

Before proceeding to the next template, I should note that speakers tend to veer away from this template for inchoatives, instantiating verbs in other, more canonically non-active templates: *hitarex* 'grew long' in *hitXaY̯eZ* rather than *he'erix*, *hizdaken* 'grew old' in *hitXaY̯eZ* rather than *hizkin*, *hit'adem* 'reddened' in *hitXaY̯eZ* rather than *he'edim* (but see Doron 2003:22 for a grammatical difference between the two), and *raza* 'thinned' in *XaYaZ* instead of *herza*. In §5.3.2 I outline an experiment to test the productivity of this template as a causativizer and an inchoativizer.

2.3.3 *XiY̯eZ*: The autosegmental root

I proposed above that the template *XiY̯eZ* is derived by use of a special root, $\sqrt{\text{ACTION}}$. There are three points to be made about this element: what does it do, why should it be a root, and what is its crosslinguistic validity.

As mentioned in §2.2.4.1, $\sqrt{\text{ACTION}}$ introduces agentive or "self-propelled" (Folli and Harley 2008) semantics. Examples (58a)–(58b) are repeated here to show that *XiY̯eZ* verbs involve agentive entailments. Inanimate causers are possible in (136a) where the verb is in *XaYaZ* but not in (136b) where the verb is in *XiYeZ* with $\sqrt{\text{ACTION}}$. That these are the two templates is evidenced by the vocalism in the stem and by the spirantization contrast between [b]∼[v].

(136) a. {✓ *ha-jeladim* / ✓ *ha-tiltulim ba-argaz*} ***ʃavr**-u* *et* *ha-kosot*
the-children the-shaking in.the-box **broke.**SMPL-PL ACC the-glasses
'{The children / Shaking around in the box} broke the glasses.'

b. {✓ *ha-jeladim* / ✗ *ha-tiltulim ba-argaz*} ***ʃibr**-u* *et* *ha-kosot*
the-children the-shaking in.the-box **broke.**INTNS-PL ACC the-glasses
'{The children / *Shaking around in the box} broke the glasses to bits.' (Doron 2003:20)

The *XiYeZ* template, made up of a lexical root, $\sqrt{\text{ACTION}}$ and Voice, is traditionally called the "intensive", but it can also house pluractional verbs (c–e) and various others (f–g):

(137) Pretheoretical classification of some verbs in *XiYeZ*:

			XaYaZ		*XiYeZ*	
Intensive	a.	$\sqrt{\text{ʃbr}}$	ʃavar	'broke'	ʃiber	'broke to pieces'
	b.	$\sqrt{\text{'kl}}$	axal	'ate'	ikel	'corroded, consumed'
Pluractional	c.	$\sqrt{\text{hlx}}$	halax	'walked'	hilex	'walked around'
	d.	$\sqrt{\text{rkd}}$	rakad	'danced'	riked	'danced around'
	e.	$\sqrt{\text{kfts}}$	kafats	'jumped'	kipets/kiftsets	'jumped around'
Non-derived	f.	$\sqrt{\text{tps}}$	—		tipes	'climbed'
	g.	$\sqrt{\text{ltf}}$	—		litef	'petted'

There is no obvious interpretation of this element beyond agentive semantics; verbs in *XiYeZ* are not simply verbs in *XaYaZ* with added agentivity entailments. In fact, "agentive semantics" is too gross a generalization itself; Doron (2003) describes the relevant thematic role as an Actor, though Doron (2014) returns to Agent. For general discussion of related notions of a direct causing participant crosslinguistically see Folli and Harley (2008) mentioned above, as well as Sichel (2010), Beavers and Koontz-Garboden (2012) and Alexiadou et al. (2013).

2.3.3.1 Pluractionality

One possible way to describe the semantics of $\sqrt{\text{ACTION}}$ is by extended reference to pluractionality. The intuition as is follows. Assume that $\sqrt{\text{ACTION}}$ is a pluractional (and perhaps also agentive) affix.

Building on recent work by Henderson (2012, To appear)—whom I thank for discussing this data with me—pluractionality can be seen as a way of pluralizing an event. This pluralization can hold spatially as well as temporally. In the data in (137a–b), the underlying verb in *XaYaZ* has a direct object. The corresponding pluralized events in *XiY̯eZ* can be individuated with respect to the direct objects: many broken pieces in (137a), many different simultaneous corrosions of the material in (137b).

For the forms in (137c)–(137e), observe that the underlying verbs in *XaYaZ* are unergative. The pluralizing operation has no direct object to operate on, and so it pluralizes the spatio-temporal event itself in *XiY̯eZ*.

Lastly, in (137f)–(137g) there is no underlying form and hence nothing to pluralize.

The database of verbs from Ehrenfeld (2012) contains over 900 forms in *XiY̯eZ*, so this line of inquiry faces a serious amount of empirical corroboration. A number of potential counterexamples can be conjured up fairly easily, though. These are cases where the alternation does not plausibly result in a plural event:

(138) a. *lamad* 'learned' ∼ *limed* 'taught'
b. *ratsa* 'wanted' ∼ *ritsa* 'satisfied'

In the examples in (138) the event does not entail change of state, unlike with breaking and eating/corroding. So perhaps there is a tripartite division of roots to be made, as follows:

(139) a. **Other-oriented (change of state):** pluralization of the object.
b. **Self-oriented:** pluralization of the spatio-temporal aspects of the event.
c. **Other cases:** no pluralization.

Proper evaluation of this novel proposal will proceed along the lines laid out above, testing whether each root instantiated in this template does indeed fit into one of the three cases in (139).

2.3.3.2 Agentivity

Setting the pluractionality hypothesis aside and keeping things uniform for the time being, I assume that $\sqrt{\text{ACTION}}$ triggers an agentive alloseme of Voice, as in §2.2.4.1 and following Doron (2003, 2014).

(140) ⟦Voice⟧ = $\lambda e \lambda x.e$ & Agent(x,e) / ___ $\sqrt{\text{ACTION}}$

It has been pointed out to me by Hagit Borer that a number of verbs in *XiY̯eZ* would stretch the notion of Agent/Actor to the point where such a denotation is no longer tenable. In the examples in (141), the verb can hardly be described as agentive since the subject is inanimate, while in (142) the subject is animate but non-volitional. These verbs are compatible with agentive subjects as well, but clearly do not require them.

(141) a.

ha-midgam	*ʃikef*	*et*	*totsot*	*ha-emet*
the-poll	reflected.INTNS	ACC	results.CS	the-truth

‘The polls (correctly) reflected the results.’

b.

be-ritsa	*axat*	***ha-ʃaon***	*ʃel*	*garmin*	*kimat*	*diek*	*kaaʃer*	*hetsig*	*stia*
in-run	one	the-watch	of	Garmin	almost	was.accurate.INTNS	when	showed	deviation

kimat	*xasrat*	*maʃmaut*	*ʃel*	*axuz*	*ve-ktsat*
almost	devoid.of	meaning	of	percent	and-little

‘In one run, the Garmin watch was precise as it showed an almost insignificant deviation of just over one percent.’ www.haaretz.co.il/sport/active/.premium-1.2309128

c.

ha-xom	*ʃibeʃ*	*l-i*	*et*	*ha-medidot*
the-heat	disrupted.INTNS	to-me	ACC	the-measurements

‘The heat messed up my measurements.

(142)

hu	*kibel*	*maka*	*xazaka*	*ba-regel*
he	received.INTNS	hit	strong	in.the-leg

‘He got hit hard in the leg.’

In these examples an external argument is still required, regardless of whether it can felicitously be called an Agent or not. What these examples show is that a rigid denotation of $\sqrt{\text{ACTION}}$ is difficult to specify, beyond some general notion of a direct cause. I believe it is significant, though, that the verbs in (141)–(142) do not have correspondents in *XaYaZ*. That is, they are not derived by adding $\sqrt{\text{ACTION}}$ to an existing verb or via some process of causativization: *ʃikef* ≮ **ʃakaf*, *diek* ≮ **dajak*, *ʃibeʃ* ≮ **ʃabaʃ*, and *kibel* ≮ **kabal*. They are derived when $\sqrt{\text{ACTION}}$ selects the alloseme of the root directly without having to agentivize a verb in *XaYaZ*.

Let us summarize the semantic contributions of $\sqrt{\text{ACTION}}$:

(143) a. When attaching to an already-existing verb in *XaYaZ*, $\sqrt{\text{ACTION}}$ adds Agent/Actor semantics.
b. When attaching to an already-existing verb in *XaYaZ*, $\sqrt{\text{ACTION}}$ might change the meaning as in (137).
c. When attaching to the root without a verb already existing in *XaYaZ*, agentive semantics need not be entailed (but an external argument is still obligatory).

Why, then, should this element be a root? The same job could in principle be accomplished using a "flavor" of little v, but I see no empirical need for "flavors" of v in my theory. Some other functional head could be invoked, but it would have to be independently motivated. I contend instead that this morpheme behaves more like a root than a functional head: it does not do syntactic work or introduce an argument as syntactic heads do, and it has a range of possible meanings and phonological information that can be associated with it, more in line with a lexical element than a functional one. If $\sqrt{\text{ACTION}}$ is a root rather than a functional head, its partially unpredictable contributions to the meaning of the verb are to be expected.

Even if it were a functional head, the equivalent question would be asked: what kind of functional head is it? As things stand, there is little to choose from in terms of empirical support for one view over the other.

In the phonology, $\sqrt{\text{ACTION}}$ blocks spirantization of the middle root consonant and triggers the insertion of vowels specific to *XiY̯eZ/hitXaY̯eZ*. Neither of these behaviors is problematic: $\sqrt{\text{ACTION}}$ is local to both root and Voice, so it can derive unpredictable semantics from the former and condition allomorphy on both. For a more explicit discussion of the morphophonology see §3.2.2.

2.3.4 *XuY̯aZ* and *huXYaZ*: Passives are predictable

The next two templates are the passive ones. It has long been observed that passive forms in Semitic are more regular than active forms. 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 and Doron 2012; Borer 2013; Kastner and Zu 2015) or lexicalist (Reinhart and Siloni 2005; Ussishkin 2005;

Laks 2011). The meaning of a verb in one of the two passive templates is compositional and transparent in a way that non-passive templates are not. For example, verbs in "passive intensive" *XuY̯aZ* are the passivized version of an active verb in "intensive" *XiY̯eZ*, (144a), and verbs in "passive causative" *huXYaZ* are the passivized version of an active verb in "causative" *heXYiZ*, (144b).

(144) Predictable alternations in the passive templates:

		Active		Passive	
a.	*XiY̯eZ* ∼ *XuY̯aZ*	*biʃel*	'cooked'	*buʃal*	'was cooked'
b.	*heXYiZ* ∼ *huXYaZ*	*heʃmid*	'destroyed'	*huʃmad*	'was destroyed'

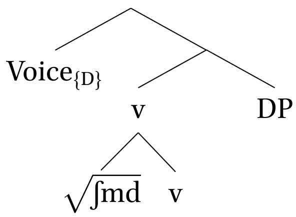
This derivational analysis accounts for two important facts about passives in Hebrew: first, that there do not exist any passive verbs (that is, verbs in *XuY̯aZ* and *huXYaZ*) without an active base from which they are derived; and second, that passive verbs cannot mean anything other than passivization of the active form, where "passivization" means suppression of the external argument via existential closure. In addition, the external argument in a passive clause (whether implied or introduced using a *by*-phrase) must be agentive and cannot be an indirect cause, a requirement that can only come from the passive morpheme (Doron 2003). In (144b), for example, 'destroyed' can have a Cause subject but the implied external argument or overt *by*-phrase subject for 'was destroyed' may only be an Agent.

In order to account for these patterns I adopt the proposal in Doron (2003) and Alexiadou and Doron (2012) that passives are brought about by merger of a head Pass above VoiceP. Pass is incompatible with merger of a DP in Spec,VoiceP immediately below it, requires in the semantics that the external argument be agentive, and is otherwise similar to the Pass head of Bruening (2013).

(145) $[\![\text{Pass}]\!] = \lambda e \exists x.e \;\&\; \text{Agent}(x,e)$ (or see the proposal in Bruening 2013)

Note that it will not do to posit an additional, passive variant of Voice in order to derive passive forms (cf. Embick 2000). This is because an existing VoiceP must be passivized, as indicated both by the meaning and by the phonology (*XuY̯aZ* is always the passive of *XiY̯eZ*, *huXYaZ* is always the passive of *heXYiZ*). Take (144b) for example:

(146)



If *heXYiZ* is derived using Voice$_{\{D\}}$, as assumed, then a transparent passivization cannot be accomplished by changing the Voice head: we would end up with an entirely different construction, one that loses all connection (semantic and phonological) to Voice$_{\{D\}}$/*heXYiZ*.

I leave open the question of why only *XiY̯eZ* and *heXYiZ* have passive counterparts (and *XaYaZ* does not, for example). At this point I see no strong arguments for either a "principled", synchronic analysis (e.g. both templates require an external argument and so passivization is guaranteed to have something to existentially close over) or an "accidental", diachronic analysis (a passive template used to exist in Classical Hebrew but has disappeared from the language). I return to this point briefly in §2.4.1.1.

And I will not have much more to say about the syntax and semantics of verbal passives due to their high degree of regularity, though the discussion does stand to inform our crosslinguistic understanding of passive constructions. To summarize, in Hebrew (as in English) the case is made for an additional Pass head above Voice (Bruening 2013), rather than a passive variant of Voice itself. See Kastner and Zu (2015) for some discussion of paradigm gaps in the passive, and §§4.2–4.3 for discussion of allomorphy patterns. This topic does provide a backdrop for the issue of adjectival passives, which I address in what follows.

2.3.5 Verbal passives and adjectival passives

Since Wasow (1977) it has been customary to make a grammatical distinction between verbal passives and adjectival passives. Wasow shed light on a number of differences between the two constructions, claiming that verbal passives are derived in the syntax whereas adjectival passives are derived in the lexicon. Much work since has agreed that the two constructions are to be distinguished, with the main points of contention falling along two lines: first, whether the two constructions are formed in different modules, i.e. syntax vs lexicon (Wasow 1977; Levin and Rappaport 1986; Horvath and Siloni 2008; Meltzer-Asscher 2011) or solely in the syntax (Embick 2004a; Alexiadou et al. 2014b; Bruening 2014; Doron 2014). And second, what the relevant diagnostics are telling us (Kratzer 2000; Embick 2004a; McIntyre 2013; Alexiadou et al. 2014b; Bruening 2014).

I will summarize the state of the art, adopting a syntax-based approach to the construction of adjectival passives. I will then show that combining the syntactic pieces proposed so far for Hebrew predicts the distribution of adjectival passives correctly. To conclude, I will also give an overview by template. Table 2.6 summarizes the results: a root can be made into a **stative adjective** in any of the three typical morphophonological forms. This fact requires the use of different adjectivizing heads corresponding to the different morphophonological forms (the same mechanism will be used in §2.3.6 for nominalizations). **Adjectival passives** are formed by adjectivizing an underlying verbal structure.

	Interpretation	Heads/structure	EA?	Form	(template)
Adjectives	stative	$\sqrt{\text{root}}$ a_{SMPL}	✗	*XaYuZ*	(*XaYaZ*)
		$\sqrt{\text{root}}$ a_{INTNS}	✗	*meXuY̯aZ*	(*XiY̯eZ*)
		$\sqrt{\text{root}}$ a_{CAUS}	✗	*muXYaZ*	(*heXYiZ*)
Adjectival passives	resultative	[Voice [v $\sqrt{\text{root}}$]] a	✓/✗	*XaYuZ*	(*XaYaZ*)
		[Voice $\sqrt{\text{ACTION}}$ [v $\sqrt{\text{root}}$]] a	✓/✗	*meXuY̯aZ*	(*XiY̯eZ*)
		[$\text{Voice}_{\{D\}}$ [v $\sqrt{\text{root}}$]] a	✓	*muXYaZ*	(*heXYiZ*)

Table 2.6: Adjectival passives in Hebrew by template.

2.3.5.1 Adjectival passives: The state of the art

A number of recent works have greatly advanced our understanding of adjectival passives. It has now become commonplace to assume that adjectival passives which entail prior events are compatible with at least some agents of these events. The main insights are as follows.

Adjectives can be distinguished according to whether they describe a stative characteristic of an entity or a state that has come about as the result of some previous event; this is the stative/resultative distinction from Embick (2004a), who presented the following diagnostics to distinguish between stative *open* and resultative *opened* by way of example.

(147) Event-oriented adverbs: resultatives only for agent-oriented adverbs as in (a), disambiguated readings for other adverbs as in (b).

a. *The package remained **carefully** ✗open/✓opened.*

b. *The **recently** open door* (it was open recently).
*The **recently** opened door* (ambiguous: door was open recently or door was being opened recently).

(148) Verbs of creation (statives only).
*The door was {**built/created/made**} ✓open/✗opened.*

(149) Secondary predicates (statives only).
*John **kicked** the door ✓open/ ✗opened.*

(150) Prefixation of *-un* (mostly resultatives).
*✗**un**open* | *✓**un**opened*

In some cases the morphology indicates whether a certain form is stative or resultative: *open* and *molten* are stative, whereas *opened* and *melted* are resultative. In many cases, however, the form is ambiguous: *closed*, *fractured* and so on. The tests above distinguish "simple" adjectives from adjectives embedding an event. In Embick's analysis, the former are derived by adjectivizing a root, and the latter by adjectivizing an event (vP/VoiceP). Embick's resultatives thus fold in both "target state" and "result state" adjectival passives, a semantic distinction which depends on whether the adjectival passive can be modified by 'still' (Kratzer 2000; Alexiadou et al. 2014b).

Work since has investigated the kind of modifiers that can be attached to an adjectival passive (Meltzer-Asscher 2011; McIntyre 2013; Alexiadou et al. 2014b; Bruening 2014; Gehrke and Marco 2014). At least the following constructions are available for (resultative) adjectival passives in English, German, Hebrew and Spanish. Agent implication is possible:

(151) a. * *The door is opened, but no one has opened it.*

b. * *Die Münze ist schon lange versunken aber keiner hat sie je versenkt*
the coin is already long sunk.Adj but nobody has she ever sunk.PASSPTCP
'The coin has been sunk for a while, but nobody has sunk it.'
(German, Alexiadou et al. 2014b:124)

By-phrases are possible only if their modification of the agent, and therefore of the event, is discernible by examining the end state. One can tell that an editor did good work but not that the editor was bored:

(152) *ha-sefer arux al jedej orex ✓metsujan / ✗mefoamam*
the-book edited.Adj by editor excellent bored
'The book was edited by an excellent/*bored editor.' (Hebrew, Meltzer-Asscher 2011:823)

Similarly, instrumentals are possible only if their modification of the event can be discerned by examining the end state. The writing of a blue pencil is distinguished from that of other pencils but the writing of a pretty pencil is not (though cf. McIntyre 2013 and Bruening 2014):

(153) *ha-mixtav katuv be-iparon ✓kaxol / ✗jafe*
the-letter written.Adj in-pencil blue pretty
'The letter was written with a blue/*pretty pencil.'
(Meltzer-Asscher 2011:825, attributed to Julia Horvath)

Alexiadou et al. (2014b) discuss cases of disjoint reference effects and control into purpose clauses in adjectival passives, further making the point for the agent to be active in the structure in one way or another. In terms of analysis, they synthesize the existing literature by proposing that VoiceP can always be embedded under an adjectivizing head. Put otherwise, Voice is present in adjectival passives that are derived from transitive verbs. This means that resultative participles are derived by merging VoiceP with *a* (or some similar head). The question of why only certain modifiers are possible receives a semantic rather than syntactic explanation: an implicit EA is available even when not represented syntactically, but the kinds of modifiers available for it are restricted semantically (Bhatt and Pancheva 2006). For languages such as Greek which allow all possible modifiers with adjectival passives, a structural explanation is given according to which an aspectual head is embedded below the adjectivizer (Anagnostopoulou 2003; Alexiadou et al. 2014b).

The next analytic question, then, is whether there are any cases in which a vP (but not VoiceP) merges with the adjectivizing head. While the authors present evidence for overt v in certain participles, they do not show that another Voice layer is impossible in such constructions. I will thus assume that the two possible structures are as follows.

(154) a. Adjective (stative): [$\sqrt{\text{Root}}$ a]
b. Adjectival passive (resultative): [[[$\sqrt{\text{Root}}$ v] Voice] a]

Bruening (2014:391) makes note of constructions like *suddenly fallen leaves*, speculating that unaccusative adjectival passives are the result of merging Voice$_{\emptyset}$ with a vP, such that the event-modifying adverb attaches to vP rather than VoiceP. Another possibility is that his example is a case of the adjectivizer attaching to vP, although such an analysis cannot explain why these underlying verbs would be unaccusative in the first place. I will stick to the structures in (154).

I also adopt the following semantics for a resultant state adjective from Kratzer (2000):

(155) $[\![\text{Adj}]\!] = \lambda R \lambda t \exists e,y.R(e)(y)\ \&\ \tau(e) \leq t$

We are now in a position to examine the Hebrew facts.

2.3.5.2 Diagnostics in Hebrew

Adjectival passives appear in one of the two passive participial forms *meXuY̯aZ* and *muXYaZ* (participles of *XuY̯aZ* and *huXYaZ* respectively), or in the *XaYuZ* form associated with *XaYaZ*. Hebrew participles serve as present tense verbal forms and as Romance-style participles, by which I mean a mixed nominal-adjectival category. The Hebrew participle is, in general, ambiguous in form between a verb and an adjective or noun (Boneh 2013; Doron 2013). In *XaYaZ* the active participle can be either a verb or a noun. In other templates (and in the *XaYuZ* passive participle) an adjectival reading is also available, as with *metsujan* 'excellent' in (156b).

(156) a. *ha-ʃelet* *more* *al* *ha-derex* *la-park*
the-sign indicates.PTCP.SMPL on the-road to.the-park
'The sign is indicating the way to the park.'

b. *josi* <u>*more*</u> ***metsujan***
Yossi teacher.PTCP.SMPL excellent.INTNS.PASS.PRES
'Yossi is an excellent teacher.'

What this implies for us currently is that *meXuYaZ* and *muXYaZ* are ambiguous between a verbal form and an adjectival form, just like English *closed*.

Doron (2000) establishes ten diagnostics distinguishing verbal passives from adjectival passives (in fact, many of them distinguish verbs from adjectives in general). Here I give a few examples of what these differences look like. Importantly, only bounded events (change-of-state and inchoatives) can serve as input to adjectival passives (which are resultative).

In active forms, the finite verb often contrasts with an analytic combination of copula and participle. Consider synthetic future verbs (157a) and analytic future participles (157b).

(157) a. Future verb:
maxar *ani* {<u>*oxal*</u> / <u>*aklit*</u>}
tomorrow I will.eat.SMPL will.record.CAUS
'Tomorrow I'll eat/record something.'

b. Future copula with a participle:
maxar* *ani* <u>*eheje*</u> {*oxél*** / ***maklit***}
tomorrow I will.be eat.SMPL.PRES record.SMPL.CAUS
(int. 'Tomorrow I will be eating/recording.')

Doron (2000) shows that verbs are not allowed after a future tense copula, so the forms in (157b) must be adjectives or nominals. They can be used when the participle is used in a generic context as a noun, as in "<u>eater</u> of vermin" (158a) or "<u>recorder</u> of things" (158b). This is to be expected if the complement of the copula in (158) is a participle.

(158) a. Analytic use of the "simple" participle:
az *tagidi,* *ʃe-rak* *ani* <u>*eheje*</u> ***oxél*** *ʃratsim* *ve-ʃ'ar* *mini* *basar*
so say.2SG.F.FUT, COMP-only I will.be eat.SMPL.PRES vermin and-rest kinds.CS meat
ha-'asurin *al* *jehudim? ;-)*
the-proscribed on Jews
'So say so! What, you want me to be the only one here who eats vermin and other kinds of meat that are proscribed for Jews? ;-)'[14]

14. http://www.tapuz.co.il/forums2008/archive.aspx?ForumId=1277&MessageId=96791273 (retrieved November 2014). The example appears in a forum conversation in which participants discuss their experiences eating shrimp in

b. Analytic use of the "causative" participle:

kanir'e *ʃe-ani* *eheje* ***maklit*** *kavua* *ʃel* *ze*

probably COMP-I will.be record.CAUS.Pres constant of this

'Looks like I'll be the one recording this', 'Looks like I'll be a constant recorder of this'

http://www.forumtvnetil.com/index.php?showtopic=18312

It is thus possible to tell apart verbal passives from adjectival passives in Hebrew, and to tease apart different readings of the participle. For example, the implied present tense in (159a) is ambiguous between a verbal (progressive) reading and an adjectival (resultative) reading, whereas the future tense in (159b) is unambiguously adjectival (Doron 2000; Horvath and Siloni 2008; Meltzer-Asscher 2011).

(159) a. *ha-kontsert* *muklat*

the-concert record.CAUS.PASS.Pres

'The concert is being recorded.'

'The concert has been recorded.'

b. *ha-kontsert* *jihie* ***muklat***

the-concert will.be record.CAUS.PASS.Pres

'The concert will have (already) been recorded.'

Kastner and Zu (2015) emphasize two differences between verbal and adjectival passives which were mentioned in passing in the literature (see especially Meltzer-Asscher 2011). First, whereas the analytic forms may have an **idiomatic reading** (160a), synthetic passives (160b) are always compositional (cf. Horvath and Siloni 2009).

(160) a. *ze* *jihie* ***muvan*** ***me-elav*** (idiomatic)

this will.be understand.CAUS.PASS.Pres from-to.him

'It will be self-evident.'

b. #*ze* *juvan* *me-elav* (literal)

this understand.CAUS.PASS.Fut from-to.him

(no immediate clear meaning)

Passive participles, being adjectival passives, can take on idiomatic readings regardless of their template. The passive participle of "simple" *matsats* 'sucked' can have an idiomatic reading (161a), but mediopassive "middle" *nimtsats* is understood literally (161b).

Norway. *ʃratsim* 'vermin' is the traditional term for non-Kosher foods such as seafood. The adjective *asurin* 'proscribed' is written in an intentionally jocular/archaic way, with a final *-n* that has changed to *-m* in the modern language.

(161) a. *ze* *haja* ***matsuts*** ***me-ha-etsba*** (idiomatic)
this was sucked.SMPL from-the-finger
'It was entirely made up.'

b. *ze* *nimtsats* *me-ha-etsba* (literal)
this suck.MID.Past from-the-finger
'This was sucked from the finger.' (no idiomatic reading)

Second, synthetic passives force disjoint readings in which the external argument and the internal argument cannot refer to the same entity (Baker et al. 1989). The adjectival form (162a), with the participle, allows coreference whereas the verbal form (162b) does not (Sichel 2009:720):

(162) a. *ha-jalda* *hajta* ***mesorek-et*** (agent =/≠ theme)
the-girl was comb.INTNS.PASS.Pres-F
'The girl was combed.'

b. *ha-jalda* *sork-a* (agent ≠ theme)
the-girl comb.INTNS.PASS.Past-F
'The girl got combed.'

The picture for Hebrew is thus fairly similar to that in the Romance and Germanic languages discussed in the literature. Where Hebrew differs is in the differences between templates.

All three templatic forms are compatible with both stative adjectives and adjectival passives, as already mentioned. And while all three adjectival passive forms are compatible with external arguments (under the restrictions noted above), adjectival passives in *muXYaZ require* an implied EA to be interpreted.

Doron (2014:170) shows that **stative adjectives** are incompatible with event modifications or event readings. Some of them even have no corresponding underlying verb:

(163) a. *ti'un* *barur* (**bekfida*)
argument clear carefully
'A clear argument'

b. *beged* *mexoar* (**beriful*)
garment ugly$_{\text{INTNS}}$ carelessly
'An ugly garment'

c. *pirxax* *mufra* (**bexipazon*)
brat deranged$_{\text{CAUS}}$ hastily
'A deranged brat'

Doron (2014:175) also observes that (resultative) **adjectival passives** in "causative" *muXYaZ* obligatorily entail an EA, even if it is implicit and not overtly represented. While an adjectival passive in *meXuY̯aZ* does not entail the existence of EA, (164a), every adjectival passive in *muXYaZ* does, (164b). In a telling near-minimal pair, the athletes in (164a) might have trained on their own, but the athletes in (164b) must have been trained through some kind of organized program.

(164) a. *sportaim* *meuman-im* *bekfida* (*meXuY̯aZ*)
athletes trained.INTNS.PASS-PL carefully
'Carefully trained athletes'

b. *sportaim* *muxfar-im* *bekfida* (*muXYaZ*)
athletes prepared.CAUS.PASS-PL carefully
'Carefully trained athletes'

Doron (2014) attributes this difference to the behavior of the causative head γ which underlies *heXYiZ*. My analysis, using Voice$_{\{D\}}$ (as in §2.3.2), follows in the same vein. Note that the implied EA is not syntactically represented; it cannot, for example, create a new discourse referent.

(165) * *nadia* *komanetʃi* *hajta* *sportait* (EA$_i$) *muxfer-et* *bekfida.* ***hu***$_i$ *asa* *avoda* *tova*
Nadia Comăneci was athlete.F prepared.CAUS.PASS-F carefully he did job good
aval *safag* *harbe* *bikoret*
but absorbed much criticism
(int. 'Nadia Comăneci was a carefully trained athlete. He (=Béla Károlyi) did a good job but was heavily criticized.')

Let us derive the different forms.

2.3.5.3 Adjectival passives in Hebrew

Simple (stative) adjectives are derived by merging an adjectivizing *a* head with the root, though we will need to postulate different *a* heads. Resultatives are derived by merging a general *a* head with a full VoiceP.

Stative adjectives have no event implications or internal structure. In the languages discussed above they are derived by merging an adjectivizing head with the root (Embick 2004a):

(166) a. *open* b. *closed* (stative reading)

a. [a $\sqrt{\text{OPEN}}$ a]

b. [a $\sqrt{\text{CLOSE}}$ a (*-ed*)]

In Hebrew, adjectives can appear in various morphophonological patterns.[15] Two of these patterns are homopohonous with the present-tense (participle) verbal passives *meXuY̯aZ* and *muXYaZ*. Therefore, I am forced to assume the existence of two separate adjectival heads, namely a_{INTNS} and a_{CAUS}, alongside any other possible patterns, just like English shows evidence of adjectival *-ed* (*wingéd*, *learnéd*) alongside verbal *-ed*. A given root typically has one basic adjectival form, (167).

(167) a. *barur* 'clear' (*XaYuZ*) b. *katan* 'small' (*XaYaZ*) c. *ʃamen* 'fat' (*XaYeZ*)

a. [a $\sqrt{\text{brr}}$ a_{XaYuZ}]

b. [a $\sqrt{\text{k̯tn}}$ a_{XaYaZ}]

c. [a $\sqrt{\text{ʃmn}}$ a_{XaYeZ}]

An adjective might appear in this form or in the participial-like forms, with either subtle (168a–b) or substantial (169a–b) differences in meaning.

(168) a. *kaur* 'ugly' (*XaYuZ*) b. *mexoar* 'ugly'

a. [a $\sqrt{\text{k'r}}$ a_{XaYuZ}]

b. [a_{INTNS} $\sqrt{\text{k'r}}$ a_{INTNS}]

(169) a. *parua* 'wild' (*XaYuZ*) b. *mufra* 'deranged'

a. [a $\sqrt{\text{pr'}}$ a_{XaYuZ}]

b. [a_{CAUS} $\sqrt{\text{pr'}}$ a_{CAUS}]

An alternative would be to assume that even these stative adjectives have underlying verbal structure, except that this structure is not interpreted. This approach is reminiscent of the Greek facts

15. As noted in Chapter 1, I use the term *pattern* when referring to one of the morphophonological forms in the adjectival or nominal domains. There are, in principle, an unlimited number of distinct patterns, but only seven verbal *templates*.

mentioned in §2.2.1.4. To recap, certain adjectives in Greek can only be derived if a verbalizing suffix is first added to the root. No verbal, eventive semantics is entailed: there is no weaving in (170) or planting for (171). Adjectival *-tos* is argued to need an eventive vP as its base, something which is not possible with nominal roots like 'weave' and 'plant'.

(170) *if-an-tos* weave-VBLZ-ADJ 'woven'

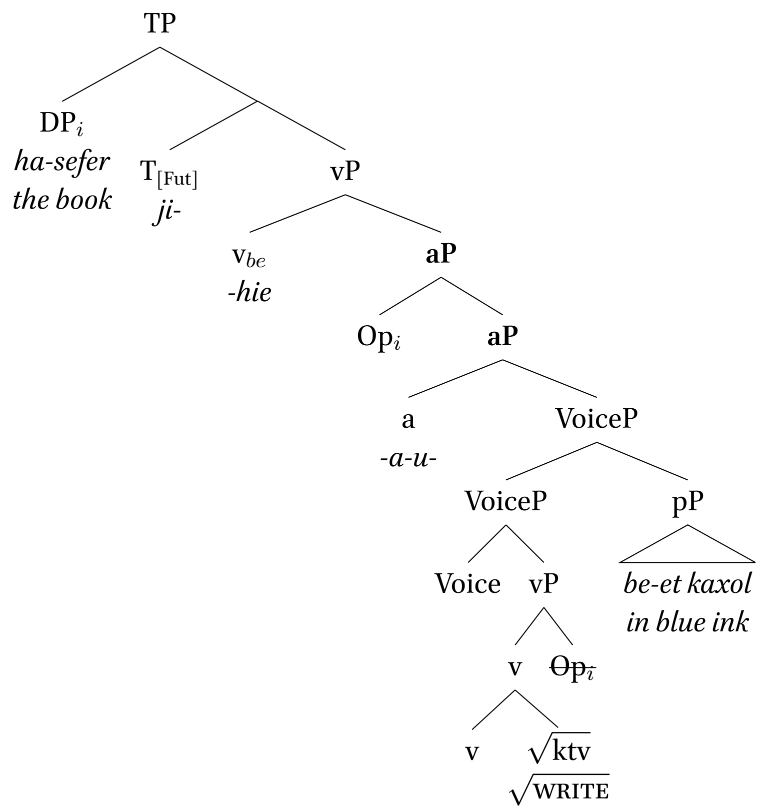
(171) *fit-ef-tos* plant-VBLZ-ADJ 'planted' (Anagnostopoulou and Samioti 2014:97)

Perhaps in the Hebrew cases above there is only one adjectivizing head *a*, which takes a verbal structure that is not interpreted. I do not have particular reason to support one view or the other, and so I stick to the analyses in (168)–(169) simply because they involve less structure. The same point can be made for R-nominals in the next section, §2.3.6. Note, however, that this alternative should then extend to English cases such as (166b): what is to stop us from assuming underlying verbal structure in *closed* which is simply not interpreted before being adjectivized by *-ed*?

Moving on to **resultatives (adjectival passives)**, the main difference between them and stative adjectives is that the former embed VoiceP. The internal argument of adjectival passives has been argued by Bruening (2014:386) to be an Operator, bound by the noun interpreted as the argument.

(172) a. *ha-sefer* *jihie* ***katuv*** *be-et* *kaxol*
the-book will.be written in-pen blue
'The book will be (will have been) written in blue ink.'

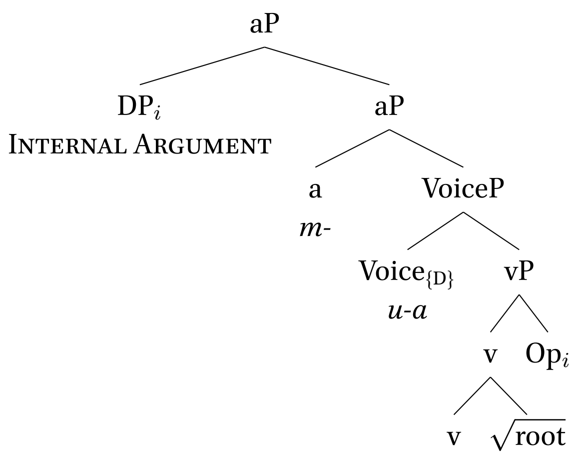
b.



Let us make sure that the combinatorial possibilities of our syntactic inventory predict the correct adjectival passives:

- **[a [Voice [v $\sqrt{\textbf{root}}$]]]** – attested, as in (172).
- **[a [[Voice $\sqrt{\text{ACTION}}$] [v $\sqrt{\textbf{root}}$]]]** – attested, adjectival passive in *meXuY̯aZ*. Our account of $\sqrt{\text{ACTION}}$ predicts agentive entailments.
- **[a [Voice$_{\{D\}}$ [v $\sqrt{\textbf{root}}$]]]** – attested, adjectival passive in *muXYaZ*. Our account of Voice$_{\{D\}}$ requires a DP in Spec,VoiceP. On the other hand, external arguments are not represented in adjectival passives. Intuitively, the result should be an external argument which is not represented syntactically. This seems to be correct, as noted in connection with examples (164–165), where an implicit external argument is entailed.

(173)



- **Voice$_{\emptyset}$** – incompatible with adjectival passives. Informally, adjectival passives denote the result of an event without explicitly naming the cause, though one is assumed; in this sense they are similar to verbal passives. Alexiadou et al. (2014b) and Bruening (2014) implement this by allowing Adj (and Pass) to only select for Voice that needs to fill its specifier. Voice$_{\emptyset}$ is not such a Voice head (although Embick 2004a does allow his Voice$_{\emptyset}$ to derive unaccusative adjectival passives in English): since there is no expectation of an external argument, there is no adjectival passive.

These derivations are similar to the ones in Doron (2014), though I depart from her specific implementation for a number of reasons. First—and as I return to in §2.6.1—the functional heads used by Doron are syntactico-semantic primitives which drive the semantics but do not translate straightforwardly into the morphophonology as syntactic heads usually do. Additionally, and more specifically to adjectival passives, Doron utilizes an active Voice head introducing the EA-related head v, which in turn introduces the external argument. In order to produce a verb in active voice, then, her system needs a lower head that requires Active Voice – this is CAUSE/γ – so that CAUSE introduces Active Voice, Active Voice introduces v, and v introduces the external argument. Some of these heads split up the semantic work that can be done by one head (Voice and v in particular), and not all of them have overt spell-out. There are consequently more syntactic elements than seems necessary. Finally, the agentive head

INTNS/ι is diffused in certain cases, for example in stative *meXuYaZ* adjectives, but it is not explained how this head loses its agentive semantics in this context.

2.3.5.4 Breakdown by template

I will now summarize the main generalizations noted by previous works. The overview proceeds by template and relies heavily on Doron (2000, 2014) and Meltzer-Asscher (2011). Both authors attempted to predict whether a certain root can be instantiated as an adjective, an adjectival passive, or both, in each of the three relevant templates. In general, Doron (2000) notes that change-of-state roots are better inputs to adjectival passives than atelic events.

***XaYaZ* (adjectival form *XaYuZ*)** No verbal passive exists for *XaYaZ*, but stative and resultative adjectives are both possible.

Only change of state roots are possible input to adjectives in this template (Doron 2000). For example, the form **karu* (int. 'read') does not exist as a stative adjective or as an adjectival passive:

(174) *ha-mixtav* *katuv* / **karu*
the-letter written read
'The letter is written (*is read).'

For those roots that can form adjectives, the main difference is between roots that derive intransitive verbs in *XaYaZ* and those that derive transitive verbs. The former lead to stative adjectives and the latter to adjectival passives (see Meltzer-Asscher 2011 for a lexicalist account).

(175) a. Stative verbs from intransitives: *kafu* 'frozen' < *kafa* 'froze'; *davuk* 'glued' < *davak* 'stuck to'.
b. Adjectival passives are possible with change of state roots: *ʃavur* 'broken' < *ʃavar* 'broke'; *sagur* 'closed' < *sagar* 'closed'; *saruf* 'burnt' < *saraf* 'burned'.
c. No corresponding verb in *XaYaZ*, no telos: *paʃut* 'simple', *savux* 'complex', *pazur* 'scatterd', *ʃaluv* 'intertwined', *akum* 'crooked', *tarud* 'preoccupied'.

The roots underlying (175c) do not appear as verbs in *XaYaZ*, meaning that they cannot combine with v and Voice. If this is the case, they cannot form the underlying VoiceP necessary for an adjectival passive and are only possible as input to stative adjectives. For the roots in (175a), their corresponding

XaYaZ verbs are intransitive. This means that the interpretation of [Voice [v $\sqrt{\text{dbk̯}}$]], for example, is unaccusative. If this is the case, then an implicit EA cannot be licensed, since unaccusatives have no EA.

***XiY̯eZ* (adjectival form *meXuY̯aZ*)** Both verbal and adjectival passives are possible in this template. Laks and Cohen (2016) provide evidence that the middle stem vowel might be pronounced slightly differently for verbs and adjectives, further supporting the split between the two.

Among the adjectives, there are two kinds of stative adjectives: those that do not have a corresponding verb, (176a), and those that are homophonous with an adjectival passive like English *closed* is, as it can be stative or resultative, (176b).

(176) a. No corresponding verb: *meguʃam* 'clumsy' (≮ **giʃem*), *meunax* 'vertical' (≮ **inex*), *memuʃma* 'disciplined' (≮ **miʃmea*), *metupaʃ* 'silly' (≮ **tipeʃ*).

b. Ambiguous between resultative and stative: *megune* 'obscene', *mekubal* 'accepted', *mefuzar* 'scattered', *meluxlax* 'dirty', *megulgal* 'rolled up', *mekulkal* 'out of order'.

The verbs underlying (176b), and any which do not fall under (176a), can form adjectival passives. For the forms in (176b), the stative reading is more salient and is often different than the compositional adjectival passive reading. For instance, the adjectival passive *megune* literally means 'that which has been censured'.

***heXYiZ* (adjectival form *muXYaZ*)** Both verbal and adjectival passives are possible in this template.

Stative adjectives are only possible from roots that do not have a corresponding verb in *heXYiZ*, (177a). A form ambiguous with a resultative might also exist, in which case its meaning is different, (177b). For example, *muʃlam* 'perfect (stative adj.)'/'that which has been completed (adj. pass)'.

(177) a. No corresponding verb: *muda* 'aware', *muʃlag* 'snowy', *mugaz* 'carbonated'.

b. Ambiguous between resultative and stative: *muʃlam* 'perfect', *muʃʃat* 'abstract'.

As an innovation, a verb might be back-formed based on adjectives like those in (177a) or derived from the related noun. For example, the substandard verb *heʃlig* 'snowed' is attested in the poet Bialik's work and can be found in use online.

Adjectival passives are available for all roots that have verbs in *heXYiZ*. As discussed above, these constructions entail an implied EA.

2.3.5.5 Summary

In closing, we have now accounted for the existing generalizations regarding what kind of passive (verbal or adjectival) and what kind of adjective (stative or resultative) can appear with what kind of root in each of the templates. Table 2.6 is repeated to conclude this section. The analysis of Hebrew provides further evidence for an eventive layer in adjectival passives. Hebrew also supports the claim that the same morphophonological form can spell out both stative and adjectival passives. This subsection provided an explicit syntax of how the various readings arise.

	Interpretation	Heads/structure	EA?	Form	(template)
Adjectives	stative	$\sqrt{\text{root}}\ \text{a}_{\text{SMPL}}$	✗	*XaYuZ*	(*XaYaZ*)
		$\sqrt{\text{root}}\ \text{a}_{\text{INTNS}}$	✗	*meXuY̯aZ*	(*XiY̯eZ*)
		$\sqrt{\text{root}}\ \text{a}_{\text{CAUS}}$	✗	*muXYaZ*	(*heXYiZ*)
Adjectival passives	resultative	[Voice [v $\sqrt{\text{root}}$]] a	✓/✗	*XaYuZ*	(*XaYaZ*)
		[Voice $\sqrt{\text{ACTION}}$ [v $\sqrt{\text{root}}$]] a	✓/✗	*meXuY̯aZ*	(*XiY̯eZ*)
		[Voice$_{\{D\}}$ [v $\sqrt{\text{root}}$]] a	✓	*muXYaZ*	(*heXYiZ*)

Table 2.7: Adjectival passives in Hebrew by template.

Finally, it is worth pointing out that the adjectival passive is still productive, especially since passives have been characterized as no longer productive in Hebrew, a claim that seems too strong given novel forms such as the adjectival passive *meturgat* 'targeted':

(178) "For whatever reason, after years of complete openness with Google, and full access to all of the data and information that I produce, it looks like the only thing they know about [me] is that I'm a man. Enough already! I'm tired of ads for shaving, cars, insurance and cologne! ..."
ex ani jaxol ligrom le-gugel latet l-i pirsom-ot ʃe-beemet meturgat-ot
how I can to.cause to-Google to.give to-me ad-F.PL COMP-really targeted.INTNS.PASS.PRES-F.PL
el-aj
to-me
'How can I get Google to give me ads that are really targeted to me?'
http://www.facebook.com/elad.lerner/posts/1207164259295353

Here, as elsewhere in the language, only change of state roots can serve as input to adjectival passives.

2.3.6 Nominalizations

This section addresses the deverbal nominalization, also known as gerund, gerundive, action noun and *masdar*. The overall claim will be similar to that made for adjectival passives in §2.3.5: nominal forms can arise in two ways. One is by nominalization of an existing verbal form, in which case the nominalizer is little n and the result is a nominal with internal verbal structure. The other is by nominalizing a root using a nominalizer with specific morphophonological form, which may or may not be similar to that of eventive nominalizations.

I operate under the working assumption that Hebrew has the same three kinds of nouns as English and other languages (Grimshaw 1990; Alexiadou 2010; Borer 2014).

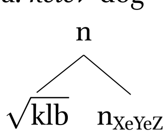
- **"Simple" nominals** appear monomorphemic.
- **"AS-nominals"** (argument structure nominals) are nominalizations of verbal forms. They have internal argument structure and are often homophonous with an R-nominal (see next).
- **"R-nominals"** (result nominals) are nominalizations without argument structure, though they appear polymorphemic. They are often homophonous with an AS-nominal.

Simple nominals have no internal structure: there are no arguments to bookhood.

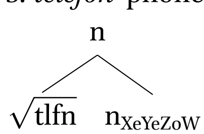
(179) *The enemy's book of the city.

In Hebrew various nominal patterns can be used to derive nouns, all of which are variants of nominalizing little n, just like in English.

(180) a. *kelev* 'dog'



b. *telefon* 'phone'



AS-nominals have internal structure, as discussed at length by various authors (Chomsky 1970; Grimshaw 1990; Marantz 1997; Harley 2009; Alexiadou 2010; Borer 2013). In (181b), Hebrew *haʃmada* 'destruction' is derived from the *heXYiZ* verb *heʃmid* 'destroyed'.

(181) a. The enemy's destruction$_{AS}$ of the city (in less than a day).

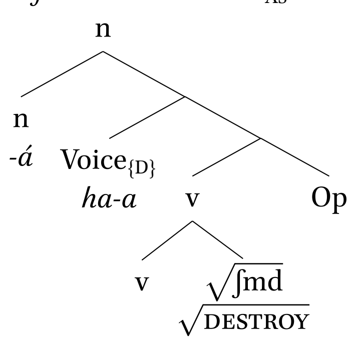
b.

haʃmada-t	*ha-ojev*	*et*	*ha-ir*	(*tox*	*jom*)
destruction$_{AS}$.CAUS-CS	the-enemy	ACC	the-city	within	day

'The enemy's destruction of the city (in a day).'

To derive an AS-nominal, simply nominalize an existing verbal structure by adding n above an existing VoiceP structure (Hazout 1995; Engelhardt 2000). I abstract away from the question of where arguments are generated; we can assume that an operator is base-generated as the internal argument and the full DP is adjoined to the noun, as we did for the internal arguments of adjectival passives in (172). See Borer (2013:559) for a similar conclusion on the similarity between nominalizations and adjectival passives.

(182) *haʃmadá* 'destruction$_{AS}$'



R-nominals and AS-nominals can be homophonous, but they differ in their argument structure. The R-nominal equivalent of (181a) fails the various diagnostics for events:

(183) The destruction$_{R}$ of the city (*in less than a day) was widespread.

Another difference between AS-nominals and R-nominals is that while the meaning of the AS-nominal is transparently related to that of the underlying verb, the R-nominal can have a special meaning. The pair in (184) exemplifies for Hebrew. The form *kibuts* is ambiguous between an action nominalization (AS-nominal) of the verb *kibets* 'gathered' and an R-nominal derived directly from the root.

(184) a. [n [Voice $\sqrt{\text{ACTION}}$ [v $\sqrt{\text{k̯bts}}$]]]
*medina-t israel tihie ptuxa le-alia jehudit ve-le-**kibuts** galujot*
state-CS Israel will.be open to-immigration Jewish and-to-gathering$_{AS}$ diasporas
'The State of Israel will be open for Jewish immigration and for the Ingathering of the Exiles.' (Israeli Declaration of Independence)

b. [n$_{\text{INTNS}}$ $\sqrt{\text{k̯bts}}$]
"According to his testimony, in the early 60s, before he began his political career in the USA, …
*ʃaha sanderz kama xodaʃim be-israel ve-hitnadev be-**kibuts***
stayed Sanders a.few months in-Israel and-volunteered in-kibbutz$_{R}$
…Sanders stayed in Israel for a few months and volunteered in a Kibbutz."
http://www.haaretz.co.il/news/world/america/us-election-2016/.premium-1.2842479

An R-nominal might not even have any corresponding AS-nominal. The R-nominal *kibuʃ* 'occupation' is not derived from an underlying verb in *XiY̯eZ*. AS-nominals like *kibuts* in the pattern *XiY̯uZ* are derived from verbs like *kibets* in *XiY̯eZ*, but the R-nominal *kibuʃ* which has the pattern *XiY̯uZ* is not derived from a verb in *XiY̯eZ*.

(185) a. *daj la-kibuʃ*
enough to.the-occupation$_{R}$
'Down with the occupation!'

b. **kibeʃ*

Separate nominal n heads are needed to derive "R-nominals", just like separate *a* heads are needed to derive stative passives.

(186) *kibuts* 'kibbutz'

n
$\sqrt{\text{k̯bts}}$ n$_{\text{INTNS}}$

The following table summarizes.

(187) Nominalizations in Hebrew and English:

		Hebrew		English
Simple	a.	*kelev*	'dog'	*book, dog*
	b.	*telefon*	'phone'	*phone, car*
AS-nominal	c.	*kibuts*	'a gathering'	*destruction*
R-nominal	d.	*kibuts*	'kibbutz'	*destruction*

The architectural bottom line is that a VoiceP can serve as the input to further derivation. If Pass, little a or little n are merged above it, the result is entirely predictable: a passive verb, an adjectival passive or an AS-nominalization. Adjectives and nominalizations have forced us to make the theory slightly weaker in that there exist independent adjectivizers and nominalizers which look like the existing templates. We have just discussed a nominalizer n_{INTNS} which has the same output as nominalizing an existing verb, [n *XiY̯eZ*]. This result seems to be a necessary evil on the morphophonological side, leading to predictable results on the syntactic-semantic side. Nominalizations and adjectivizations of the root do not have internal structure and might carry different meaning than that of the homophonous complex form derived from the verb.

2.3.7 Summary

These templates complete the morphosyntactic account of the verbal system. The "simple" template *XaYaZ* was shown to be syntactically underspecified but morphologically marked. The "causative" template *heXYiZ* also houses a number of unaccusative verbs. Like in the case of the "middle templates", I argued for structural ambiguity which is not visible in the morphophonology. The two passive templates, which show transparent combinatory behavior, are derived using a head that merges above VoiceP. Finally, adjectival passives and nominalizations can be derived either from an underlying verb or directly from the root, with consequences for argument selection and interpretation.

Table 2.1 is repeated as Table 2.8 to summarize the verbal heads discussed in this chapter. Two themes have been recurrent throughout. First, the interpretation of roots is local (Arad 2003; Marantz 2013a): the first *contentful* head to merge with the root selects its meaning. For example, in a root-derived inchoative verb such as *nirdam* 'fell asleep' in *niXYaZ*, it is $\text{Voice}_{\emptyset}$ that selects the meaning of the verb (v is semantically inert beyond the event variable). This aspect of the architecture also explains why passive verbs are only ever a passive version of the active verbs they are derived from: the Pass head will never be local enough to the root in order to result in special meaning.

Heads				Syntax	Semantics	Phonology	Section
	Voice			(underspecified)	(underspecified)	*XaYaZ*	§2.3.1
	Voice	$\sqrt{\text{ACTION}}$		(underspecified)	Action	*XiY̭eZ*	§2.3.3
Pass	Voice	$\sqrt{\text{ACTION}}$		Passive	Action	*XuY̭aZ*	§2.3.4
	$\text{Voice}_{\{D\}}$			EA	(underspecified)	*he-XYiZ*	§2.3.2
Pass	$\text{Voice}_{\{D\}}$			Passive, EA	(underspecified)	*hu-XYaZ*	§2.3.4
	$\text{Voice}_{\varnothing}$			No EA	(underspecified)	*ni-XYaZ*	§2.2.1
	Voice		$p_{\varnothing}$	EA = Figure	(underspecified)		§2.2.2
	$\text{Voice}_{\varnothing}$	$\sqrt{\text{ACTION}}$		No EA	Action	*hit-XaY̭eZ*	§2.2.1
	Voice	$\sqrt{\text{ACTION}}$	$p_{\varnothing}$	EA = Figure	Action		§2.2.2

Table 2.8: The requirements of functional heads in the Hebrew verb.

Second, argument structure alternations are analyzed as the result of functional heads constraining the interpretation of the root; it will not do to treat templates as entire morphemes, and it will not do to ignore the idiosyncratic requirements of individual roots nor those of semantically defined root classes. Table 2.2 is repeated as Table 2.9 summarizing the root classes discussed and their semantic effects.

Morphology	Section	Verb type	Root type
hitXaY̭eZ	§§2.2.1.1, 2.2.4.1, 2.2.6	Reflexive Inchoative	Self-oriented Other-oriented
hitXaY̭eZ	§§2.2.4.2, 2.2.6	Reciprocal Figure reflexive	Naturally reciprocal Naturally disjoint (Other-oriented)
heXYiZ	§2.3.2	Alternating unaccusative Alternating unergative	Change of color Emission
XiY̭eZ	§2.3.3	Pluractional object Pluractional event	Other-oriented Self-oriented (activity)
Passive participle	§2.3.5	Resultative adjective	Change of state
XaYaZ	§2.3.1	Underspecified	(all)

Table 2.9: The requirements of root classes in the Hebrew verb.

Hebrew is not the only language in which roots place requirements on the syntactic derivation. It has been suggested in different ways that there is a difference between the semantics of $\sqrt{\text{DESTROY}}$, $\sqrt{\text{GROW}}$ and $\sqrt{\text{BREAK}}$ beyond just their meaning, a difference which leads to an inability to take complements in nominalized form (Chomsky 1970; Marantz 1997).

(188) $\sqrt{\text{DESTROY}}$: Change of state, externally caused

a. The enemy's destruction of the city.

b. The city's destruction (by the enemy).

(189) $\sqrt{\text{GROW}}$: Change of state, internally caused

a. *John's growth of tomatoes.

b. The tomatoes' growth (*by John).

(190) $\sqrt{\text{BREAK}}$: Result

a. *John's break of the glass.

b. *The glass' break.

The details are less important than the intuition that something about the lexical semantics of the root constrains what should otherwise be an identical syntactic derivation.

Similar observations have been made more recently for a variety of phenomena in different languages (Haspelmath 1993; Levin and Rappaport Hovav 1995; Schäfer 2008). I have already mentioned the observations on change of state roots in Hebrew adjectival passives in §2.3.5, due to Doron (2014), as well as the discussion of reflexive (or Self-Oriented) and disjoint (or Other-Oriented) roots due to Alexiadou (2014b) and Spathas et al. (2015) in §2.2.4.1. In her work on Italian verbs of motion, Folli (2001) describes different kinds of motion events (roots) which lead to verbs that are either unaccusative, unergative or ambiguous between the two. Levinson (2014) likewise shows that verbs of creation in English license different kinds of syntactic constructions depending on their own semantics. For a summary of additional cases see Alexiadou et al. (2014a) or Kastner (2016).

Furthermore, it has been shown that even within an existing change-of-state alternation, the causative verb may have a meaning that the intransitive does not (Levin and Rappaport Hovav 1995:85):

(191) a. He broke his promise/the contract/the world record.

b. *His promise/The contract/The world record broke.

(192) a. This book will open your mind.

b. *Your mind will open from this book.

(193) a. The waiter cleared the table.

b. *The table cleared.

There is a clear sense in which the lexical semantics of different roots dictates the kind of derivations they may participate in. This topic calls for further research and formalization.

2.4 Crosslinguistic considerations

2.4.1 Heads and features

The framework developed in §§2.2–2.3 makes use of a number of different syntactic heads. In this section I show how these fit into a crosslinguistic theory of argument structure.

Two questions ought to be distinguished when we ask about the crosslinguistic validity of this theory:

1. Does the syntactic inventory of every language always contain these heads (Voice, v and *p*)?
2. Does every language have the kinds of features on these heads that Hebrew does, i.e. $\text{Voice}_{\{D\}}$, $p_{\emptyset}$, $\sqrt{\text{ACTION}}$, etc?

The answer to the first question is yes. I assume that Voice, v and *p* are an inherent part of the syntactic system of every language. I am less certain about the applicative head Appl, but the recent proposal by Wood and Marantz (To appear) which I discuss in §2.4.1.2 below allows us to reconceptualize Appl as a variant of Voice.

The answer to the second question is less clear cut and potentially more interesting. First, we need to ask what features are possible on different heads, for example on Voice.

In Hebrew, I have made the case that Voice can be [+D] as in $\text{Voice}_{\{D\}}$, [−D] as in $\text{Voice}_{\emptyset}$ or underspecified as in default Voice. But the architecture allows any syntactic feature to appear on Voice. Nothing in the setup prohibits $\text{Voice}_{[wh]}$, for instance, which would require a *wh*-phrase in Spec,VoiceP. Now granted, any theory of syntax must stipulate in one way or another which features are possible on which functional elements. One way to restrict our theory is to require only *uninterpretable* features (Chomsky 1995), being purely syntactic features, to exist on Voice. The EPP feature [D] is one such feature. This kind of solution would rely on a certain view of which features are interpretable and which are not; the notion of whether uninterpretable features are necessary has itself been questioned in recent work (Preminger 2014). Ideally, our theory of features on argument-introducing heads would be part of a general theory of argument structure, feeding processes such as case assignment and specifying the triggers for A-movement.

Expanding the crosslinguistic envelope, then, is every language predicted to have the same features on the same heads as Hebrew does? Not necessarily. It is certainly possible that English, for instance, has only one Voice head, so that argument structure alternations such as those in (194) arise through the general underspecification of Voice.

(194) [Voice [v $\sqrt{\text{BREAK}}$]]

a. John broke the vase.

b. The vase broke.

Another possibility is pursued by Schäfer (2008) for German and Wood (2015) for Icelandic, where similar variants of Voice are used as in our system but at times without any phonological indication. I remain neutral with regards to specific claims about these languages, though my preference is to only postulate a variant of a head (meaning a head with a marked feature on it) when there is morphophonological reason to do so.

In some languages it is possible to find overt evidence for these heads. Icelandic Voice$_{\emptyset}$ fits the bill (Wood 2015) and the Greek data discussed by Spathas et al. (2015), reviewed in §2.2.4.1, led to a theory making use of Voice$_{\emptyset}$ (pronounced *-thike*) and $\sqrt{\text{ACTION}}$ (pronounced *afto-*). In recent unpublished work following similar lines, Oseki (2016) proposes that Japanese makes use of Voice, Voice$_{\emptyset}$ and Voice$_{\{D\}}$. The following table summarizes Hebrew, Greek and Japanese. The table is simplified: *niXYaZ* is technically epiphenomenal rather than an exponent of Voice$_{\emptyset}$, to name one example (§2.2.1).

(195) Exponents of syntactic elements in a number of unrelated languages:

Head	Hebrew	Greek	Japanese
Voice	*XaYaZ*	(silent)	*-e-*
$\text{Voice}_{\emptyset}$	*niXYaZ*	*-thike*	*-r-*
$\text{Voice}_{\{D\}}$	*heXYiZ*	?	*-s-*
$\sqrt{\text{ACTION}}$	*XiYeZ*	*afto-*	*-ak-*?
$p_{\emptyset}$	*niXYaZ*	?	?

It thus appears to be potentially useful to adopt this framework for additional languages and map out which heads and features are instantiated in which language.

This framework not only allows us to describe different languages with similar tools, it allows us to ask more fine-grained questions about crosslinguistic variation. Consider the following differences between Hebrew and Greek: The first can lead to new discoveries about Greek. The second can form part of a general theory of lexical semantics and how it interacts with the syntax.

(196) a. Hebrew uses *hitXaYeZ* for both reflexives and reciprocals (§§2.2.4.1–2.2.4.2). Greek uses *afto-* with a nonactive base for reflexives (§2.2.4.1) and *alilo-* with a nonactive base for reciprocals (Alexiadou 2014b).

b. Hebrew Other-Oriented roots are not compatible with $\sqrt{\text{ACTION}}$; their semantics is impoverished, (40). In Greek, only Other-Oriented roots are compatible with *afto-*.

The first difference opens up the following line of questioning: are Greek reflexives and reciprocals different in ways that can inform our understanding of unaccusativity, in the way that Hebrew reflexives, reciprocals and anticausatives in *hitXaYeZ* mask structural differences? To the best of my knowledge, this question has not been explored yet. It is possible to ask this question now, though, since we have a vocabulary with which to describe the system and make predictions. For example, if there is no structural difference between Greek reflexives and reciprocals save for the form of the prefix, it should be the case that the same root can instantiate both constructions, though only if its lexical semantics is compatible with them. See Alexiadou et al. (2014a) for related discussion of crosslinguistic interactions between the lexical semantics of roots and syntactic structure.

The second difference shows that even if we find similar classes of roots crosslinguistically (in this case Other-Oriented roots such as $\sqrt{\text{BREAK}}$ or $\sqrt{\text{HIT}}$), they might not interact with similar elements in the same way. Again, we can develop this theory now that we have a framework for roots of different semantic classes and the syntactic elements they combine with.

Next, in §§2.4.1.1–2.4.1.2, I consider which heads might combine with each other and how the overall inventory of heads might be reduced.

2.4.1.1 Logical possibilities for combinations

Sections §§2.2–2.3 attempted to account for a range of data by exploring the combinations of different heads in the structure. Table 2.8 above provided a summary of how different heads combine in the structure. I will address two points here: what combinations are not attested within Hebrew and what combinations should be attested crosslinguistically.

The unattested combinations are listed in Table 2.10. The final column notes whether the *non-existence* of each form is predicted under our theory (check marks show a good match of theory to data).

	Heads				Syntax	Semantics	Predicted?
a.		$\text{Voice}_{\{D\}}$	$\sqrt{\text{ACTION}}$		EA	Action	✗
b.		$\text{Voice}_{\{D\}}$	$\sqrt{\text{ACTION}}$	$p_\varnothing$	EA, EA = Figure	Action	✗
c.		$\text{Voice}_{\{D\}}$		$p_\varnothing$	EA, EA = Figure	(underspecified)	✗
d.	Pass	Voice			Passive	(underspecified)	✓/✗
e.	Pass	Voice		$p_\varnothing$	Passive, EA = Figure	(underspecified)	✓/✗
f.	Pass	$\text{Voice}_\varnothing$			Passive, No EA	(underspecified)	✓
g.		$\text{Voice}_\varnothing$		$p_\varnothing$	No EA, EA = Figure	(underspecified)	✓

Table 2.10: Unattested combinations of syntactic elements in Hebrew.

The combinations in **(a)** and **(b)** predict a strongly agentive template: $\text{Voice}_{\{D\}}$ requires an external argument and $\sqrt{\text{ACTION}}$ ensures that this argument has agentive semantics. But we have no evidence for such a template, which would have a prefix from $\text{Voice}_{\{D\}}$ and non-spirantization from $\sqrt{\text{ACTION}}$. This gap has no principled explanation: perhaps both heads perform similar enough work functionally that such a template is not necessary. There already exists a head that requires an external argument

(Voice$_{\{D\}}$), and there already exists a head that requires agentive semantics ($\sqrt{\text{ACTION}}$), so the system is in no need of a redundant combination of the two.

It is also possible for (a) and (b), at least technically, that when Voice$_{\{D\}}$ and $\sqrt{\text{ACTION}}$ combine a null allomorph of $\sqrt{\text{ACTION}}$ is selected: thus when a verb in *heXYiZ* is agentive, there is a silent $\sqrt{\text{ACTION}}$ in the structure. This proposal is unfalsifiable and I will not attempt to defend it.

The structure in **(c)** would consist of an external argument saturating the Figure role passed up by $p_{\emptyset}$. In effect, this is what happens in ordinary figure reflexives. Regular Voice carries out this role since if it did not, the derivation would not converge. But I do not think that the combination in (c) is blocked for any principled reason.

It is worth noting at this point that the combinations in (a)–(c) all involve an overt variant of Voice and an overt variant of *p*. Time will tell if this is a spurious correlation or whether this pattern indicates an issue with multiple overt argument-introducing heads.

The combinations in **(d)–(f)** all pertain to the structures Pass can combine with. Pass can only merge with structures that have a guaranteed external argument: Voice$_{\{D\}}$ and $\sqrt{\text{ACTION}}$ are fine, but as seen in the table, the other heads are not. The intuition is that Pass must "know" that it has an external argument to quantify over. This intuition is at least partly compatible with the structures in (d)–(f), and in fact Biblical Hebrew did have a passive counterpart to the "simple" (Voice+v) template. That template has since been lost.

The combination in (f) is correctly predicted not to be possible since Pass has no external argument to quantify over.

Finally, the combination in **(g)** is predicted not to exist, and correctly so. If Voice$_{\emptyset}$ and $p_{\emptyset}$ were to combine, the Figure role of $p_{\emptyset}$ would be passed up but no external argument would be able to saturate it. The derivation would crash at interpretation; this gap is predicted.

On the crosslinguistic angle now, the theory did predict that certain heads could combine. Since $\sqrt{\text{ACTION}}$ is by definition a modifier of Voice, it may combine with Voice, yielding *XiYeZ*, or with Voice$_{\emptyset}$/$p_{\emptyset}$, yielding *hitXaʕeZ*. Because the individual elements all have their own syntax and semantics, the result of combining them is to a large extent predictable.

The combination of $\text{Voice}_{\emptyset}$ and $\sqrt{\text{ACTION}}$ has already been explored for Greek in §2.2.4.1, where it was shown that the two bring about reflexive readings. This is exactly the kind of pattern that is predicted to arise when these heads are in the structure, though as discussed, the rest of the grammar (including the root) needs to be compatible with the construction. At some point along the line the theory should be able to predict how heads combine in a given language, depending on other aspects of the grammar.

Oseki (2016) does suggest that the Japanese causative *-sase* should be decomposed into an Applicative head *-s-* and the $\text{Voice}_{\{D\}}$ morpheme *-s-*, in a system which allows for various combinations of Voice heads. Other combinations thus do seem to be attested in one language where another cannot combine them; in Hebrew this specific combination cannot be examined because Hebrew does not have a "morphological" Appl affix; benefactive and malefactive arguments are introduced using the preposition *le-* 'to'.

(197) *ha-arje bijel ʃu'it (la-jeladim)*
the-lion cooked beans (to.the-children)
'The lion cooked (the children) beans'

Standard Arabic and some Arabic dialects might be more informative. In these languages an "Applicative template" can introduce an applied argument (an extra indirect object) without need for a preposition (Al-Kaabi 2012). It remains to be seen how the Hebrew framework can accommodate patterns in Arabic.

Applicatives bring up a more general point which relates to the kinds of argument-introducing heads in the syntax: the framework as a whole now allows for Voice heads, *p* heads and Appl heads. All are empirically necessary, but recent work suggests that they need not be distinguished theoretically.

2.4.1.2 On argument-introducing heads

In a recent account of the way argument structure is derived and interpreted, Wood and Marantz (To appear) propose to reduce the overall inventory of functional heads. Working within a similar framework, in which much of the burden of deriving properties of the event lies in the semantic component, Wood and Marantz suggest that non-internal arguments (external and applied arguments introduced by Voice, Appl, *p* and P) are in fact variants of the same predicational head. This head is called *i**.

If Wood and Marantz (To appear) are correct, the difference between *p*, Appl and Voice is an illusion: they are all the same predicational head underlyingly, albeit in different contexts. Voice is but *i** that merges with a vP. Little *p* is but *i** that merges with a PP. And P itself is *i** modified by a (prepositional) root.

Our goal here is not to evaluate their proposal, which is supported by conceptual considerations as well as empirical study of figure reflexives in Icelandic, the Adversity Causative in Japanese and possession in Quechua and other languages. Instead, I want to highlight one welcome point of convergence between the *i** hypothesis and my proposal for Hebrew. In the inventory of functional heads I have laid out, $\text{Voice}_{\emptyset}$ and $p_{\emptyset}$ are conspicuously similar: they do similar work in the syntax and have the same spell-out. If we follow the *i** hypothesis, the two *should* be similar: they are the same functional head, only in different contexts.

To be clear, I do not believe that the *i** hypothesis must be true for my account to go through. But if this hypothesis is on the right track, a strong version can be formulated under which all exponents of *i** (as well as its variants $i^*_{\emptyset}$ and $i^*_{\{\mathrm{D}\}}$) should be identical to each other. Such a hypothesis would immediately predict the similarity between Voice and *p*—both default and silent—and that between $\text{Voice}_{\emptyset}$ and $p_{\emptyset}$. Adopting the *i** hypothesis we may modify (195) as (198).

(198) Syntactic elements in a number of unrelated languages, adopting Wood and Marantz (To appear):

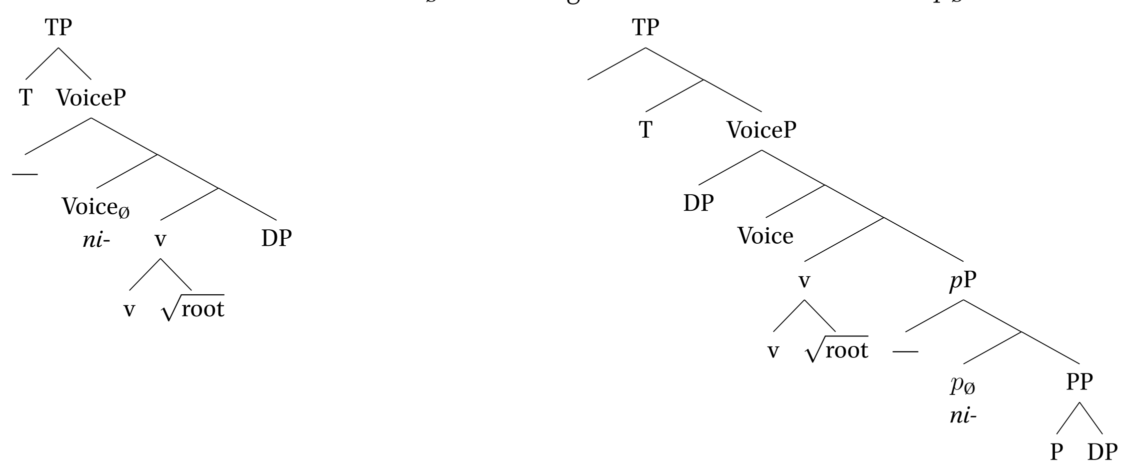
Head	Hebrew	Greek	Japanese
i^*	*XaYaZ*	(silent)	*-e-*
$i^*_{\emptyset}$	*niXYaZ*	*-thike*	*-r-*
$i^*_{\{D\}}$	*heXYiZ*	?	*-s-*
$\sqrt{\text{ACTION}}$	*XiY̯eZ*	*afto-*	*-ak-?*

The i^* hypothesis would also lead us to expect similar correlations crosslinguistically, a prediction which remains to be tested as the tools employed in this dissertation and in related works such as Schäfer (2008), Spathas et al. (2015) and Wood (2015) are extended to additional languages.

2.4.2 A note on morphotactics

This section concludes with a note on linearization and head movement. I have argued that Voice$_{\emptyset}$ starts off high, above v and the root, while $p_{\emptyset}$ starts off below them. Both Voice$_{\emptyset}$ and $p_{\emptyset}$ are supposed to be pronounced identically, as a prefix to the verb and certain vocalic readjustments.

(199) a. Anticausatives in *niXYaZ* with Voice$_{\emptyset}$: b. Figure reflexives in *niXYaZ* with $p_{\emptyset}$:



Not much needs to be said about affixation in (199a) since the structure can be linearized as is. Chapter 3 develops this part of the theory: one morphophonological cycle combines the root with Voice and associated elements, and a second cycle attaches the prefix T. The phonological material on T might end up as a suffix due to general phonological constraints of the language (for example, if T is purely vocalic).

This is a different kind of theory than that of Shlonsky (1989) and Ritter (1995) who assume that all affixation results from head movement of the verb, "picking up" affixes as it moves up the syntactic tree (Pollock 1989) and eventually reaching the tense affixes on T.

Not all analyses assume that V reaches T in Hebrew. According to Borer (1995) and Landau (2006), Hebrew V may raise to T in cases of ellipsis and VP-fronting, but not necessarily in the general case. For Landau, this V-to-T movement is driven by T's need to express inflectional features, which appear on T in Hebrew but may lower to V in other languages or be expressed via *do*-support in English. Implementing affixation using Agree between T and V absolves V of having to adjoin to T itself.

My theory is one in which the syntax lines up the basic structure for the morphophonology to operate on. Hebrew requires intricate allomorphic interactions between tense marking, subject ϕ-features, the features of Voice, modifiers of Voice and the root. This information is distributed across a number of different heads, as explored in this chapter. In the next chapter I restrict the phonological derivation not via head movement but by using two independently needed proposals: that allomorphy is only possible under string adjacency and that the general phonology of the language regulates the construction of phonological words.

Returning to (199b), a challenge arises as we try to linearize $p_{\emptyset}$ between the root and T. The problem is that for all intents and purposes, $p_{\emptyset}$ should be pronounced in the same position as $\text{Voice}_{\emptyset}$ is in (199a). The phonological consequences go beyond just one exponent which needs to be placed correctly: in *niXYaZ* the prefix itself is conditioned by T.

(200) The spell-out of $p_{\emptyset}$ is conditioned by T:

a.	T[Past, 3SG.M]	**ni**-xnas	'he entered'
b.	T[Fut, 3SG.M]	**ji**-kan**e**s	'he will enter'
c.	T[Past, 2SG.F]	**ni**-xnas-**t**	'you.F entered'
d.	T[Fut, 2SG.F]	**ti**-kans-**i**	'you.F will enter'

The upshot is that $p_{\emptyset}$ needs to be local to T in order to correctly spell out its own prefix and add vowels to the stem.

There is a mechanism for exceptional tweaking of individual morphemes in the morphophonology which I can employ: Local Dislocation (Embick and Noyer 2001). This mechanism swaps the linear order of two adjacent morphemes at Spell-out. Local Dislocation is assumed to apply after Vocabulary Insertion; I keep the syntactic labels in (201) for consistency of exposition.

(201) a. Linearized structure:
T-Voice-v-$\sqrt{\text{root}}$-$p_{\emptyset}$

b. Local Dislocation:
$\Rightarrow$ T-Voice-v-$p_{\boldsymbol{\emptyset}}$-$\sqrt{\textbf{root}}$

c. Pruning of silent exponents:
$\Rightarrow$ T-$p_{\emptyset}$-$\sqrt{\text{root}}$

At the end of the day, the analysis in (201) simply formalizes the idea that $p_{\emptyset}$ is a prefix.

Local Dislocation happens after VI, so $p_{\emptyset}$ will not be able to be conditioned properly by T. Instead, I can assume that the actual VI for $p_{\emptyset}$ is *i*-, and the *n*- prefix a partial exponent of T.

Alternatively, standard head movement can raise $p_{\emptyset}$ and adjoin it to v, deriving the correct morpheme order (an implementation like that of Matushansky 2006 will do). The problem is not empirical but conceptual: all other derivations proceed without head movement in word building. Here I require $p_{\emptyset}$ to raise to v. What feature drives this movement? Any feature that accounts for solely this movement would be suspiciously stipulative. But if head movement is more common, does the complex head then raise further, to Voice and then to T? A theory which allows phonological words to be read directly off the structure, but which also allows construction of phonological words by head movement, runs the risk of being too permissive.

Attempts to derive head movement effects have led to various proposals which I cannot contrast here. The operation Conflation (Hale and Keyser 2002; Harley 2013) adjoins only the phonology of a complement onto that of its sister, similar to Local Dislocation. This operation can be thought of as purely phonological Incorporation (Baker 1985, 1988). See Rimell (2012:Ch. 2.5) for an evaluation.

Another theoretical proposal is that of head movement as remnant movement (Koopman and Szabolcsi 2000; Koopman 2005, 2015). On this approach all affixes are heads which take their base as a complement. Suffixes are endowed with an EPP feature raising their complement to Spec, resulting in the affix spelling out to the right of the stem. For this proposal to work, the structure in (199b) would need to be changed since $p_{\emptyset}$, as a prefix, needs to take v+$\sqrt{\text{root}}$ as its complement: [$p_{\emptyset}$ [v [v $\sqrt{\text{root}}$] [PP]]]. But now it is not clear where the prepositional object PP appears. PP is, by hypothesis, the complement of *p*; if we treated it as the complement of v, we would be abandoning the little *p* hypothesis, leaving us with no morpheme to spell out the *ni-* prefix in the first place.

The next chapter fleshes out the morphophonological part of the theory. In the remainder of this chapter I mention a handful of exceptions to the generalizations established thus far and discuss alternative analyses of Hebrew.

2.5 Possible exceptions

In this section I briefly point out four recalcitrant datapoints. Perhaps unsurprisingly, all four are in the *niXYaZ* template; this template has been celebrated in the past as being the least regular of all verbal forms in terms of consistent semantics as well as prosodic shape across tenses (Schwarzwald 2008; Laks 2011).

2.5.1 Verbs of emission

The verbs *ne'enax* and *ne'enak* in *niXYaZ* both mean 'sighed' or 'moaned'. Are they inchoatives (non-active) or figure reflexives (active)? Since they take no prepositional complements, they do not fit the syntactic definition of figure reflexives and are predicted to be nonactive; but they fail the standard unaccusativity diagnostics, as do other verbs of emission in Hebrew (Potashnik 2012; Siloni 2012; Gafter 2014a). I am not aware of previous work on Hebrew discussing these verbs. An analysis of these exceptions, to the extent that one is possible, would rely on investigations of verbs of emission in other languages (Levin 1993; Levin and Rappaport Hovav 1995; Pross 2015).

2.5.2 Some subordinating constructions

At least two *niXYaZ* verbs take a non-finite clause as their obligatory complement:[16]

(202) *dani* {*niz'ak/nexpaz*} *la-'azor* *le-yosi*
Danny rushed.MID to-help.INF to-Yossi
'Danny rushed to help Yossi.'

It is not clear how to analyze these verbs at this point. One possible avenue is to argue that they do embed a *p*P after all, since the *la-* in the infinitive can be analyzed as a preposition (this is diachronically the case), as in (203). This is more of an argument from diachrony.

(203) *dani* *niz'ak* {***la**-'erua* / ***la**-'azor* *le-josi*}
Danny hurried.MID to.the-event to-help to-Yossi
'Danny rushed to the scene/to help Yossy.'

Another is to challenge their status in the synchronic grammar, since both have an archaic feel to them. Nevertheless, these verbs are still used by speakers of the language. Neither of these ways to explain away the data seems attractive at the moment. Perhaps further investigation of *p* as a variant of *i**, as in §2.4.1, will reveal how the same element can introduce a prepositional phrase alongside an infinitival complement.

2.6 Alternatives: root-based approaches

This section contrasts my approach to Hebrew verbal morphology with a number of prominent proposals that share the two major assumptions: morphological structure is built in the syntax, and an abstract root (consonantal in Semitic) lies at the base of the derivation. Lexicalist analyses are reviewed in §2.7.

Returning to the overarching themes guiding this dissertation, a contrast was brought up between the "emergent" approach to verbal templates and the morpheme-based approach. My theory treats templates as epiphenomenal, as does that of Doron (2003) in §2.6.1. The analyses of Arad (2005) in §2.6.2 and Borer (2013) in §2.6.3 treat each template as its own morpheme.

16. I thank Edit Doron for drawing my attention to these examples.

This difference relates to a broader question: how syntax feeds the interfaces. If a template is a morpheme, then there is no strong architectural claim to be made. But if different syntactic structures can give rise to identical morphophonology, as I claim, we are forced into a strong view of the syntax as the sole generative engine. That is to say, if similar interpretations can arise from different syntactic structures—for example reflexive readings with entirely different underlying structures—we are led to a strong view of the autonomy of syntax; the existence of figure reflexives and regular reflexives does not entail one syntax for both constructions. Instead, independent structures may be interpreted similarly. The accounts surveyed below all differ from mine on these points to different extents.

2.6.1 Distributed morphosemantics (Doron 2003)

Like in my theory, the seminal analysis of Hebrew verbs in Doron (2003) employs a number of functional heads to derive the different templates. Doron (2003) was the first to identify basic non-templatic elements that combine compositionally in order to form Hebrew verbs. For example, a causative head γ is used to derive the "causative" *heXYiZ* template, where I make use of a Voice$_{\{D\}}$ head.

This dissertation is influenced directly by Doron's work and to a large extent the heads discussed above mirror hers. Table 2.11 provides an overview.

This chapter	Doron (2003, 2014); Alexiadou and Doron (2012)		
v	V		Event
Voice	v		Causative (external argument)
$\sqrt{\text{ACTION}}$	ι	(INTNS)	Agentive/Action
Voice$_{\emptyset}$, $p_{\emptyset}$	μ	(MIDDLE)	Non-active
Voice$_{\{D\}}$	γ	(CAUSE)	Causative
Pass	π	(PASS)	Passive

Table 2.11: Functional heads in two related theories of Hebrew.

The important conceptual difference is that the elements in the left-hand column are syntactic whereas those on the right can be characterized as morphosemantic: each one has a distinct semantic role. As I hope to have shown, however, it is not the case that a single head derives a single template.

The morphology of *niXYaZ*, for instance, masks a syntactic and semantic distinction between nonactives and figure reflexives. One morpheme such as MIDDLE cannot generate both. Instead, I have argued for a more fine-grained breakdown of verb types in the middle templates, explaining why some are unaccusative and others take obligatory arguments.

The system proposed in this chapter uses contemporary syntactic machinery rather than a new system with Hebrew-specific heads (though Alexiadou and Doron 2012 do extend their system to English and Greek). A Doron-style system takes the semantics as its starting point, attempting to reach the templates from syntactic-semantic primitives signified by the functional heads. Such a system runs into the basic problem of Semitic morphology: one cannot map the phonology directly onto the semantics. There is no way in which a causative verb has a unique morphophonological exponent (which would look like an affix in non-Semitic languages).

To appreciate the difficulty of the task, consider the proposed structure for a "causative" verb like *hefgiʃ* 'caused to meet' (Doron 2003:61). This structure is assumed to contain a MIDDLE head μ as well as a CAUSE head γ:

(204) [External Argument [γ [Internal Argument [μ [$\sqrt{\text{pgʃ}}$]]]]]

While the CAUSE head γ can be argued to reflect a causative morpheme/prefix, the existence of a MIDDLE head μ shows that additional assumptions are required if the semantics is taken as the starting point; this latter head also appears in the "middle" templates *niXYaZ* and *hitXaY̯eZ*, though the semantics and phonology of these templates are different. Furthermore, it is unclear how to derive either the syntax or the phonology from the semantic structure: it is difficult to treat the elements in (204) as morphemes and arrange them in a structure that can be spelled out cyclically; MIDDLE and CAUSE in (204) cannot both be spelled out overtly to derive a single prefix over the internal argument. In contrast, my account explains how the morphophonology can be derived directly from the syntax.

Let us return to reflexive verbs to see a false prediction made by this system. Doron (2003:60) derives reflexives in *hitXaY̯eZ* by assuming that MIDDLE ($\text{Voice}_{\emptyset}$) assigns the Agent role for this root.

This explains why *histager* 'secluded himself' is agentive, hence reflexive. However, if the only relevant elements are Voice$_{\emptyset}$ and the root, then a verb in the same root in *niXYaZ* (where I have Voice$_{\emptyset}$ and Doron 2003 has MIDDLE) is also predicted to be agentive. This expectation is incorrect: *nisgar* 'closed' is unaccusative. The previous analysis is almost a mirror image of the one presented here: while I let $\sqrt{\text{ACTION}}$ add agentivity to a structure with Voice$_{\emptyset}$, thereby deriving reflexives, the morphosemantic account invokes added agentivity for certain roots, bypassing the syntax in ways that lead to false predictions.

I should take a moment to emphasize the most important gains of the morphosemantic theory. Treating templates as emergent from heads that do separate syntactic and semantic work gave us a new way to analyze argument structure alternations across templates, based on a wealth of empirical data. The theory also made a compelling case for the root as an atomic element participating in the derivation, making a number of novel observations along the way. Where we have made progress in this dissertation it is by flipping one of the assumptions on its head: that the primitives have strict syntactic content and flexible semantic content (allosemes), rather than strict semantic content and unclear syntactic content.

2.6.2 Templates as morphemes (Arad 2005)

In juxtaposition to an emergent view, Arad (2005) treated verbal templates as distinct spell-outs of Voice. Together with Arad (2003), both works mounted a strong defense of the root as the base of the derivation beyond Hebrew as well.

For Arad, templates are different "flavors" of v, each a separate CV-skeleton, and the vocalic melody is inserted at Voice. Each template might have a feature such as [−transitive], which is shared by *niXYaZ* and *hitXaY̭eZ*. The general problem with morphemic approaches to templates has been raised a number of times so far. A given template simply does not have a deterministic syntax or semantics (save for the two passive templates). Arad (2005:198) actually speculates that a configurational approach (like in our theory) might be more viable than a feature-based approach.

Regarding argument structure alternations, Arad (2005) claims that all templates can derive roots from verbs but that two of the templates—*niXYaZ* and *hitXaY̯eZ*—can also derive verbs from other verbs. In so doing, she hopes to capture alternations such as those between *XaYaZ* and *niXYaZ* or between *XiY̯eZ* and *hitXaY̯eZ*. When Arad tries to predict which templates can detransitivize or causativize verbs in other templates, she is forced to stipulate these relations. The basic observation is entirely accurate, in my view: in a given template, some verbs are root-derived and some are derived from another verb in a different template. In *niXYaZ*, inchoatives are root-derived and anticausatives are derived from underlying active verbs in *XaYaZ*. I submit that the theory as a whole is more constrained if functional heads have specific syntactic and semantic properties; idiosyncrasy can then be left to the root, as proposed by Arad herself.

2.6.3 The Exo-Skeletal Model (Borer 2013, 2015)

Another contemporary morphemic approach to templates is sketched in the Exo-Skeletal Model of Borer (2013:Ch. 11). The bulk of Borer (2013) is devoted to developing the model based on English, with the Hebrew chapter included for cross-linguistic support and as the beginning of an exploration in its own right. Given that the Exo-Skeletal analysis is still preliminary, I do not expect it to address as wide a range of phenomena as I attempt to cover in this dissertation. Nevertheless, it is worthwhile pointing out a number of potential problems as this type of analysis is developed in the future.

On the Exo-Skeletal approach, templates are once again derivational morphemes with no hierarchical structure between them. All objections I have leveled at the morphemic approach to templates are valid here too. It is not clear what the syntax and semantics of a given template should be (other than with the two passive templates) given the range of verb types that can appear in each templatic form. Borer (2015) speculates that additional features like the heads from Doron (2003) can condition the selection of certain templates, but the question then arises of how the relation between these features and these templates should be seen.

In order to derive argument structure alternations, Borer (2013:564) raises the possibility that some templates might stand in a hierarchical relationship to others, for example *XiY̯eZ* and its detransitivized version *hitXaY̯eZ*. The promissory discussion seems to single out these two templates but leaves open the possibility of additional hierarchical relations, rightly in my view.

The empirical core of Borer's chapter lies in patterns of nominalization and with the underspecification of *XaYaZ*. Her view of nominalization is similar to mine in §2.3.6 and her analysis of *XaYaZ* is similar to mine in §2.3.1; see also §3.4.4. To a large extent the hypotheses converge, though I maintain that an analysis of Hebrew in which templates are individual morphemes cannot have the same empirical coverage or even conceptual consistency as the kind of account provided in this dissertation.

2.7 Alternatives: stem-based approaches

Syntactic derivations with functional heads are necessary if we are to predict argument structure alternations correctly. As the next chapter shows, these heads also allow us to account for the morphophonology. But before proceeding we must discuss a different kind of alternative analysis. The other notable attempts to derive the Hebrew patterns are lexicalist, stem-based ones, which I consider next.

2.7.1 Morphomes and conjugation classes (Aronoff 1994, 2007)

Aronoff (1994, 2007) puts forward a view of morphology as an independent component of the grammar. His view is committed to treating individual stems (lexemes, "morphomes") as the basic lexical unit that feeds additional derivation and inflection. On such a view, each template is in essence a different conjugation class. Roots do not exist as contentful elements, only as collections of consonants over which paradigmatic, phonological generalizations can be made (though Aronoff 2007:827 does suggest to treat them "much like Latin roots").

Theoretical differences aside, Aronoff's framework makes no attempt to explain the argument structure alternations in the language. There is no attempt to account for how reflexive verbs only appear in *hitXaY̯eZ*, or why verbs in *XiY̯eZ* are agentive, or indeed any of the phenomena discussed thus far. Divorcing roots from meanings also does little to explain why meanings do persist across templates for a given root, or to delineate in what configurations meaning must be conserved (transparent argument structure alternations) and where special meaning can be tapped (alloseme of the root).

2.7.2 The Theta System (Reinhart and Siloni 2005; Laks 2011)

Reinhart and Siloni (2005), and following them Laks (2011, 2013a,b, 2014), present a lexicalist account of the causative alternation in Hebrew. These works argue that a process of decausativization applies in the language. Under such a view, causative verbs are the basic verbal forms in the language, from which the speaker derives reflexives, anticausatives and reciprocals in other templates. Each template thus has a prototypical role in the lexicon. For example, *XiY̯eZ* houses causative verbs, from which anticausatives in *hitXaY̯eZ* are derived.

The question then arises of how to account for nonactive verbs that have no active alternation in another template. If there is no active base, how can a decausativized alternation arise? This is exactly the case of inchoative middle verbs, described in §2.2.1.3. The proposed solution is that the causative verb exists in the lexicon as a *frozen* entry, a verb that cannot be used in the syntactic derivation but can be used in the lexicon to derive other forms.

Two objections now arise. First, this kind of theory does not explain why a given template has whatever morphosyntactic behavior it has, e.g. transitive or intransitive, reflexive or not. The generalizations are stipulated on a template-by-template basis: *niXYaZ* and *hitXaY̯eZ* are anticausative, for example, because they do not receive a [cause change] feature in the lexical derivation. Yet we have seen that these "middle" templates are not intransitive across the board; they do house active verbs, specifically figure reflexives and in some cases reciprocals. Under a decausativization analysis, middle templates are correctly predicted to be more marked than their active bases; but it is not explained why each template has the specific morphophonological characteristics it has, and to what extent these correlate with its morphosyntax.

The second problem has to do with the notion of a "frozen" lexical entry. According to Laks (2014:116), "[*F*]*rozen entries lack phonological matrix and morphological properties* [...] *but they are assumed to be conceptually represented in the lexicon. The frozen entry, which is not accessible for syntactic derivations, can nonetheless serve as input for lexical operations.*" It is unclear how this notion can be falsified if a "frozen" entry exists to rescue the theory whenever one is necessitated. In fact, what this approach is relying on is a concept very similar to the abstract root while denying it at the same time.

One recent attempt to demonstrate that the "frozen" idea is falsifiable is described by Fadlon (2012), who presents two experiments that are claimed to adjudicate between the lexicalist analysis of Reinhart and Siloni (2005) and the structural analysis of Arad (2005) in favor of the former. However, on closer inspection the results do not provide support for one theory over the other.

2.7.2.1 Experimental arguments for "frozen" entries (Fadlon 2012)

The experiments carried out by Fadlon (2012) were set up as follows. Native speakers of Hebrew performed a rating task in which they read a vignette that was followed by a question. The vignette included an event for which one of the participants could be construed as a causer. For example, in one story Mary was carrying a dish that fell out of her hand, causing John to gloat. The participant was then asked to rate, on a scale of 1–8, whether Mary was "the executor of one specific action that resulted in the gloating of John" (Fadlon 2012:213).

The intuition behind this setup was that in order to facilitate the unaccusative concept of "falling", participants would have to invoke the causative alternation from which the anticausative is postulated to emerge via decausativization. A cline is thus hypothesized, on which causative verbs that have decausativized alternations (vocabulary items) like English *break* are more accessible than causative frozen lexical entries with decausativized alternations (compare English *gloat*). These in turn are more accessible than concepts that have no causative representation in the mental lexicon whatsoever, perhaps like English *appealing*.

The corresponding three groups of materials were as follows. Causative verbs with anticausative alternations included pairs such as *niʃbar* 'broke (intransative)' < *ʃavar* 'broke (transitive)'. Yet this group also included pairings such as *nafal* 'fell' < *hepil* 'caused to fall' which switch from the *XaYaZ*∼*niXYaZ* alternation to the *XaYaZ*∼*heXYiZ* alternation. The alternations are equivalent on Theta Theoretic assumptions but not on my own. In my assessment, this switch moves us from testing morphosyntactic alternations to testing semantic alternations. This is not to say that the Theta Theoretic assumption is wrong: the distinction is simply an integral part of the difference between the two frameworks, and as such needs to be acknowledged when setting up a comparison between theories.

Frozen entries with existing unaccusative consisted of verbs such as *herkiv* 'rotted', which have a corresponding adjectival passive but no causative version. As noted in §2.3.2.2, though, causative alternations in this template are attested and in fact predicted. These are similar to what I have dubbed "inchoatives". Fadlon (2012) calls them "one-place unaccusatives."

For the third group, Fadlon was in need of verbs that can never alternate and for whom a causative alternation is not possible. These are argued to be experiencer verbs as in *xamak mi-meni* '(the idea) escaped me' or *medaber elaj* '(the idea) appeals/speaks to me'. These verbs are called "two-place unaccusatives" and the idea is attributed to Pesetsky (1995). I will challenge the assertion that these verbs are unaccusative in Hebrew, but let us first turn to the results.

The hypothesis states that having a word exist in the vocabulary enhances access to its concept and that having an entry in the mental lexicon enhances access as well. There is no mention of whether the stimuli were matched for frequency, and the two effects are argued to be cumulative. Hence, alternating verbs are predicted to be the most accessible, followed by "one-place unaccusatives", followed in turn by "two-place unaccusatives". The results of Experiment 1 bear out this prediction (Fadlon 2012:214), as evaluated based on subjects' ratings.

Yet while the results are consistent with Fadlon's hypothesis, they do not refute the root-based account of Arad (2005) nor are they problematic for my own theory. If it is indeed true that there is no such concept as "cause something to escape x's attention", and that there is no causative verb for this concept in any human language, then whatever constraint enforces this gap would be active no matter what the morphological architecture is. Specifically, Arad (2005) makes no prediction about the behavior of "two-place unaccusatives" or about a relevant ontology of roots.

Granted, an explicit theory that makes a prediction is more useful than a theory that does not make a prediction. Ideally, we would want to derive the relevant prediction from Arad's system. But as alluded to above, this is impossible because the so-called "two-place unaccusatives" resist any kind of unaccusative analysis. The list of these verbs used in Experiment 1 is reproduced in (205)–(207). All three subsets suffer from various confounds, but most importantly, all fail unaccusativity diagnostics.

The items in (205) are (i) in the "intensive", active template, containing $\sqrt{\text{ACTION}}$ under our analysis, and (ii) present-tense forms. The present tense can be used as a participial form or an adjective (§2.3.5) so we might be facing a confound in the materials; Fadlon (2012) does not discuss whether adjectives should pattern with verbs, although her reliance on "one-place predicates" corresponding to adjectives but not to causative verbs implies that verbs and adjectives should be treated differently. The forms in (206) are similarly participial/adjectival forms.

(205) Present (participle, adjectival) forms of the "intensive" template.

a. *medaber el* 'speaks to', 'appeals to'

b. *meʃane le* 'matters to'

(206) Present (participle, adjectival) forms of the "simple" template.

a. *xaser le* 'is lacking for'

b. *xore le* 'unpleasing to'

The forms in (207) are past-tense verbs in the "simple template". They do not easily pass unaccusativity diagnostics. Possessive datives are impossible, since an affected object is already specified. VS order does not sound natural, either.

(207) "Simple" template verbs.

a. *xamak me* 'escaped from'

b. *matsa xen be-ejnej* 'appealed to'

In sum, of the "two-place unaccusatives", none strike me as truly unaccusative, at least not by the diagnostics given in this dissertation. Even if this were the case, all a root-based theory would have to say is that these two roots are special, for exactly the same reason that Fadlon (2012) requires them to be special. The results of Experiment 1, then, are entirely consistent with both a lexicalist analysis and a root-based analysis.

Experiment 2 sought to eliminate a double confound in Experiment 1: the "two-place unaccusatives" are two-place predicates, unlike the "one-place unaccusatives", but are also psych-verbs. To this end, Fadlon (2012) compared the psych-verb "two-place unaccusatives" of Experiment 1 with a class of two-place psych verbs that do participate in the causative alternation. These are object experiencer verbs such as *worry*: *The doctor worried John* and *John worried* are both possible. Since the causative alternation exists, the corresponding unaccusative ought to be more accessible. The verbs used are given in (208). In our system these would all be analyzed as figure reflexives or active verbs, not as unaccusatives. As noted by Fadlon herself, they are two-place predicates.

(208) a. *hit'anjen be-* 'got interested' (< *injen* 'got someone interested')

b. *tama al* 'wondered about' (< *hetmia* 'was puzzling')

c. *hitsta'er al* 'was sorry about' (< *tsi'er* 'saddened')

d. *nidlak al* 'got excited about' (< *hedlik* 'turned on')

e. *hitrageʃ me-* 'got excited from' (< *rigeʃ* 'excited')

f. *hitja'eʃ me-* 'got discouraged' (< *ji'eʃ* 'caused despair')

While the case could be made for a more elaborate analysis of psych-verbs (Belletti and Rizzi 1988; Landau 2010b), Fadlon (2012) does not engage with one for the verbs she is considering.

The results of Experiment 2 run contrary to the prediction. While it is expected that the condition associated with the newly introduced verbs in (208) would lead to a more accessible representation, the opposite result was found. Unaccusatives that participate in the causative alternation are the most accessible, though their median score drops from 8 in Experiment 1 to 6.5 in Experiment 2 (presumably due to different vignettes being used). These verbs are followed by the "two-place unaccusatives" (median score 5) and then by the verbs in (208) with a median score of 4.

In order to explain this pattern, the author attributes the result to the thematic role of the subject in these sentences. For "two-place unaccusatives" as in *The idea escaped Danny's mind*, the subject is an inanimate Theme. The controls introduced in Experiment 2, as in *Joey got interested in fashion*, feature animate Experiencers as subjects. Recall the task: participants rated how likely it was that an animate Causer brought about the target event. For instance, how likely it was that Danny's sister caused the idea to escape his mind, or how likely it was that Dave caused Joey to be interested in fashion. With this in mind, the author argues that "*Causers established in the context as affecting inanimate objects were rated higher, while causers established as affecting humans were rated lower. The reason for this is that when the affected entity is human, it is more likely to share or to be viewed as sharing responsibility for the event taking place. As a result, the causer's part in the execution of the event is rendered less perceptible*" (Fadlon 2012:223). In other words, since we have already picked out one animate causer, we are unlikely to pick out another. This line of reasoning cannot be evaluated without a more articulated picture of what judgment the participant is performing. To play devil's advocate, perhaps we ought to have expected structural (syntactic) priming, in which case picking out an animate causer will actually make us *more* likely to pick out another animate causer? In a footnote, the author mentions that an additional unpublished experiment eliminates the animate-causer confound and produces the expected results (Fadlon 2012:224ff13).

To wrap up discussion of Fadlon's contribution, there is no ignoring the fact that she has documented a number of patterns that any theory of the mental lexicon would need to deal with. That said, there are two main flaws in the argument: firstly, the crucial condition with unaccusative verbs involves verbs that are not unaccusative, and secondly, it is not shown that the theory she attempts to dismiss (Arad 2005) is unable to account for the results. Therefore, I conclude that we are still better off letting go of the "frozen" hypothesis, and that in any case it is not superior to a structural, root-based account.

2.8 Conclusion

The main issue addressed in this chapter was the following: how are semantic roles distributed in the syntax and how are they reflected in the morphology. The overarching question is a familiar one from linguistic theorizing: what does the learner need to know about each and every construction (root, verb) and what can be underspecified? If the learner knows that a verb in *niXYaZ* has one fewer external argument, for example, then she does not need to memorize that fact about each and every verb in that template.

I have argued for a system in which neither θ-roles nor valency-reducing operations are necessary. Instead, an active syntactic structure and a nonactive syntactic structure—that is, one with an external argument and one without—can both result in the same "middle" morphological marking. The correct interpretation of the verb is a result of functional heads combining with an idiosyncratic root.

The analysis presented here attempted to answer a general question and a specific question relating to the morphology of Modern Hebrew. Generally, it is the case that one cannot predict the meaning of a verb from its morphophonological form (its template), nor can one predict what template a verb will have based solely on its meaning. The solution to this mapping problem was implemented in a system that builds syntactic structure and then interprets said structure at PF and LF. For a consistent system to be set up, templates must be viewed as emergent from functional heads in the structure and not as morphemes, which is the traditional view.

Once the structure is set up correctly, roots have the power to influence the interpretation at the semantics. I have sketched what a framework looks like that allows us to discuss the empirical and theoretical consequences of root semantics: the structure also needs to be interpreted under certain locality constraints. In this chapter it was argued that strict adjacency of the nearest contentful element is the deciding factor in selecting the alloseme of the root. This element is usually, but not always, the first categorizing head.

In the next chapter I argue that the same locality constraint holds at the parallel interface, that with phonology. We will derive the morphophonology of the templates and in so doing bolster the arguments for root classes active at the interface and against templates as morphemic primitives.

Chapter 3

MORPHOPHONOLOGY

3.1 Introduction

In the previous chapter I asked what the learner needed to specify about each and every verb and what can be underspecified if she is to learn the morphology of the language as a whole. If the learner knows that a verb in the *niXYaZ* template does not have a direct object, then she does not need to memorize that fact about each and every root instantiated in that template, i.e. for each and every verb in *niXYaZ*. Similarly in the phonology, the question is what is lexically specified (crucially depends on the underlying representation) and what must be the same across the paradigm (underspecified and can be filled in by the grammar). For Modern Hebrew, this can be put the following way: what can vary between templates and what cannot? When can the root do exceptional things and when is it reigned in?

In this chapter I derive the templatic effects themselves, giving the spell-out for each of the morphemes discussed in Chapter 2. The technical goal is to devise a formal system that gets the morphophonology of the verbal system right. Working within a contemporary theory of locality in morphology, we will be led to expect lexically specific phonology in certain (local) configurations but not in others. This will be shown to be correct.

The theoretical contribution lies in (i) supporting a certain theory of locality domains for allomorphy, (ii) showing that these morphophonological domains are fed by the syntactic structure, and (iii) developing an account of templatic morphophonology without templates.

The current gaps in our knowledge of the Semitic morphophonological system can be summed up as follows.

(209) a. How do the morphosyntactic and morphophonological systems interact in Hebrew? In other words, how do we characterize the contribution of a template?

b. What are the relevant building blocks? Are the templates morphemes? If not, why is their phonology so regular?

c. Are the vowels morphemes? If so, what morphosyntactic features do they reflect? What must the speaker know about them?

The current section sets the stage by describing lexical exceptionality in phonology and the relevant structural representations, in order to establish a common background, before proceeding to outline the rest of this chapter. When I use the term *template* it is as a descriptive term for a collection of exponents in a paradigm. As argued throughout the dissertation, the template is not a morpheme.

3.1.1 Morphologically triggered phonological alternations

This chapter concerns itself with phonological alternations. Alternations can be thought of as sitting along a continuum, from fully predictable phonological alternations to completely arbitrary suppletion (see Embick 2010, 2015 and Nevins 2011 for discussion). At one end are "purely" **phonological alternations**, wherein one phoneme might have different allophonic pronunciations which are not indicative of specific morphosyntactic structure. For example, the English rule of intervocalic /t/-flapping turns /raɪt̠-ər/ to [raɪɾ̠ər]. English /t/ and /ɾ/ are not contrastive.

(210) Phonological alternation

a. *write* /raɪt/ → [raɪt̠]

b. *writer* /raɪt-ər/ → [raɪɾ̠ər]

Moving along the continuum, the conditioning environment can be determined by factors beyond the general phonology of the language. Allomorphs might be conditioned by phonological environment or morphological environment. One type of **morphologically conditioned allomorphy** is triggered by the **morphophonological environment**, relating to certain morphemes and their phonological exponent. The English indefinite article shows such behavior: it is *an* before vowels and *a* before consonants. The use of *an* prevents hiatus of *a* and a following vowel. The allomorph is chosen based on phonological context.

(211) Phonologically conditioned allomorphy

   a. *a dog*

   b. *an apple*

While the alternation can be seen as preventing a sequence of two vowels, hiatus is allowed elsewhere in the language: **a apple* but ✓*banana attack*. Still, certain nouns pose exceptions to the rule. For instance, /h/-initial nouns show variation: some speakers prefer *an historic*, even though their /h/ is otherwise as much a consonant as their other fricatives. A similar example can be found in Spanish, where feminine nouns ordinarily take the feminine definite article *la* rather than the masculine definite article *el*. Yet when the noun itself begins with a stressed *á*, the *el* allomorph of the determiner is chosen in order to avoid the sequence *a á* (Harris 1987; Nevins 2011). These alternations are conditioned by the phonological context without being purely phonological themselves.

(212) a. la mesa
   the.F table.F

   b. el libro
   the.M book.M

   c. el agua
   the.M water.F

In other cases of morphologically conditioned allomorphy, the conditioning environment is **morphosyntactically determined** with no direct reference to the phonological environment: the past tense of an irregular verb like *get* is *got*.

(213) Morphosyntactically conditioned allomorphy:
get ∼ *got*

At the other end of the continuum are alternations which have no plausible phonological basis. **Suppletion** is the canonical case of unpredictable morphophonological alternations: no phonological constraint or rule of English leads us immediately from *go* to *went* or from *person* to *people*.

(214) Suppletion
  a. *go* ∼ *went*
  b. *person* ∼ *people*

Even if an attempt is made to break suppletion down into separate parts, such that *went* is analyzed as a suppletive stem *wen-* and the past tense suffix *-t* (following Embick and Halle 2005), the fact remains that most of this process must be lexically specified outside of the phonology proper. In this context, however, see Gouskova et al. (2015) for the reverse argument to the effect that all allomorphy is essentially arbitrary and lexically-conditioned.

The relevant question to our study lies in how exceptionality is constrained. If a morpheme can exhibit exceptions to a rule, can it always do so regardless of the form it is embedded in? In the following sections I identify a number of cases in which different classes of Hebrew roots show exceptional behavior. Then, adopting a theory of locality domains for allomorphy, we will predict and verify that under certain configurations, exceptionality gives way to invariance across the paradigm. These results flesh out a theory of the kind of alternations that exist in a language and the kind of information that a learner must acquire. As a side effect we will also derive the templatic morphophonology of the language.

3.1.2 Exceptionality in spirantization

We begin by examining the Hebrew data more closely. The consonantal inventory of Modern Hebrew is given in Table 3.1, where the highlighted segments are those that undergo spirantization to their fricative counterparts. Segments in parentheses are either limited to loanwords (tʃ, dʒ, ʒ) or are slowly disappearing (ʔ, h). See §1.4 for some comments on the dialect described here and Gafter (2014b) for a study of dialectal differences. I transcribe /ɡ/ as "g", /ts/ as "ts", /χ/ as "x" and /ʁ/ as "r".

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

Table 3.1: The consonantal inventory of Modern Hebrew.

Most consonants do not spirantize, (215a–c), but the stops /p/, /b/ and /k/ undergo lenition to [f], [v] and [x] following a vowel, (215d–f).

(215) Spirantization:

	Root		Past 3SG.M	Future 3SG.M
a.	'light'	√dlk̯	dalak	ji-dlok (*ji-zlok)
b.	'steal'	√gnv	ganav	ji-gnov (*ji-ɣnov)
c.	'find'	√mtsʔ	matsa	ji-mtsa (*ji-vtsa)
d.	'cancel'	√**b**tl	**b**itel	je-**v**atel
e.	'met'	√**p**gʃ	**p**agaʃ	ji-**f**goʃ
f.	'write'	√**k**t**b**	**k**ata**v**	ji-**x**tov

It has been questioned whether this process is fully productive, with the first large-scale investigation appearing in Schwarzwald (1981a). Findings are mixed, depending to a large extent on the phonological and morphological environment, but spirantization does appear to be a general rule of the language. I will now concentrate on one morphological environment where this alternation is blocked and one class of exceptional roots.

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

3.1.2.1 Exceptions in the morphology

Recall our notation: X, Y and Z stand for the consonants in the $\sqrt{\text{root}}$. For cases where spirantization is blocked I borrow the non-syllabic diacritic: Y̯.

In the verbal templates *XiY̯eZ* and *hitXaY̯eZ* the middle consonant does not spirantize. For an overview and critical assessment, see Schwarzwald (1981a), Adam (2002), Martínez (2010, 2013) and Gouskova (2012); I will treat this generalization as robust for the purposes of this chapter.

(216) No spirantization of the middle consonant in *XiY̯eZ*:

			Template	Past 3SG.M	Future 3SG.M
$\sqrt{\text{spr}}$	a.	'counted'	*XaYaZ*	sa**f**ar	ji-s**p**or
	b.	'told'	*XiY̯eZ*	si**p**er	je-sa**p**er

The middle consonant Y̯ was originally geminated in these templates, *XiYYeZ* and *hitXaYYeZ*. The templates are often still notated in similar fashion, in acknowledgment of gemination that is not preserved in contemporary usage (in many dialects of Arabic, for instance, gemination in cognate templates has been preserved; Tucker 2010; Wallace 2013). Importantly, in the synchronic system speakers must know that verbs in these templates do not spirantize their middle consonant. Emphasizing one of the conclusions of Chapter 2, templates cannot be simply viewed as conjugation classes since every template carries its own syntactic and semantic constraints. This is a form of morphologically-conditioned allomorphy.

Section §2.3.3 argued that these templates are derived by merging an $\sqrt{\text{ACTION}}$ root in the structure. Differences between templates take a number of forms, including prefixation, a change to the stem vowels and possible de-spirantization. It is $\sqrt{\text{ACTION}}$ that blocks spirantization and inserts the correct vowels for the templates currently under discussion (see Moore-Cantwell 2013 for a wug study of irregular verbs in *XiY̯eZ*). I will assume that its exponent carries a [–continuant] feature which docks onto the middle consonant for lexical roots that have a medial /p/, /b/ or /k/ (Zoll 1996; Wolf 2007). See Faust (2016) for additional evidence that morphophonological processes target root classes differentiated by specific segments in Semitic languages, and Wallace (2013) for a similar account of gemination in Akkadian, Emirati Arabic and Iraqi Arabic.

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

This discussion highlights one aspect of the system presented here: syntactic structure has predictable phonological spell-out that delimits allomorphic possibilities. Spirantization is not completely arbitrary (pace a strong reading of Martínez 2010); lack of it is based on morphosyntactic structure. Derivation of these patterns is returned to below, in §3.2.2.

3.1.2.2 Exceptions in the root

The dissertation as a whole contrasts the consequences of syntactic structure with those of individual lexical items (roots). This contrast was investigated for the syntactic and semantic behavior of the different templates in the preceding chapter. In the second case of blocked spirantization, we will see here that regardless of morphosyntax, some roots truly are exceptional, again in line with the general theme of the dissertation.

Some roots block postvocalic spirantization even when there is no special morphological trigger. These are cases where /k/ and /x/ were historically part of a phonemic distinction between voiceless pharyngeal /ħ/, voiceless uvular /q/ and voiceless velar /k/, plus an allomorphic distinction between /k/ and /x/ (the latter postvocalically unless geminated). In the historic system /ħ/ and /q/ did not participate in alternations but /k/ spirantized to [x]. These distinctions have been preserved in the orthography. Since the voiceless uvular is all but lost save for certain dialects, Classical Hebrew /q/ is transcribed as Modern Hebrew /k̫/ in this dissertation.

(218) Synchrony and diachrony:

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

While children are explicitly taught this distinction at school, most of the grammar will have been acquired before mastery of the orthography is achieved. Following previous studies on spirantization, I assume that the alternation /k/∼[x] is regular and that non-alternating /k̫/ and /x/ are exceptions to the rule. There is evidence that speakers attempt to reduce spirantization irregularities such as these, leading either to paradigm leveling or variation (Schwarzwald 1981a; Adam 2002; Martínez 2008, 2010, 2013; Gouskova 2012). Since my aim here is to point out lexical exceptionality of individual roots, I will not pursue a more precise description of the empirical landscape.

We must thus characterize the system independently of orthographic aids and diachronic considerations. Consider the following three roots. The first is regular, $\sqrt{\text{ktb}}$: in the future tense, its underlying initial /k/ spirantizes postvocalically to [x], as in (219a). The second root, $\sqrt{\text{xnj}}$, has an underlying /x/ and does not undergo fortification to *[k] word-initially in the past tense, (219b) – it was historically $\sqrt{\text{ħnj}}$. The third, $\sqrt{\text{k̯nj}}$, is exceptional: even after a vowel, initial /k̯/ does not spirantize, (219c) – it was historically /qnj/. All verbs are given in *XaYaZ*, which allows spirantization.

(219) Three roots in *XaYaZ*:

	Root		Past 3SG.M	Future 3SG.M
a.	'write'	$\sqrt{\textbf{k}\text{tb}}$	**k**atav	ji-x̱tov
b.	'park'	$\sqrt{\underline{\text{x}}\text{nj}}$	x̱ana	ja-x̱ne
c.	'buy'	$\sqrt{\text{k̯nj}}$	**k**ana	ji-**k**ne

The conclusion is that individual roots might have special phonology associated with them, just as they might have special requirements or intepretations in the syntax/semantics. Regular roots alternate between [k]∼[x], but some roots always have [k] and others always have [x]. The speaker and the grammar must keep track of the identity of the root. The remainder of this chapter will pay close attention to the structural environments in which the root can condition special phonology.

3.1.3 Structural representation

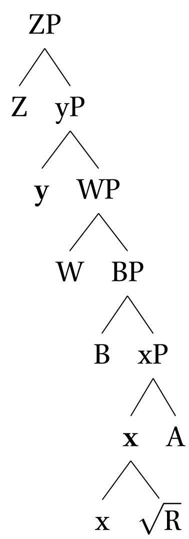
What we will see is that root exceptionality is handled locally to the root and is not expected to affect higher heads. This structural conclusion might seem counter-intuitive since in Hebrew, morphosyntactic features including higher ones such as agreement and passivization are all pronounced in the same phonological word as the root. In purely linear terms, there is no obvious difference between passive morphology, tense morphology or non-spirantization: all appear to be instantiated within a disyllabic or trisyllabic phonological word. Nevertheless, in order to understand the system we require a notion of locality that is first and foremost structural, with important linear caveats. The individual elements of the Semitic verb cannot be linearized as independent exponents, unlike in many non-Semitic languages, but the principles constraining allomorphy will be shown to be the same regardless of the language.

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

Building on proposals developed by Bobaljik (2000) and Embick (2010, 2015), I take vocabulary insertion to proceed "inside-out", from the most deeply embedded element outwards. Contextual allomorphy is limited by linear adjacency and proceeds in phases, as follows. If x is a phase head, then upon merger of an additional phase head y above x, all the material in the complement of x will be spelled-out from the inside out (from $\sqrt{\text{R}}$ in the example below proceeding with additional phases until Z).

A variant of this idea is proposed by Marantz (2013a), where merger of a phase head sends its own complement to spell-out (rather than that of the next phase head down). As assumed in Chapter 2, roots are modifiers of categorizing heads and as such are not in the complement domain of these heads. For the phenomena examined in this chapter only one phase head will typically be involved. As a result, it does not matter for present purposes which of the two variants we choose: the root will be in the same phase as material above v. The crucial part of the analysis will be the requirement that linear adjacency of overt elements is required for allomorphy; I call this the **Strict Linear Adjacency Hypothesis**. Allomorphy is constrained to apply only within a phase and only under linear adjacency of the trigger and the element undergoing allomorphy, as in (221)–(223). I set aside possible complications brought about by head movement; these were addressed in §2.4.2.

(220)



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

a. $\sqrt{\text{R}}$ and x

b. x and B

c. B and W

d. W and y

e. y and Z

(222) Allomorphy is possible across null exponents:

a. $\sqrt{\text{R}}$ and B if x is null

b. x and W if B is null

c. B and y if W is null

d. W and Z if y is null

e. etc.

(223) Allomorphy is not possible across two phase heads (e.g. $\sqrt{\text{R}}$ and Z across the heads x and y).

What this means is that if the root is in the position marked R, and x is the verbalizer v (assuming a silent verbalizer), then the root R will be visible to B and not to W, unless B is covert. It is predicted that an overt head in B would block the local configuration necessary for allomorphy of W given a root in R, and that is what we will see for the Passive head in §3.3.2 as it merges in the position labeled B here. Specifically, root exceptionality is handled fairly low in the tree and is not expected to affect the higher heads that are not local to the root. This claim will be tested both on cases of allomorphy and cases of intervention.

Here is an example of what these allomorphic interactions look like. In Latin a linear intervention effect holds in the perfect: an overt Perf head can condition special person/number endings only if there is no overt intervening exponent of T (Embick 2010; Kastner and Zu 2015). In the present tense, T is covert and a special ending arises after the perfective morpheme *v*, namely *-ī* in (224b).

(224) a. *am-**ō***
√love-**TH.1SG**
'I love'

b. *am-ā-$\boxed{v}$-**ī***
√love-TH-$\boxed{\text{Perf}}$-**1SG**
'I have loved'

Yet when T is spelled out by an overt exponent such as *ba/ra* (225) or *b/r* (226), the 1SG ending for a Class I root like √am 'love' is consistent—*m* in the past and *o* in the future, without reference to the less local Perf element.

(225) Past tense *-m*.

a. *am-ā-<u>ba</u>-**m***
√love-TH-<u>Past</u>-**1SG**
'I loved'

b. *am-ā-$\boxed{ve}$-<u>ra</u>-**m***
√love-TH-$\boxed{\text{Perf}}$-<u>Past</u>-**1SG**
'I loved'

(226) Future tense *-ō*.

a. *am-ā-<u>b</u>-**ō***
√love-TH-<u>Fut</u>-**1SG**
'I will love'

b. *am-ā-$\boxed{ve}$-<u>r</u>-**ō***
√love-TH-$\boxed{\text{Perf}}$-<u>Fut</u>-**1SG**
'I will have loved'

Perf can only condition the agreement ending when no overt exponent of T intervenes. This logic will guide our investigation of the Hebrew data.

3.1.4 Chapter outline

This chapter treads the line between analysis of allomorphy (either predictable or the result of lexical exceptionality) and cases where allomorphy is blocked, resulting in syncretism (invariance within the paradigm). I will make the case that the morphological templates are not primitives of the system but emerge as a by-product of spelling out the functional heads proposed in Chapter 2. What this chapter will not do is provide the details necessary to derive all inflectional paradigms in the language; my aim here is instead to explain how the syntactic structure is spelled out in conjunction with individual roots through individual examples. Nevertheless, I do depart from previous work on Hebrew and Arabic (Ussishkin 2000, 2005; Tucker 2010; Wallace 2013) in going beyond the citation form (3rd person masculine singular past tense) and presenting full paradigms where necessary. In previous work on Hebrew, Faust (2012) has shown that the resulting analysis can be quite intricate, so we will limit ourselves to derivations in service of the general aims, leaving detailed implementation of the entire verbal morphophonology to follow-up work.

Section §3.2 deals with allomorphic alternations: §3.2.1 provides more details on the different classes of exceptional roots and §3.2.2 examines how the vowels are determined across templates, first for regular roots and then for exceptional roots. Section §3.3 deals with invariance across the paradigm: §3.3.1 examines how the agreement affixes are determined and the following two sections analyze templatic effects in the passive, vowel syncretism in §3.3.2 and the interaction of the passive with root classes in §3.3.3. We then turn to alternative approaches: a slightly different way of doing things within the same theory (§3.4) and a stem-based approach operating under different assumptions (§3.5). Section §3.6 concludes and sets up the next chapter.

A reminder on notation from §1.4: syncopated vowels are marked with angled brackets, *hal<a>xá*, *tip<e>sá*. I use acute accents to mark stress. Additionally, in some examples non-low vowels can be seen lowering to [a] before [x] word-finally: *jilabeʃ* 'will be worn' ($\sqrt{\text{lbʃ}}$) but *jiʃak**a̲**x* 'will be forgotten' ($\sqrt{\text{ʃkx̲}}$). In templates such as *heXYiZ* where the last vowel was historically long, an epenthetic [a] is inserted before the [x]: *helb**i**ʃ* 'dressed someone up' but *heʃk**ia̲**x* 'made someone forget'.

3.2 Allomorphy

3.2.1 Lexical exceptionality in root classes

The verbal morphophonology of Hebrew is fairly uniform once a template is specified: most roots enter into a predictable alternation in a given template. For example, the "simple" template *XaYaZ* in (227) forms past tense 3SG.M verbs as *XaYaZ* and future ones as *ji-XYoZ*. Similar examples were seen in (215a–b).

(227) Some regular roots in *XaYaZ*:

	Root		Past 3SG.M	Future 3SG.M
a.	'write'	$\sqrt{\text{ktb}}$	katav	jixtov
b.	'wash'	$\sqrt{\text{ʃtf}}$	ʃataf	jiʃtof
c.	'break'	$\sqrt{\text{ʃbr}}$	ʃavar	jiʃbor

This section discusses lexical exceptions: roots which disrupt the regularity of paradigms like (227). In what follows I give an overview of different exceptional classes as they are manifested in the underspecified template *XaYaZ*. Section §3.2.2 will shift the focus back from roots to functional heads, showing how they too trigger allomorphy in conjunction with the lexical exceptions.

Semitic roots are traditionally classified into different groups defined by one of their underlying consonantal representations: /j/-final $\sqrt{\text{XYj}}$, geminated/spread $\sqrt{\text{XYY}}$, /n/-initial $\sqrt{\text{nYZ}}$, and so on. In this sense, root classes are similar in feel to the conjugation classes of European languages. A recent formalization of the division to classes can be found in Faust (2016).

In each class, the forms of some tenses may be different than in regular roots such as those in (227), including changes to the stem vowels.

(228) Some irregular roots in *XaYaZ* by root class:

Class		Root		Past 3SG.M		Future 3SG.M	
/j/-final $\sqrt{\text{XYj}}$	a.	'happened'	$\sqrt{\text{k̭rj}}$	kara̱	(*karaj̱)	jikre̱	(*jikroj, *jikrej)
	b.	'wanted'	$\sqrt{\text{rtsj}}$	ratsa̱	(*ratsaj̱)	jirtse̱	(*jirtsoj, *jirtsej)
	c.	'bought'	$\sqrt{\text{k̭nj}}$	kana̱	(*kanaj̱)	jikne̱	(*jiknoj, *jiknsej)
/ʔ/-final $\sqrt{\text{XYʔ}}$	d.	'froze'	$\sqrt{\text{k̭pʔ}}$	kafa̱	(*kafaʔ̱)	jikpa̱	(*jikpoʔ, *jikpaʔ)
	e.	'read'	$\sqrt{\text{k̭rʔ}}$	kara̱	(*karaʔ̱)	jikra̱	(*jikroʔ, *jikraʔ)
/w/-medial $\sqrt{\text{XwZ}}$	f.	'resided'	$\sqrt{\text{gwr}}$	gar	(*gaw̱ar)	jagu̱r	(*jigwor, *jagwur)
	g.	'got up'	$\sqrt{\text{k̭wm}}$	kam	(*kaw̱am)	jaku̱m	(*jikwom, *jakwum)

The underlying consonants which are not present in surface forms can be seen in other forms of the root. For example, the action nominal of *XaYaZ* is in the pattern *XYiZa*:

(229) a. $\sqrt{\text{ʃbṟ}}$: ʃviṟa 'breaking'

b. $\sqrt{\text{k̭nj̱}}$: knij̱a 'buying'

c. $\sqrt{\text{k̭pʔ̱}}$: kfiʔ̱a 'freezing'

In any case, the notation used here for the identity of roots is meant as an index to a store of phonological information. For example, $\sqrt{\text{XwZ}}$ roots as in (228f–g) could also be analyzed as roots whose underlying representation is *XZ* plus a vocalic diacritic, as *XuZ*, or even as $\sqrt{\text{\#123}}$ with an abstract pointer to the relevant underlying representations and rules of vocabulary insertion. The latter option might be the most likely, since some root suppletion exists in Hebrew. The existence of two phonological forms for the same root indicates that its content is more likely to consist of a pointer than one of the two forms (Harley 2014a,b; Faust 2014, 2016).

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

Returning to the non-suppletive alternations, it is possible to trace the historical changes that led to many of these irregular patterns; I will not discuss these matters here. What is noteworthy is that root classes can show their exceptionality in some templates but not others. For example, /j/-initial $\sqrt{\text{jYZ}}$ roots show their irregular colors in *niXYaZ*, *heXYiZ* and *huXYaZ* but not elsewhere. Our purpose here is to show the general patterns.

Some classes do not show predictable alternations like those in (228), as can be seen from the idiosyncratic forms in (231). There are also various other exceptions, as in (232).

(231) Some /n/-initial roots in *XaYaZ*, $\sqrt{\text{nYZ}}$:

Class		Root		Past 3sg.m	Future 3sg.m	
/n/-initial $\sqrt{\text{nYZ}}$	a.	'fell'	$\sqrt{\text{npl}}$	nafal	jipol	(*jinpol)
	b.	'dripped'	$\sqrt{\text{nzl}}$	nazal	jizol/jinzol/jizal	
	c.	'gave'	$\sqrt{\text{ntn}}$	natan	jiten	(*jinton, *jiton)
	d.	'avenged'	$\sqrt{\text{nk̯m}}$	nakam	jinkom	

(232) Other idiosyncratic exceptions in *XaYaZ*:

Class		Root		Past 3sg.m	Future 3sg.m	
Various exceptions	a.	'lay down'	$\sqrt{\text{ʃkb}}$	ʃaxav	jiʃkav	(*jiʃkov)
	b.	'wore'	$\sqrt{\text{lbʃ}}$	lavaʃ	jilbaʃ	(*jilboʃ)
	c.	'learned'	$\sqrt{\text{lmd}}$	lamad	jilmad	(*jilmod)
	d.	'whispered'	$\sqrt{\text{lxʃ}}$	laxaʃ	jilxaʃ	(*jilxoʃ)
	e.	'took'	$\sqrt{\text{lk̯x}}$	lakax	jikax	(*jilkox, *jilkax)
	f.	'traveled'	$\sqrt{\text{nsa}}$	nasa	jisa, jinsa	(*jiso, *jinso)

In all these cases, the alternations are due to idiosyncratic requirements of specific lexical items (roots) and are not the result of predictable, phonologically-conditioned processes (Faust 2012). For example, future *jikre* 'will happen' is derived from $\sqrt{\text{k̯rj}}$ in *XaYaZ*, as can be gleaned from nominal forms such as *karjan* 'news anchor'. The regular form would have been **jikroj*, (228a–c). This is a morphophonological rule relativized to $\sqrt{\text{XYj}}$, not a general rule which turns /oj/ into [e].

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

a. /ojev/ 'enemy' → [o.jev] (*eev)

b. /avoj/ 'woe! (interjection)' → [a.voj] (*ave)

c. /oj/ 'oi! (interjection)' → [oj] (*e)

To summarize the first set of examples, Hebrew roots can alter the vowels of the verbal stem and elide segments in ways which are often predictable, but not entirely so.

Hebrew has additional templates beyond *XaYaZ* exhibited above and similar effects arise there, too, for example in *XiY̯eZ*:

(234) Some regular and irregular roots in *XiY̯eZ*:

Class	Root			Past 3SG.M		Future 3SG.M	
Regular $\sqrt{\text{XYZ}}$	a.	'complicated'	$\sqrt{\text{sbx}}$	sibex		jesabex	
Doubled $\sqrt{\text{XYY}}$	b.	'spun'	$\sqrt{\text{svv}}$	s<u>o</u>vev	(*sivev, *sibev)	jes<u>o</u>vev	(*jesavev)

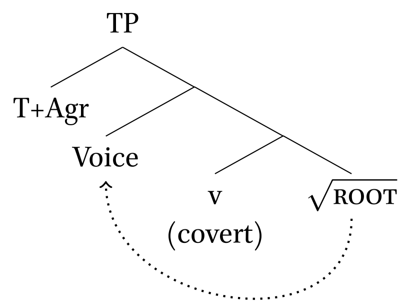
One question is to what extent lexical exceptionality is maintained across templates (and when do templates ignore lexical idiosyncrasies). This chapter poses the following generalizations and proceeds to explain them within the theory set up in Chapter 2.

(235) a. Vowels in the verbal stem vary by the root, as in (228), (231)–(232) and (234).
  b. The vowels vary by template and by phi-feature combination.
  c. Passive marking neutralizes vowel differences between templates.

We have already seen generalization (235a) in action in this section: the root is a locus of exceptionality since it conditions idiosyncratic vowels (regular *sagar* ∼ *jisg<u>o</u>r* but exceptional *lavaʃ* ∼ *jilb<u>a</u>ʃ*). For a given template, its form (its vowels) varies according to the class of the root.

My analysis relies on the structures developed in Chapter 2. Technically, the current chapter develops that system in two ways. First, I specify the spell-out of each head proposed there. Second, I treat the vowels as contextually conditioned segments hosted on the Voice head. That is to say, the vowels can be seen either as a spell-out of Voice or as a spell-out of a Theme head adjoined to Voice post-syntactically, as in Oltra Massuet (1999) and Embick (2010). At this point I see no difference emerging between the two possibilities and will treat the vowels as exponents of Voice for simplicity.

Let us see how this works by analyzing the patterns above. The structure is given in (236). To recap from Chapter 2, little v is a categorizing head, verbalizing an acategorial root. Voice is the standard head that introduces an external argument. The object is merged as the complement of v and the external argument is merged in the specifier of Voice.

(236) 

The stem vowels originate on Voice. Ignoring v—which is phonologically null—contextual allomorphy of Voice is conditioned by the identity of the root. The two, Voice and the root, are in a local relationship at PF since v is silent: the sequence is linearized as Voice-v-$\sqrt{\text{root}}$, at which point the operation Pruning (Embick 2010) removes silent elements like v. Since Voice and $\sqrt{\text{root}}$ are now local, the latter can condition allomorphy on the former. The dotted arrow should be read as "conditions allomorphy on".

Following ideas first made explicit by McCarthy (1981), I assume that the stem vowels are spelled out as unmarked *a-á* in the past tense of *XaYaZ*. In the future only one vowel is inserted, *ó*. This analysis does not attempt to give a reason for why there are two vowels in the past tense and only one in the future tense, which could be offered by a prosodic or skeleton-based approach (Ussishkin 1999). I also assume that affixes may bear stress underlyingly. For in-depth discussions of the intricacies of Hebrew stress, especially in the nominal domain, see Graf and Ussishkin (2002), Becker (2003) and Bat-El (1993, 2008). Ussishkin (2005) also provides some discussion of the interaction of stress and syncope.

(237) Vocabulary items for:
$\sqrt{\text{XYZ}}$ *katav* 'wrote' $\sim$ *jixtov* 'will write'
$\sqrt{\text{XYj}}$ *kara* 'happened' $\sim$ *jikre* 'will happen'
$\sqrt{\text{XYʔ}}$ *kafa* 'froze' $\sim$ *jikpa* 'will freeze'.

a. v $\leftrightarrow$ (silent)

b. Voice $\leftrightarrow \begin{cases} \text{a,á} & / \text{ T[Past] \_\_\_} \\ \textit{-o-} & / \text{ T[Fut] \_\_\_} \\ \text{(silent)} & / \text{ T[Fut] \_\_\_ } \sqrt{\text{XYj}} \\ \text{(silent)} & / \text{ T[Fut] \_\_\_ } \sqrt{\text{XYʔ}} \\ \ldots \end{cases}$

c. $\sqrt{\text{XYZ}} \leftrightarrow$ *XYZ*

d. $\sqrt{\text{XYj}} \leftrightarrow$ *XYe* / T[Fut] ___

e. $\sqrt{\text{XYʔ}} \leftrightarrow$ *XYa* / T[Fut] ___

In what follows I combine these kinds of Vocabulary Items in an Optimality Theoretic grammar (Prince and Smolensky 1993/2004).

The implementation in (237) treats the morphophonological behavior of root consonants as allomorphy. In Faust (2016) this kind of allomorphy is broken up into two steps, one which transforms $\sqrt{\text{XYj}}$ into $\sqrt{\text{XY}}$ and another which implements morphophonological rules specific to a root class without a third consonant.

The upshot of this configuration is that the root can determine the choice of theme vowels. I next explain how tense and agreement information interact with the root. Where necessary I re-introduce structural decisions made in the previous chapter. The summary table of syntactic heads is reproduced here as Table 3.2 for convenience.

Heads				Syntax	Semantics	Phonology	Section
	Voice			(underspecified)	(underspecified)	*XaYaZ*	§2.3.1
	Voice	$\sqrt{\text{ACTION}}$		(underspecified)	Action	*XiY̯eZ*	§2.3.3
Pass	Voice	$\sqrt{\text{ACTION}}$		Passive	Action	*XuY̯aZ*	§2.3.4
	$\text{Voice}_{\{D\}}$			EA	(underspecified)	*he-XYiZ*	§2.3.2
Pass	$\text{Voice}_{\{D\}}$			Passive, EA	(underspecified)	*hu-XYaZ*	§2.3.4
	$\text{Voice}_{\emptyset}$			No EA	(underspecified)	*ni-XYaZ*	§2.2.1
	Voice		$p_{\emptyset}$	EA = Figure	(underspecified)		§2.2.2
	$\text{Voice}_{\emptyset}$	$\sqrt{\text{ACTION}}$		No EA	Action	*hit-XaY̯eZ*	§2.2.1
	Voice	$\sqrt{\text{ACTION}}$	$p_{\emptyset}$	EA = Figure	Action		§2.2.2

Table 3.2: The requirements of functional heads in the Hebrew verb.

3.2.2 Allomorphy in the templates

Let us see a simple case of spirantization in action before we begin inflecting our verbs for tense and agreement. The structure in question is Voice-v-$\sqrt{\text{spr}}$, with URs /a,á/-(null)-/spr/.

(238) *safár* 'counted':

a. Voice ↔ *a,á* / T[Past] ___

b. v ↔ (silent)

c. $\sqrt{\text{spr}}$ ↔ *spr*

I borrow a subset of the constraints used by Martínez (2010):

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

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

To these I add:

(240) a. ***Complex**: No complex coda clusters.
Assign a violation mark for every consonant followed by another consonant syllable-finally, $*\text{CC}]_\sigma$.

b. **Stress-to-Weight Principle (SWP)**: If stressed, then heavy.
Assign a violation mark for every monomoraic stressed syllable, $*\text{C}\acute{\text{V}}]_\sigma$.

c. **Ident(Fortis)**: Input-output correspondents are identical in [cont] for input segments marked by the diacritic C̥.
Assign a violation mark for every segment in the input with the diacritic C̥ whose output correspondent differs in its value for [cont].

Lexical items are concatenated according to the structure: higher elements are linearized to the left. The tableau in (241) shows two processes applying at once: postvocalic spirantization (b∼c) and insertion of the Voice vowels.

(241) [Voice [v $\sqrt{\text{spr}}$]] ‘counted’:

	a,á-$\sqrt{\text{spr}}$	*Complex	Id(Fortis)	*V-Stop	SWP	Id(Cont)
	a. aáspr	*!				
☞	b. safár					*
	c. sapár			*!		
	d. safrá				*!	*

Recall next that verbs in *XiY̯eZ* do not show spirantization of the middle root consonant. *XiY̯eZ* is derived using the root $\sqrt{\text{ACTION}}$ which attaches to Voice. As discussed in §§2.2.4, 2.3.3, this head invokes certain agentive readings. Structures with $\sqrt{\text{ACTION}}$ block spirantization as in (242a).

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

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

The floating [−cont] feature is correctly docked using the following constraint:

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

(244) [Voice $\sqrt{\text{ACTION}}$ [v $\sqrt{\text{spr}}$]] ‘told’:

	i,é-$[-\text{cont}]_{\text{ACT}}$-$\sqrt{\text{spr}}$	Id(Fortis)	Align-R($\sqrt{\text{ACTION}}$, [σ-)	*V-Stop	SWP	Id(Cont)
☞	a. sip̯ér			*		
	b. sifér	*!				*
	c. sip̯ré			*	*!	
	d. t̯ifér		*!	*		*

3.2.2.1 Vowels conditioned by T+Agr

Having set up the basic technology, we will see that in the same template, different combinations of stem vowels arise depending on the features of T+Agr (tense and agreement). In anticipation of some confounding issues, let me first of all explain the cyclic derivation and the process of syncope.

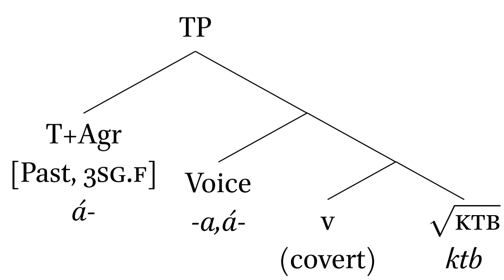
Some affixes bear underlying stress; when they attach to the stem, its previously stressed vowel syncopates. See the 3sg.f, 3pl.m and 3pl.f forms in (245).

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

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

In this dissertation I argue for a framework in which structure is interpreted incrementally from the root out. Just as the meaning is combined compositionally at LF, so are exponents concatenated cyclically at PF. The structure for *katvà* 'she wrote' is as in (246). VI and phonological calculation apply incrementally.

(246)



The structure in (246), linearized, is as in (247). I eliminate phonologically covert elements—"Pruning" in Embick (2010)—for expository ease.

(247) T[Past, 3SG.F]-Voice-$\sqrt{\text{ktb}}$

(248) **Cycle 1 (VoiceP):**

a. $\sqrt{\text{ktb}} \leftrightarrow$ *ktb*

b. Voice $\leftrightarrow$ *a,á* / T[Past] ___

c. *a,á-ktb*

d. Phonology yields:
$\Rightarrow$ *katáv*
See (241) for a similar derivation.

I assume that Spell-out proceeds cyclically (McCarthy 2007, 2008a,b; Wolf 2008): first Voice and v combine with $\sqrt{\text{ktb}}$ to give *katáv*. Then the agreement suffix attaches, (249).

(249) **Cycle 2 (TP):**

a. T[Past, 3SG.F]-*katáv*

b. 3SG.F ↔ *á* / Past ___

c. *á-katáv*

d. Phonology yields:
⇒ *katvá*
See (251) for the derivation.

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

The constraints in (250) and the tableau in (251) illustrate how syncope arises when a stressed vowel loses its stress to a stressed affix.

(250) a. **IDENT(STRESS)**: Input-output correspondents are identical in [stress].
Assign a violation mark for every stressed segment in the input which has an output correspondent that is not stressed.
$\forall S \in I\ [\ \exists S' \in O\ \&\ S \Re S' \rightarrow [\ \acute{S} \rightarrow \acute{S}'\ ]]$

b. **IDENT(STRESS)-AFFIX**: Input-output correspondents are identical in [stress] for affixes.
Assign a violation mark for every stressed affix in the input which has an output correspondent that is not stressed.

c. **MAX**: Do not delete segments.
Assign a violation mark for every segment in the input that does not have a correspondent in the output.

(251) [T[3SG.F] *katáv*] 'she wrote':

	$\acute{a}_{3SG.F}$ + katáv	*COMPLEX	ID(V́)-AFF	ID(V́)	MAX
	a. ákatav			*!	
☞	b. katvá				*
	c. ákatv	*!			*
	d. katavá			*!	
	e. katáva		*!	*	

I assume an undominated constraint banning multiple stressed syllables in a single word. The affix *á* is not able to attach as a prefix for general phonological reasons, (251a,c). Adam (2002), Bat-El (2003), Ussishkin (2005) and various others assume that syncope is the result of a specific constraint or constraints limiting the stem to one binary foot. The same result can be achieved with general constraints like *Complex, as shown by Wallace (2013) for Arabic and as practiced here.

I should emphasize the crucial work done by Ident(Stress): the winning candidate (251b) does not violate this constraint because under the formulation used here, a deleted vowel does not violate the I-O correspondence in the output. What this technical solution implements is the relationship between stress and syncope: syncope in verbal forms applies to underlyingly stressed vowels.

So much for the basics of syncope. With this interlude out of the way, we return to the data.

The stem vowels in (245) are invariant: *a,á*. But in the three templates *XiY̯eZ*, *hitXaY̯eZ* and *heXYiZ*, the past tense vowels are determined by the subject's phi-features, depending on whether the subject is 1st/2nd person or 3rd person. The paradigms in (252) use $\sqrt{\text{bʃl}}$. In *XiY̯eZ* ('cooked') and *hitXaY̯eZ* ('got cooked'), 1st/2nd person have /a/ as the second vowel and 3rd person has /e/ (though this is only visible for 3sg.m). In *heXYiZ* ('ripened'), 1st/2nd have /a/ and 3rd has /i/.

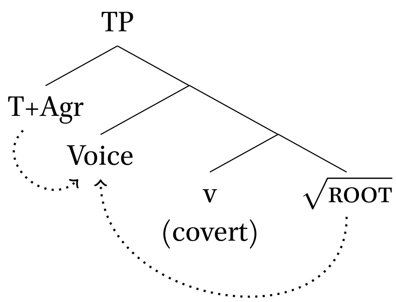
Boldfaced vowels show the difference in agreement: /a/ above the line (1st and 2nd person), /e/ or /i/ below it (3rd person). There are thus different vowels for different combinations of T+Agr.

(252) Past tense, vowels alternate:

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

In my account vowels are treated as the spell-out of Voice. Since Voice is local to T+Agr (and is in the same phase), T+Agr can condition allomorphy of the vowels. This conditioning is symbolized by the higher dotted arrow in (253). The lower dotted arrow was already introduced in (236) to signal that the root can condition allomorphy (vowels) on Voice. As a result, different phi-feature values condition different stem vowels, as can be seen in (252).

(253)



Verbs in *heXYiZ* are derived using a special Voice head, $\text{Voice}_{\{D\}}$; see §2.3.2 for justification.

(254) *heXYiZ*: *hevʃál-ti* 1SG.PAST ∼ *hevʃíl-a* 2SG.F.PAST

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

b. T[Past, 1st] ↔ *-ti*

c. T[Past, 2nd] ↔ *-a* / ___ $\text{Voice}_{\{D\}}$

d. $\sqrt{\text{bʃl}}$ ↔ *bʃl*

(255) a. *hevʃálti* 'I ripened': [T[Past,1SG] [$\text{Voice}_{\{D\}}$ [v $\sqrt{\text{bʃl}}$]]]
Cycle 1: he-vʃál
Cycle 2: hevʃál-ti

b. *hevʃíla* 'she ripened': [T[Past,3SG.F] [$\text{Voice}_{\{D\}}$ [v $\sqrt{\text{bʃl}}$]]]
Cycle 1: he-vʃíl
Cycle 2: hevʃíl-a

Our theory has now derived a number of generalizations by making use of the underlying syntactic (morphological) structure: Voice spells out theme vowels that may be conditioned by the root, by another modifier ($\sqrt{\text{ACTION}}$) and by T+Agr, but only under linear adjacency. I will next explore the conditioning of Voice by the root in more detail.

3.2.2.2 Vowels conditioned by T+Agr and the root

The lower of the two arrows in (253) points out another prediction of the theory. It is also predicted that stem vowels can be conditioned by the identity of the root, since Voice and the root are adjacent over silent v; this is exactly what we have already seen in §3.2.1. The VI rules in (256) are repeated from earlier.

(256) a. Voice ↔ (silent) / T[Fut] ___ $\sqrt{\text{XYj}}$ (237b)

b. $\sqrt{\text{XYj}}$ ↔ *XYe* / T[Fut] ___ (237d)

On the first cycle (VoiceP), the VI rules in (256) insert *kré* as the form of [Voice [v $\sqrt{\text{k̯rj}}$]]. On the second cycle, the 3SG.M prefix *ji*—which is generated on T, above VoiceP—is added. No noteworthy constraints are at play here so I give the simple concatenation:

(257) /ji-k̯ré/ → [jikré] 'will happen'

The combination of both arrows in (253) further predicts that the separate conditioning for T+Agr on the one hand and for the root on the other hand may interact. This is correct: for a /j/-final root like $\sqrt{\text{lvj}}$, the vowels in *helva* 'lent' are different than for a regular root like $\sqrt{\text{bʃl}}$. In (258), the regular root is on the left ('ripened') and the /j/-final root on the right. Underlined vowels are due to the root class and boldfaced ones are due to agreement.

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

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

In the analysis, vowels cannot be overwritten by VI; once *-e-* is inserted as the stem vowel in context of a $\sqrt{\text{XYj}}$ root, it remains.

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

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

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

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

d. T[Past, 1st] $\leftrightarrow$ *-ti*

e. 3F.SG Past $\leftrightarrow \begin{cases} -\textit{tá} & /\ \text{V}\ \_\_\_ \\ -\textit{a} & /\ \_\_\_\ \text{Voice}_{\{D\}} \\ -\textit{á} & \end{cases}$

One loose end in (258) remains to be tied up: the vowel /e/. It can be seen that 3SG.F *helve̲tá* has the same vowel as the 1st/2nd forms, /e/, and not /a/ as in 3SG.M *helvá*. This surface similarity is due to the interaction of two separate processes: syncope of underlying *á* and epenthesis to repair an illegal cluster. I show this using a regular root in (260), deriving *jilbeʃú* 'they will wear' in *XaYaZ*.

(260) [T [Voice [v $\sqrt{\text{lbʃ}}$]]] 'they will wear':[1]

	ji-ú- + lbáʃ	*COMPLEX	ID(V́)-AFF	ID(V́)	MAX	DEP
	a. jilbaʃú			*!		
☞	b. jilbeʃú				*	*
	c. jilbʃú	*!			*	
	d. jilbáʃu		*!			

Here is another example of this interaction, from the *niXYaZ* template in the past tense. When the suffix is stressed as in the 3rd person, deletion of underlying /a/ leads to an illicit cluster **xns*. This cluster is repaired using epenthetic [e].

(261) Syncope of de-stressed /a/ followed by epenthesis in the regular past tense verb 'entered':

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

Looking at exceptional root classes, the same pattern as in (258) can be seen for a "doubled" root like $\sqrt{\text{svv}}$ 'spun'. Again the vowels are different than in the regular forms ('cooked'), depending both on

1. Candidate (260c) assumes the prosodification [jilb.ʃu]. An alternative [jil.bʃu] can be ruled out by highly-ranked *CCC.

the root and on the T+Agr combination. Underlined vowels are due to the root class and boldfaced ones are due to agreement.

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

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

To recap: special root classes show special phonology in this configuration, in that the stem vowels change according to the root class (regular *heXYiZ* 1PL *hevʃál-nu* but special *helvé̲-nu*; regular *XiY̯eZ* 1PL *biʃál-nu* but special *so̲v**á**v-nu*).

3.2.3 Interim summary

The lesson from structures such as (253) and the data above is that syntactic structure dictates what kind of allomorphy is allowed and what element it is conditioned by. Lexical exceptionality applies "first" (at Vocabulary Insertion), if the root has exceptional phonology, simply because the root is the lowest element in the structure. Morphologically conditioned allomorphy then applies (additional VI rules), followed by the general phonology of the language.

The generalization we have derived can be repeated in the following form: in the same template, there may be different vowels for different combinations of root class and T+Agr. Root classes are thus similar to the conjugation classes of European languages in that a representative vowel or vowels are chosen by the root, in a way that feeds into the rest of the morphophonological derivation but carries no syntactic or semantic import (see Faust 2012 for a similar analysis of the final /j/ in $\sqrt{\text{XYj}}$ as a class marker). This state of affairs is predicted by our framework: Voice is sensitive to T+Agr and can "see" the features on T—but not the eventual exponent of T—while it also "sees" the root.

I have no principled reason, however, for why the 1st and 2nd person vs 3rd person split of (252) happens in the past tense but not in the future. The contrast might have to do with the future being built on a more "general" nonpast form, since the same stem of the future is used for infinitives, participles and imperatives.

Lexical exceptionality can be seen in other root classes such as those mentioned in §3.2.1. I will give one more example in §3.2.4, but first there remains an additional comment to be made on cyclicity.

I have assumed that spell-out proceeds morpheme-by-morpheme and that certain morphemes are discontinuous as in (259). The same results can be reached with "parallel" OT derivations that make no use of a fine-grained cycle, at least for the cases discussed so far; the discussion of passives below requires at least two cycles. I revisit two tableaux to illustrate.

In (251), modified as (263), I assumed that the Voice cycles creates *katáv* which is then the base for the affix -á. But the correct form would arise from a "flat" phonological derivation as well.

(263) [T[3SG.F] *katáv*]:

	á-aá-ktb	*COMPLEX	ID(V́)-AFF	ID(V́)	SWP	MAX	DEP
	a. ákatav				$\boxed{*!}$		
☞	b. katvá					*	
	c. ákatv	*!				*	
	d. katavá			*!			
	e. katáva		*!				

In (260), modified as (264), I likewise assumed two cycles. But the derivation can proceed in one step if we assume that an extrametrical syllable is allowed. SWP then takes care of the competition between (b)–(e).

(264) For [T [Voice [v $\sqrt{\text{lbʃ}}$]]]:

	ji-ú-á-lbʃ	*COMPLEX	ID(V́)-AFF	ID(V́)	SWP	MAX	DEP
	a. ji.(lab.ʃú)			*!	*		
☞	b. jil.(be.ʃú)					*	*
	c. (jilb.ʃú)	*!			*		
	d. jil.(bá.ʃu)		*!				
	e. ji.(leb.ʃú)				$\boxed{*!}$	*	*

These “flat” derivations are similar in essence to the stem-based analysis critiqued in §3.5. I will look at one more tricky case of exceptionality next, before moving on to cases of syncretism in which it will be argued that at least one early cycle is still necessary.

3.2.4 More lexical exceptionality

In the 3PL.M future of *XaYaZ*, the minimally distinct roots √k̯rj and √k̯rʔ show a clear difference: *jikrú* ‘they will happen’ contrasts with *jikre̲ú* ‘they will read’. The plural suffix -ú was part of the derivation in tablueaux (260) and (264), and we have already seen some of the relevant VI rules:

(265) a. √XYj ↔ *XYe* / T[Fut] ___ (237d)
b. √XYʔ ↔ *XYa* / T[Fut] ___ (237e)
c. T[Fut,3] ↔ *ji-*
d. 3PL ↔ *ú-* / T[Fut] ___

It is difficult to derive this contrast purely in the phonology. Since the difference is directly related to the different root classes, I stipulate the constraint in (266).

(266) **SYLLABLE(ʔ)**: √XYʔ stems require a final vowel.
Assign a violation mark for each √XYʔ root that does not have a vowel as its last segment in the output.
$\sqrt{XYZ}_{XY\text{ʔ}} \in I \rightarrow [\ \forall S' \in O\ [\ Z \Re S' \rightarrow S' \in \{a,e,i,o,u\}\ ]\ ]$

(267) [T[3PL] [Voice [v √k̯rj]]] ‘they will happen’, stem vowel syncopates:

	ji-ú-k̯ré	ID(V́)-AFF	ID(V́)	MAX
	a. ji-kreú		*!	
☞	b. ji-krú			*
	c. ji-kréu	*!	*	
	d. ji-kerú		*!	

(268) [T[3PL] [Voice [v √k̯rʔ]]] ‘they will read’, epenthetic vowel inserted:

	ji-ú-k̯rá$_{XY\text{ʔ}}$	ID(V́)-AFF	SYLL(ʔ)	ID(V́)	DEP
	a. ji-kraú			*!	
	b. ji-krú		*!		
☞	c. ji-kreú				*
	d. ji-krá	*!			
	e. ji-kúra			*!	

The exact formulation of SYLLABLE(ʔ) is less crucial than what is at stake: some allowance must be made for root classes to exercise exceptional morphophonology. The theory laid out in this chapter aims to constrain this exceptionality. For the implementation in the case of $\sqrt{\text{XYʔ}}$ roots, perhaps a general constraint could be posited requiring all roots to be pronounced in at least one syllable, with classes like $\sqrt{\text{XYj}}$ exempt from this requirement by a some lexically-indexed constraint.

One final analytical point: the 3rd person singular feminine past tense suffix was given as *-ta* before a vowel back in (259e). We have also seen it surfacing as *-a*: *XaYaZ* past tense *axl-á* 'ate 3SG.F'. It has recently been claimed by Faust (2016) that this affix should be encoded as a morphologically conditioned allomorph triggered by the root class, rather than as a general phonologically conditioned allomorph. Faust's argument is compelling. Briefly, he contrasts forms of $\sqrt{\text{XYj}}$ verbs and $\sqrt{\text{XYʔ}}$ verbs. The former show the *-ta* suffix after a vowel, whereas the latter show the *-a* suffix after a vowel. He thus argues that the triggering environment cannot be defined purely phonologically, since in both cases the stem is vowel-final.

(269) Masculine and feminine suffixes in two *heXYiZ* root classes:

	Root		3SG.M Past	3SG.F Past
a.	'referred'	$\sqrt{\text{pnj}}$	hefn**á**	hefn**e**-t̲á̲
b.	'healed'	$\sqrt{\text{brʔ}}$	hevr**í**	hevr**í**-a̲

The point is well taken; one way around it is to assume that $\sqrt{\text{XYʔ}}$ roots like $\sqrt{\text{brʔ}}$ do provide a glottal stop which is then deleted in the phonology, feeding selection of *-ta*. I leave the matter as it is for now. See Harbour (2008b) for additional analysis of *t-* as a feminine marker in Hebrew.

3.2.5 Summary

This section showed how the syntactic elements from Chapter 2 give rise to templatic effects without treating the templates themselves as prosodic primitives. This idea is in line with one of our overall themes – that the Semitic verb is made up of functional heads linearized under specific phonological constraints, with templates emerging as an epiphenomenon. This analysis does not attempt to explain certain patterns, though: C-initial suffixes are not underlyingly stressed in the paradigms we have seen. In the current theory this is an accident rather than an organizing principle of prosodic constituents in the language.

In keeping with the other theoretical claim about combining roots and structure, we have seen how the functional material combines with lexical (root) material in ways that are mutually constrained: the structure allows certain allomorphic patterns while individual lexical items can exercise their own idiosyncrasy. The next section tests this claim by examining cases in which the structure does not allow allomorphic interactions to take place.

3.3 Syncretism

I have adopted a theory of allomorphy that implements the strict linear adjacency hypothesis. It has so far been shown that this theory can correctly analyze cases of allomorphy. But the strict linear adjacency hypothesis also makes predictions regarding where *syncretism* is expected to hold: as noted in the discussion of (220), if an overt element Z appears between X and Y, [[X **Z**] Y], X will not be able to condition allomorphy of Y. And as shown by Embick (2010), the result of this configuration is usually syncretism of Y, such that Y has the same form regardless of X or any material below X.

In this section I test this prediction and argue that it is borne out in two domains of the Hebrew verb: syncretism in agreement affixes (§3.3.1) and syncretism in passives (§§3.3.2–3.3.3).

3.3.1 Agreement affixes do not depend on the root

As we have already seen, agreement affixes depend mostly on the tense of the verb and in some cases on the template. For example, 2nd person plural agreement is marked by the suffix *-tem* in the past but by the circumfix *t-ú* in the future: *biʃál-<u>tem</u>* 'y'all have cooked' ∼ *<u>t</u>-evaʃl-<u>ú</u>* 'y'all will cook'. The table in (270) lists the agreement affixes. They never depend on the root. For a theory that attempts to predict whether a given affix will surface as a prefix or a suffix without reference to phonological features, see Harbour (2008a).

(270) General affixal paradigms across templates:

	Past		Future	
	SG	PL	SG	PL
1	STEM-**ti**	STEM-**nu**	**j**-STEM	**n**-STEM
2M	STEM-**ta**	STEM-**tem**	**t**-STEM	**t**-STEM-**ú**
2F	STEM-**t**	STEM-**tem**	**t**-STEM-**í**	**t**-STEM-**ú**
3M	STEM	STEM-**ú**	**j**-STEM	**j**-STEM-**ú**
3F	STEM-**á**	STEM-**ú**	**t**-STEM	**j**-STEM-**ú**

The paradigm in (271) instantiates (270) by contrasting past and future for $\sqrt{\text{bʃl}}$ in *XiY̯eZ*.

(271) Past and Future forms for *biʃel* ‘cooked’:

	Past, *XiY̯eZ* $\sqrt{\text{bʃl}}$		Future, *XiY̯eZ* $\sqrt{\text{bʃl}}$	
	SG	PL	SG	PL
1	biʃál-**ti**	biʃál-**nu**	**j**-evaʃél	**n**-evaʃél
2M	biʃál-**ta**	biʃál-**tem**	**t**-evaʃél	**t**-evaʃ<é>l-**ú**
2F	biʃál-**t**	biʃál-**tem**	**t**-evaʃ<é>l-**í**	**t**-evaʃ<é>l-**ú**
3M	biʃél	biʃ<é>l-**ú**	**j**-evaʃél	**j**-evaʃ<é>l-**ú**
3F	biʃ<é>l-**á**	biʃ<é>l-**ú**	**t**-evaʃél	**j**-evaʃ<é>l-**ú**

The same agreement affixes are used regardless of root class, as can be seen in (272) using $\sqrt{\text{lvj}}$, the same root from (258), in the verb ‘lend’. Affixes in (272) are identical to those in (271), irrespective of the difference in root class.

(272) Past and Future forms for a verb in $\sqrt{\text{XYj}}$:

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

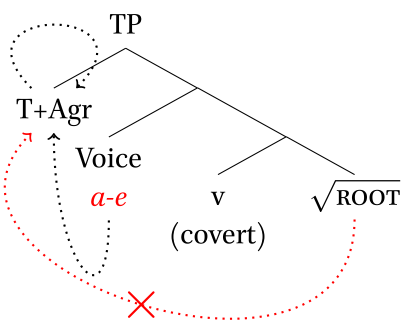
Agreement affixes depend on the template to a very small degree. The 3rd person affixes are stressed in all templates save for *heXYiZ*, as was seen in (252), repeated here as (273).

(273) 3rd person suffixes are stressed in past tense *XiY̯eZ* ‘cooked’ and *hitXaY̯eZ* ‘got cooked’ but not *heXYiZ* ‘lent’:

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

Revisiting the diagram from (253) as (274), it is evident that Agr is local to T, so T can condition allomorphy on it. In addition, Agr is local to Voice, which is where $\text{Voice}_{\{D\}}$ would appear (leading to *heXYiZ*; see §2.3.2). Both Voice and T should be able to trigger allomorphy of Agr, which they do.

(274)



Relevant lexical items are repeated from (259). The agreement affix in (275) cannot depend on any lower information such as the root.

(275) Paradigm invariance in *heXYiZ*

a. $$\text{2SG.M} \leftrightarrow \begin{cases} \textit{-ta} & /\ \text{T[Past]}\ \_\_ \\ \textit{t-} & /\ \text{T[Fut]}\ \_\_ \end{cases}$$

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

There might be a more illuminating analysis of this contrast to be found than that in (275b), but the facts are consistent with the current theory.

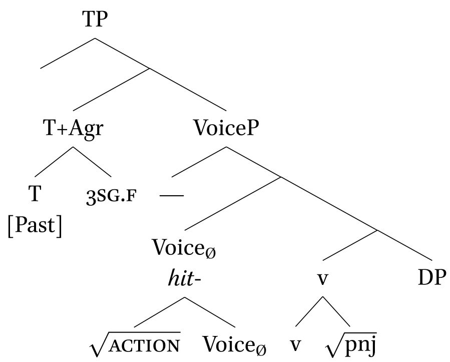
On the one hand, Voice can condition Agr as in the case of $\text{Voice}_{\{D\}}$/*heXYiZ*. On the other hand, Agr is not local enough to the root to be conditioned by it, since Voice contains overt material that intervenes, namely the vowels and a possible prefix. And so, different root classes cannot condition special agreement markers. The root is too far down the structure, "obstructed" by overt Voice (spelled out as vowels and possibly a prefix), for Agr to see it.

What this brief study of agreement affixes shows is that allomorphy is sensitive to linear adjacency of hierarchically arranged elements, as expected. Agreement affixes are independent pieces of morphology that cannot be derived in the phonology proper: there is no reason for the 1PL.Past suffix -*nu* to alternate with the 1PL.Fut prefix *n*-. This must be treated by using separate vocabulary items. But allomorphy of this item cannot be conditioned by low material such as the root. No analysis which eschews internal structure can predict the generalizations analyzed here: that agreement affixes depend on the tense but not on the root, and especially that the paradigm is uniform across templates and across otherwise exceptional roots, as can be seen by comparing general (270)–(271) with the class in (272). This goal is manageable in a theory where phonological words are syntactically complex but not under a dichotomous distinction between inflection in the syntax and derivation in the lexicon (Reinhart and Siloni 2005; Laks 2014), as shown in §3.5.

The current analysis makes an additional prediction. If additional overt material intervenes between T+Agr and Voice, the endings should syncretize completely and show some default form. I show that this is true for passives in §3.3.2. But having made my main claims, a bit of housekeeping is now in order.

To make things more concrete, here are sample derivations for past tense *hitXaY̯eZ hitpantá* 'she evacuated' in (276)–(278) and future tense *titpané* 'she will evacuate' in (279)–(281). These verbs instantiate the /j/-final root $\sqrt{\text{pnj}}$ in *hitXaY̯eZ*. The structure was motivated in §2.2.1: a special nonactive Voice head, Voice$_{\emptyset}$, is modified by an agentive modifier, $\sqrt{\text{ACTION}}$. The latter blocks spirantization of the middle root consonant, the former contributes a prefix, and both condition the vowels of the stem jointly.

(276)



(277) Realization rules:

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

b. $\sqrt{\text{ACTION}} \leftrightarrow [-\text{cont}]_{\text{ACT}}$ / ___ $\{ \sqrt{\text{XYZ}} \mid \text{Y} \in \text{p, b, k} \}$

c. Voice$_\emptyset \leftrightarrow$ *it,a,é* / ___ $\sqrt{\text{ACTION}}$

d. T[Past] $\leftrightarrow$ *h-* / ___ *it*

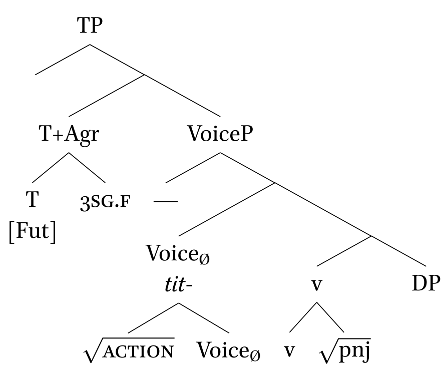
e. 3F.SG (Past) $\leftrightarrow$ *-tá* / ___ V

(278) a. Cycle 1 (VoiceP):
/it-a,e-pné/ $\rightarrow$ [it.pa.né]

b. Cycle 2 (TP):
/h-tá-it.pa.né/ $\rightarrow$ [hit.pan.tá]

Continuing on to the future tense equivalent of (276)–(278):

(279)



(280) Realization rules:

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

b. $\sqrt{\text{ACTION}} \leftrightarrow [-\text{cont}]_{\text{ACT}}$ / ___ $\{ \sqrt{\text{XYZ}} \mid \text{Y} \in \text{p, b, k} \}$

c. Voice$_\emptyset \leftrightarrow$ *it,a,é* / ___ $\sqrt{\text{ACTION}}$

d. 3SG.F $\leftrightarrow$ *t-* / ___ T[Fut]

(281) a. Cycle 1 (VoiceP):
/it-a,e-pné/ $\rightarrow$ [it.pa.né]

b. Cycle 2 (TP):
/t-it.pa.né/ $\rightarrow$ [tit.pa.né]

What we have seen up to this point is that certain classes of roots lead to irregular morphophonology. The different functional heads that create the structure can condition allomorphy on each other, or be conditioned by a special class of roots, as long as the right locality conditions are obeyed. The derivations above capture the complex conditioning factors discussed thus far: T, Agr, Voice and $\sqrt{\text{root}}$ condition each other in a phonological word with strict prosodic requirements.

Next, we predict that if additional overt material intervenes between T+Agr and Voice, the affixes should syncretize completely and show some default form. This is the case for passives.

3.3.2 Vowels syncretize in the passive

We have seen in §3.2.2.1, (252), that 1st and 2nd person might have a different second vowel associated with them than does 3rd person, (282a). This split is neutralized in the passive: all ϕ-feature combinations have the same /u/-/a/ vowels, (282b).

(282) Active vs passive for $\sqrt{\text{bʃl}}$ 'cook' agreement:

	Template	Past 3SG.M	Past 1SG
a.	*XiY̯eZ* (active)	biʃ<u>e</u>l	biʃ<u>a</u>l-ti
b.	*XuY̯aZ* (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, (283a), but not in the passive, (283b).

(283) Active vs passive for $\sqrt{\text{bʃl}}$ 'cook' tense:

	Template	Past 3SG.M	Future 3SG.M
a.	*XiY̯eZ* (active)	b<u>i</u>ʃel	je-v<u>a</u>ʃel
b.	*XuY̯aZ* (passive)	b<u>**u**</u>ʃ**a**l	je-v<u>**u**</u>ʃ**a**l

These patterns of syncretism are predicted on our theory. The full paradigm follows below. Our passivizing morpheme is the passive head Pass, as argued for in §2.3.4. Passive forms are derived either from *XiY̯eZ* verbs (yielding *XuY̯aZ*) or *heXYiZ* verbs (yielding *huXYaZ*). The paradigms below show that the 1st/2nd person vs 3rd person split is neutralized in the passive, as is any distinction based on tense; the vowels on all stems are /u/-/a/ in the following two tables.

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

	XuY̯aZ $\sqrt{\text{gdl}}$		*huXYaZ* $\sqrt{\text{gdl}}$	
	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

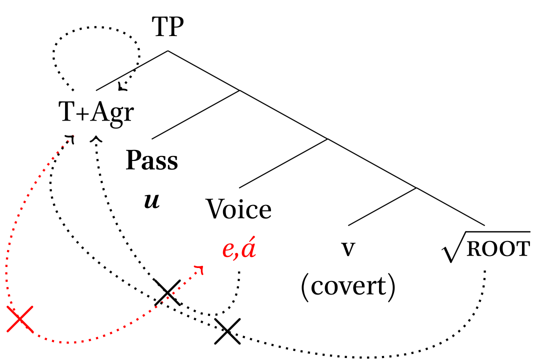
b. Future tense for passive *jegudal* 'will be raised' and *jugdal* 'will be enlarged':

	XuY̯aZ $\sqrt{\text{gdl}}$		*huXYaZ* $\sqrt{\text{gdl}}$	
	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

In addition, for each pair of templates, the affixes are the same in each of the two tenses; for example, the standard 2M.SG past suffix *-ta* is used in both *XuY̯aZ* and *huXYaZ* in (284a).

This pattern is exactly what our theory of locality predicts: overt Pass blocks T+Agr from conditioning allomorphy on Voice as in (285), developing (274). Similarly, there is no special spell-out for the passive conditioned by certain roots since overt Voice intervenes. I give Pass as *-u-* in the tree but become more precise immediately below.

(285)



All surface forms that do not conform to the generalization are independently predicted based on what we have seen so far: syncope of de-stressed vowels feeding potential epenthesis.

A derivation follows for the different cycles deriving *huXYaZ* future tense *jugdelú* 'they will be enlarged': First the combination of $\text{Voice}_{\{D\}}$ and $\sqrt{\text{pkd}}$, then adding in Pass, and then the agreement affixes.

(286) a. $\text{Voice}_{\{D\}} \leftrightarrow$ *e,á* / Pass ___
b. $\sqrt{\text{gdl}} \leftrightarrow$ *gdl*
c. Pass $\leftrightarrow$ $[\text{+high +round}]_{\text{Pass}}$
d. 3PL $\leftrightarrow$ *j,ú*

The passive -u- is analyzed as a floating autosegment that must dock onto an existing vowel, using MAXFLT from Wolf (2007:3).

(287) **MAXFLT:** All autosegments that are floating in the input have output correspondents.
$\forall$F $\in$ I, where F is a feature:
$[\neg\ [\ \exists S \in I$ such that S is a segment and F is attached to S$]]$
$\rightarrow [\exists F' \in O$ such that $F\ \Re\ F']$

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

'they will be enlarged'	W ~ L	*COMPLEX	MAXFLT	SWP
Cycle 1: Only VoiceP a. (j-ú + $[\text{+high +round}]_{\text{Pass}}$) + **e,á-$\sqrt{\text{gdl}}$**	egdál ~ egádl	W		
Cycle 2: Only PassP b. (j-ú) + **$[\text{+high +round}]_{\text{Pass}}$-egdál**	ugdál ~ egdál		W	
Cycle 3: TP c. **j-ú-ugdál**	jug(de.lú) ~ ju(ged.lú)			W

There is one more complication: recall from (258) and (262) that the 3rd person suffixes of *heXYiZ* are not stressed, unlike those of other templates. Yet I assume that *huXYaZ* is derived from *heXYiZ* and in (284b), the *huXYaZ* 3rd person suffixes are stressed: active *hegdí̲la* but passive *hugdelá̲*.

How does the stressed allomorph of the suffix get inserted in the first place? This is possible since Agr is local to Pass, so Pass conditions allomorphy of the affix, requiring stressed affixes. All passive affixes attract stress. Again, this allomorphy cannot be sensitive to any material below Pass, as is the case: neither the original template nor the root can condition allomorphy on the agreement affix.

(289) 3SG.F ↔ á / ___ Pass

There might be a way to give an even more general analysis: I am claiming that the suffixes in the future forms of *heXYiZ* and its passive counterpart *huXYaZ* are conditioned differently. But maybe both are stressed underlyingly, with the active form retaining stress on the stem and not allowing it to be attracted to the suffix. The outer affix will then be preferred to the inner one.

For example, take the 2PL future forms *tagdílu* (active) and *tugdelú* (passive). If the suffix *-ú* is always underlyingly stressed in this template, then stressed /í/ in the stem must "win out" somehow for stress purposes. Many analyses of Hebrew stress do note that high vowels are more resistant to change: Graf and Ussishkin (2002:251), Becker (2003:46) and Bat-El (2008:36,41) all point out that high vowels are less subject to reduction or deletion than other vowels. A useful formalism one could exploit is that of Harmonic Alignment, specifically as applied to vowels of differing sonority (Gouskova 2003:Ch. 4). High vowels like /i/ are less sonorous than /e/ and /a/, allowing us to place them on a sonority hierarchy from which individual markedness constraints can be derived; see Bat-El (2008) for such an analysis.

The analysis of passives cannot be done without an intermediate cycle, as attempted by Ussishkin (2005) and discussed in §3.5.

(290) Modifying (288) without intermediate cycles (a) and with one intermediate cycle (b):

'they will be enlarged'	W ~ L	*COMPLEX	MAXFLT	SWP
No lower cycles:				
a. j-ú-[+high +round]$_{\text{Pass}}$-eá-gdl	jug.(de.lú) ~ (ju.ge)(de.lú)			
One lower cycle:				
b. j-ú-[+high +round]$_{\text{Pass}}$-egdál	jug.(de.lú) ~ ju.(gú.del)			W

But let me summarize the structural claim I have been developing. Voice cannot "see" past Pass and onto T+Agr, so it picks one set of vowels for the entire paradigm. We now have a crosslinguistic prediction for passive suffixes as a special case of the strict linear adjacency hypothesis: no contextual allomorphy should obtain across an overt passive affix.

3.3.3 Passive with different root classes

As a final verification of the predictions made by the current theory, we must examine the interaction of different root classes with Pass. The expectation is confirmed: paradigm invariance and lexical exceptionality go hand in hand in predictable fashion, since they are triggered by different parts of the structure.

I take the root $\sqrt{\text{pnj}}$ as representative of the class of /j/-final $\sqrt{\text{XYj}}$ roots in particular and exceptional root classes in general. The paradigms in (291a) are for the *XiY̯eZ–XuY̯aZ* pair and those in (291b) are for the *heXYiZ–huXYaZ* pair. All forms are in the singular. Past tense is given on the left and future on the right, for each pair. Both parts of the prediction are borne out: vowels syncretize in the passive (on the right-hand side of each tense), although the form of the vowels is not regular *u-a* but rather a root-specific form. These latter paradigms are a bit rare in that there are not many $\sqrt{\text{XYj}}$ roots instantiated in these templates. For the 1st and 2nd person forms, some speakers prefer to use /e/ as the second vowel of the stem, rather than /i/.

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

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

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

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

A falsification would consist of a new, unexpected form making reference to both the root and higher material such as Pass or T+Agr. The only potential falsification of the prediction lies with the 3rd person feminine singular, which introduces *-ta*. As we have already seen, however, the conditioning environment of this allomorph of the suffix is predictable; it appears postvocalically as in (259e) and the discussion at the end of §3.2.4. The existence of *-tá* in the passive 3SG.F.Past forms above does not result from a banned allomorphic interaction of Voice and T+Agr over an intervening Pass head. Rather, the expected syncretic stems are generated and the correct phonologically conditioned allomorph of 3SG.F is inserted. The system makes the right predictions.

3.3.4 Summary

The purpose of this section was to test the prediction that exceptional phonology is handled "low" (locally to the root) and then passed on to additional cycles, which themselves are not exceptional. This claim was borne out. I have provided arguments for linear adjacency as a key component in the calculation of allomorphy, subject to linearization of certain syntactic structures, working towards a maximally constrained formal system. The verbal templates have again been argued to be epiphenomenal, arising due to combinations of vocalic affixes with a consonantal root. I believe that these results go beyond those of the alternative systems surveyed next in §§3.4–3.5.

3.4 Alternatives: root-based approaches

3.4.1 Tiers, revisited

Back in §1.6 I presented the seminal analysis of McCarthy (1979, 1981) who argued that the Semitic verb is made up of three tiers: a CV skeleton (the template), individual consonants (the root) and a vocalic melody (additional grammatical information). The current proposal supports some of his assumptions and rejects others. CV skeletons are no longer needed as primitives in the theory if we allow templates to be emergent phonological objects.

The previous chapter showed that templates cannot be mapped straightforwardly onto morphemes: a given morphophonological form (template) is compatible with a number of different syntactic structures and semantic interpretations. This chapter implemented these forms as hierarchically arranged additions to a basic stem.

There are seven verbal templates but no distinct skeletons on our account (no seven distinct lexical items). Instead, there are functional heads and phonological constraints, all of which are independently needed. The original tier-based theory captures many phonological facts but does so at the cost of losing any ability to generalize about the syntax and semantics. On a syntactic analysis, the only primitives are in the syntax. Regularities in the phonology are emergent from the structure, as we have seen in this chapter, just like regularities in the semantics are emergent from the structure as we have seen in Chapter 2.

It has been pointed out to me by Maria Gouskova that a theory of morphological CV skeletons predicts patterns that are perhaps unattested crosslinguistically and are certainly unattested in Hebrew or Arabic. The idea is as follows: if CV skeletons are primitives, a language might have the alternations in (292) which are purely prosodic, metathesizing different segmental chunks:

(292) a. Intransitive template: CVC<u>VC</u> (*pit<u>ok</u>* 'wugged.intransitive')
Transitive template: CVC<u>CV</u> (*pit<u>ko</u>* 'wugged.transitive')

b. Causative template: CaC<u>V</u> (*pat<u>o</u>* 'wugged.causative')
Passive template: <u>V</u>CaC (*<u>o</u>pat* 'wugged.passive')

This is not the case in Hebrew: any change from one template to another is the result of added segmental (and syntactic) material, namely vocalic and consonantal affixes. This is not to rule out CV skeletons entirely. It may well be the case that in some languages prosodic templates constrain the morphophonology (see Coon To appear on a case in Mayan and McCarthy 1989 for a number of other language families), though I suspect that the more likely cases are those similar to the "phase alternations" of Rotuman, where the prosodic shape of the stem depends on the phonological size of the affix (McCarthy 2000). Hebrew shows no alternations such as those in (292), arguing further for an emergent analysis of templates rather than an atomic one.

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

Drawing on the analyses of McCarthy (1981) and Tucker (2010), unpublished work by Wallace (2013) provides a detailed analysis of non-concatenative morphology in Akkadian, Iraqi Arabic and Emirati Arabic, with a focus on patterns of syncope and gemination. The ideas presented here develop Wallace's account and extend it to the entire verbal paradigm, mounting a cross-Semitic argument for transitioning from tiers to functional heads.

3.4.2 Morphosyntax or morphophonology? Issues of learnability

As discussed in §3.2.2.1, 1st and 2nd person use a different second vowel than 3rd person verbs. I have attributed this difference to morphosyntactic features, but it could also be argued that the vowel depends on the following suffix: a consonant-initial suffix on a verb triggers lowering of the last vowel to /a/.

The data contain patterns that can form the basis for two distinct generalizations. But in any given dataset, a large number of patterns can be found if the hypothesis space is not constrained. It is important to consider what generalizations the learner might make; not all patterns in the input are necessarily learned as such (Hayes et al. 2009; Hayes and White 2013; Becker et al. 2011). In our case, I will contrast the "morphosyntactic" generalization with the "morphophonological" one, making the case for the former over the latter but noting possible follow-up studies that could shed light on the role of the latter in learning the system.

Let us remind ourselves of the basic facts. Vowels in the verbal stem vary with subject agreement: 1̲s̲t̲/̲2̲n̲d̲ person forms have the /a̲/ vowel, whereas **3rd** person forms have either /**e**/ or /**i**/, depending on the template.

(293) Vowel contrast by agreement in a past tense *heXYiZ* verb:

	heXYiZ $\sqrt{\text{ʃlm}}$ 'completed'	
	SG	PL
1	heʃlá̲m-ti	heʃlá̲m-nu
2M	heʃlá̲m-ta	heʃlá̲m-tem
2F	heʃlá̲m-t	heʃlá̲m-tem
3M	heʃl**í**m	heʃl**í**m-u
3F	heʃl**í**m-a	heʃl**í**m-u

We have been treating this pattern as morphosyntactically conditioned: vowels depend on morphosyntactic features. This means that the generalization is a structural one.

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

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

(295) a. [**i**], V/Ø-initial: *hevʃ**i**l-Ø̲, hevʃ**i**l-a̲, hevʃ**i**l-u̲*

b. [**a**], C-initial: *hevʃ**a**l-t̲i, hevʃ**a**l-t̲a, hevʃ**a**l-t̲, hevʃ**a**l-n̲u, hevʃ**a**l-t̲em*

Under this view:

(296) a. **Morphophonological generalization:** The learner notices that in verbs, the vowel changes when the suffix begins with a consonant.

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

The morphophonological account states that all verbs have the underlying template-specific vowel, i.e. /e/ for *XiY̭eZ* and *hitXaY̭eZ*, 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.

(297) Schematic derivations under the morphophonological account

1SG	hevʃi̱l-ṯi	→	hevʃa̱l-ṯi	→	hevʃalti
3PL	hevʃil-u	→	—	→	hevʃilu

Note that the morphophonological rule in (296b) must be restricted to verbal environments. It is not generally the case that Hebrew vowels lower before a consonant, nor at any syllable boundary, (298a), nor at any morpheme boundary, (298b).

(298) Vowel lowering before a consonant is not a general rule:

	Form	If the rule applied	Gloss
a.	he̱ʃ.lím	*ha̱ʃ.lim	‘completed’
b.	ʃamé̱n-tʃik	*ʃama̱n-tʃik	‘fat-DIM’

On the morphophonological account, it is the form of the suffix that leads to the split. No reference is made to syntactic or semantic features, though the suffix must be recognized as part of a verbal form.

The morphosyntactic proposal is perhaps theoretically more appealing in that it is part of a research program that makes crosslinguistic predictions. If the theory presented here is on the right track, then overt passive affixes should *always* block contextual allomorphy across them as argued for in §§3.3.2–3.3.3. I have not yet found languages that support or refute this claim for passives, though see the discussion in Embick (2010) for similar configurations.

Are there any other V-initial or C-initial suffixes on which these hypotheses can be tested? The answer is equivocal. The 3SG.F past tense suffix is usually *-ta* postvocalically, as we saw in §§3.2.2.2, 3.3.3. However, in §3.2.4 it was observed that $\sqrt{\text{XYj}}$ and $\sqrt{\text{XYʔ}}$ roots have vowel-final stems and a vocalic suffix, contrary to the generalization. Perhaps there is a way to specify a lexical exception for these root classes, rescuing the morphophonological account.

Looking elsewhere, the standard language has a 2PL.F suffix that has fallen out of use in everyday speech. In (299), the suffix is *-na* but the second vowel is /e/, which is not found elsewhere in the feminine paradigm for *heXYiZ*:

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

If the vowel depends on T+Agr, then dialects containing this form can be readily explained by our theory. The morphophonological account would falsely predict **talba̱ʃna*. 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; for a preliminary proposal see §5.3.3.

That being said, it is possible to imagine that during acquisition, the child would first notice the phonological cue rather than a semantic or structural cue (Gagliardi and Lidz 2014). Yet for the synchronic system there is no clear reason to prefer the morphophonological account.

3.4.3 One vowel at a time

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

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

(300) a. $\sqrt{\text{bʃl}}$ + Voice = *ba̱ʃl*
b. Add $\sqrt{\text{ACTION}}$: *baʃe̱l*
Optionally add Pass: *bu̱ʃa̱l*

c. Add T[Past]: *biʕel*
Or T[Fut]: *je-vaʕel*

This process of single vowel insertion resembles the system in Faust (2012) where each vowel is considered individually. Faust (2012:481) ends up with rules like those in his (44), our (301)–(302), where "V" means "vowel" and the template is a morphological primitive.

(301) Vocabulary items for *heXYiZ* with regular roots:

a. V ↔ XYaZ
b. V ↔ XYeZ / [present]
c. V ↔ XYoZ / [future], [infinitive]
d. V_{XiYeZ} ↔ XYeZ / active, ___C(V)]$_{\#}$
e. V_{heXYiZ} ↔ XYiZ / active, ___C(V)]$_{\#}$

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

a. $\sqrt{\text{XYj}}$ ↔ XY / V
b. $V_{XaYaZ,XiYeZ}$ ↔ XYiZ / *heXYiZ* $\sqrt{\text{XYj}}$, [1/2 past]
c. V ↔ XYeZ / *heXYiZ* $\sqrt{\text{XYj}}$, [future]
d. V ↔ XYot / *heXYiZ* $\sqrt{\text{XYj}}$, [infinitive]
e. V [feminine] ↔ [-ta] / *heXYiZ* $\sqrt{\text{XYj}}$, [past]

Unfortunately, such a system is unrestricted in terms of locality: any element is capable of overwriting any vowel (similar problems arise for Faust 2016). In addition, overwriting vowels in one fell swoop would miss out on the notion that the lower domain (VoiceP) can see the morphology of the root whereas higher heads add affixes or overwrite local vowels (in the case of Pass). To a lesser degree, it is also doubtful to what extent one could tap into single vowels as indicators of structure. In other words, to what extent are these rules psychologically real. In my theory, I am making the case for the inherent locality in the syntactic structure to feed in directly into Vocabulary Insertion and the phonological derivation.

3.4.4 The Exo-Skeletal Model

The Exo-Skeletal Model has only recently begun to tackle the Semitic morphological system (Borer 2013:Ch. 11, Borer 2015; see also §2.6.3). Most of the work so far has concentrated on the idiosyncrasies of *XaYaZ*, taking its high degree of irregularity to argue that it is not derived using any derivational material, in juxtaposition to the other templates.

In this theory the templates *XiY̯eZ*, *heXYiZ*, *niXYaZ* and *hitXaY̯eZ* are morphosyntactic primitives. They combine with the consonantal root and with additional inflectional material such as tense and agreement. By now I have made the claim repeatedly that it will not do to treat templates as independent morphemes if we are to account for the syntactic and semantic generalizations laid out in Chapter 2. I have also argued in this chapter that my approach correctly predicts patterns of allomorphy and syncretism so I will not belabor that point.

Instead, I focus on a particularly interesting idea raised by Borer (2013, 2015): that *XaYaZ* has no functional material of its own but is a linearization of the root itself. Like any claim, this one can only make sense within a given theoretical framework. The intuition brought out by this analysis is that the other templates have functional material which *XaYaZ* does not. The goal of that account is the same as mine: to allow this template maximal leeway for lexical exceptionality of the root.

Seen in this light, I believe that the two theories converge. On the account developed in this dissertation, there are no overt heads intervening between the root and Voice or between Voice and T+Agr. This setup allows the root to be most exceptional in *XaYaZ*, which is exactly what we started off with in §3.2.1. The two theories simply implement this idea in different ways.

Other assumptions are not necessarily shared between the two frameworks. As noted above, I believe there is good reason not to treat templates as individual derivational morphemes, an assumption that Borer (2013) is committed to (though the implications are discussed in Borer 2013:564, where the idea of hierarchical organization between templates is considered). Future work in the Exo-Skeletal Model would bring additional differences between the two theories to light.

3.5 Alternatives: the stem-based approach

In this section I present a number of arguments against the "stem-based" theory of Semitic morphophonology (Bat-El 1989, 1994, 2003, 2008; Laks 2011, 2013a,b, 2014; Ussishkin 1999, 2000, 2003, 2005, 2006), mostly arguing against the proposal in Ussishkin (2005). I level three main arguments against this theory after describing it briefly: the problem of the missing base, the problem of overgeneration (which results from missed generalizations), and the lack of a link to the morphosyntax.

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 *XiY̯eZ* from *gadal* 'grew up' in *XaYaZ* by treating the vowels as an affix and using three constraints:

(303) 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.

(304) Ussishkin (2005:194). Instead of violation marks, individual vowels point out the violating segments.

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

In effect, the "affix" *i-e* spells out the template and is protected by highly-ranked Max-Affix.

3.5.1 Issue 1: The problem of the missing base

At its core, the difference between the two theories leads to the question of whether the grammar stores entire stems or smaller pieces that are then put together. The stem-based approach denies the existence of the root as a grammatical object, deriving instead surface forms from each other. However, a system in which one verb is derived from the other either assumes or predicts that there must always be a *XaYaZ* form to use as a base. As Ussishkin (2005:212) himself mentions in passing, this is not the case:

(305) a. *nirdam* 'fell asleep' ($\nless$ **radam*)
b. *nifrad* 'separated' ($\nless$ **parad*)
c. *diber* 'spoke' ($\nless$ **davar*)
d. *kibel* 'received' ($\nless$ **kabal*)

Doron (2003) lists many other examples and Kramer (2006) furnishes a similar argument from Coptic; this is the same problem that plagued the anticausativization analysis of valency alternations discussed in §2.7.2. Ussishkin (2005:213) speculates that the theory could be modified to allow derivation from a different base, in which case the base would have to be identified on a paradigm-by-paradigm basis. I contend that having one root as the base of derivation for all templates might be a more useful generalization.

3.5.2 Issue 2: Overgeneration

For the most part, stem-based analyses limited themselves to third person singular past tense forms. Recall that agreement affixes can be conditioned by the tense and the template, but not by a special class of the root. This behavior has a locality-based explanation in our theory but is not predicted on the stem-based approach. Since the stem-based approach does not permit hierarchical structure, 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 (304) 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) derives passive forms for 3SG.M past. In (306), σ-ALIGN is a disyllabic constraint. The passive "affixes" are privileged by MAX-AFFIX, resulting in overwriting of the base vowels.

(306) Ussishkin (2005:196)

a. *XuY̯aZ* from *XiY̯eZ*:

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

b. *huXYaZ* from *heXYiZ*:

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

The passive template overwrites the vowels of an active base: *gidel* 'grew' → *gudal* 'was grown'. In other words, tense and agreement kick in first (giving *gidel*) and are then overwritten by the passive. Yet since the morphophonological analysis limited itself to data from the unmarked 3SG.M past form, it overgenerates: tense information is predicted to condition vowel alternations (as when *je-ga̲del* 'will grow' has a different vowel than the past form *gi̲del*).

This analysis does not explain why vowels syncretize across person/gender combinations in the passive, as was discussed in §3.3.2. 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 (306), passive forms are derived by melodic overwriting of vowels in the active forms:

(307) a. gidel + u-a = gudal

b. hegdil + u-a = hugdal

To create a future passive 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 without additional stipulations:

a. he-gdil → ja-gdil → ✓ ju̲gda̲l

b. gidel → je-gadel → ✗ ju̲ga̲del / ✗ ju̲gada̲l / ✓ jegu̲da̲l

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:

c. gidel → gudal → ✗ jegadal / ✗ jegadul / ✗ jegodol / ... / ✓ jegudal

d. 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 *XiY̯eZ* 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 is reacting against.

In the theory developed in this chapter, different vowel realization rules are sensitive to different structures and Pass is allowed to overwrite the first vowel it runs across. A similar solution could be devised for the stem-based theory, but this modification would admit a serial derivation based on hierarchical combination of the different morphemes. The actual status of the affixes is not defined in the stem-based system.

3.5.3 Issue 3: Arbitrary affixation

More generally, the problem of explanatory adequacy with this theory is that it stipulates certain vowel combinations without explaining where they come from. Are these vowels morphemes, and if so, what does the morpheme denote? What is its role in the syntax? The approach I am developing uses functional heads, which allow for a better description of the system as a whole.

Recall next that agreement affixes can be conditioned by the tense and the template but not by a special class of the root, (270). This behavior has a locality-based explanation in our theory, but is not predicted on the stem-based approach. The stem-based grammar is sensitive to the consonants in the root, so why do they never condition allomorphy on the affix?

The passive was already discussed above. This analysis does not explain why vowels syncretize across person/gender combinations in the passive, as was discussed in §3.3.2. In order to describe the facts, additional constraints would have to be introduced in order to specify which vowel gets inserted for which person/gender combination. Yet such constraints would have to be indexed to the passive environment and outrank whichever constraints introduce the right vowels.

3.5.4 Summary

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

In essence, the stem-based approach accepts templates as morphemes but denies the root as a morpheme. The approach I have followed in this dissertation makes the opposite claim: roots are morphemes, but templates are an epiphenomenon of the spell-out of functional heads. One main advantage of the syntactic approach is that it allows us to describe the syntactic-semantic behavior of the templates more accurately—as seen in Chapter 2—without compromising the phonological grammar, as seen in the current chapter.

3.6 Conclusion

A cyclic, locality-based theory of morphophonology makes predictions about which elements can condition allomorphy on other elements and about the kind of information each element in the structure needs to provide. Roots can belong to different classes, and their lexically specified phonology emerges only under the right locality conditions – only when the relevant functional head can "see" the root. This much is true of our theory in general, before we have even considered Hebrew. But the same theoretical approach holds for non-concatenative morphology as well. Agreement affixes, for example, cannot be conditioned by the root in Hebrew.

Similarly, in cases where overt heads intervene, allomorphy will be blocked (Embick 2010, 2015). This is why the vowels inside the verbal stem in Hebrew syncretize across tenses and ϕ-feature combinations in the passive: they are conditioned by tense and agreement in active verbs, but not when the passive head intervenes.

The claim about passives is part of a general approach to locality in allomorphy proposed by Embick (2010) for a number of languages and supported more recently by Božič (2015), Gribanova (2015) and Kastner and Zu (2015), among others. This theory makes strong crosslinguistic predictions about the lack of contextual allomorphy across overt affixes. What still remains to be done in the study of allomorphy is to reconcile different findings. I have made the case for the strict locality hypothesis but much recent work challenges this strong claim, showing that it must be weakened for various empirical phenomena (Bobaljik 2012; Svenonius 2012; Merchant 2015; Grestenberger 2015; Bermúdez-Otero 2016; Caha 2016; Moskal and Smith 2016; Ostrove 2016). There is also a body of work making the case for phases as the locus of morphological cycles (Newell 2008; Marvin 2013). Finding a unified analysis for all these cases lies beyond the scope of the current chapter, though I hope to have contributed to the discussion by pushing back on the strict locality front.

The predictions of the strict locality hypothesis are borne out for Hebrew but are unexpected on a stem-based approach which takes templates to be morphological primitives. Instead of independent

CV skeletons, the verbal templates have been shown to emerge as a by-product of spelling out individual functional heads.

In Chapters 4 and 5 we delve deeper into questions of acquisition and processing, tackling the following two questions: How do learners get to this system in the first place? And is there evidence that speakers manipulate roots and templates in comprehension and production? To start with the second question, I provide evidence for a structural configuration of roots and functional heads that is predicted by the system developed thus far, based on the results of a neurolinguistic experiment.

Chapter 4

PROCESSING

4.1 Experimental evidence for roots and templates

This chapter collects a number of quantitative ways to attack the questions raised thus far: are Semitic roots and templates represented differently than roots and affixes in non-Semitic languages? What are the combinatory processes shared by Semitic and other languages? In this chapter I examine whether the mental lexicon of non-concatenative languages is different than that of languages with concatenative morphology.

Over the course of Chapters 2 and 3 I constructed an argument to the effect that the underlying grammatical architecture is identical for all languages, building verbs in the grammar with very specific loci for crosslinguistic variation. This view is supported here in two steps. First, I survey the existing experimental literature on Semitic morphology and summarize the findings on roots and patterns as elements in the mental lexicon. Then, I present my own neurolinguistic experiment on Hebrew which probed these elements directly; the discussion is based on Kastner et al. (2016) and I thank my collaborators for permitting me to include it here.

This chapter focuses on reading experiments. Because of this, transcriptions of Hebrew reflect the orthography, not the pronunciation, unless explicitly noted otherwise.

4.2 Previous studies on Semitic

Attempts to import experimental methods from concatenative languages to the study of non-concatenative languages can be traced most prominently to a series of studies kickstarted in the mid 1990s in work by Ram Frost, Avital Deutsch and their colleagues. These studies mostly used the masked priming paradigm, a variant on standard priming in which the prime is displayed for a very short amount of time, usually in the range of 30-70 milliseconds (ms). Priming is diagnosed by shorter reaction times (RTs) to the target item.

The masked priming paradigm has featured prominently in studies of lexical access in Semitic. Masked priming is different than overt priming in that no lexical-conceptual meaning is believed to be accessed when seeing the prime: semantic priming effects do not obtain (for challenges to this claim see e.g. Feldman et al. 2009, 2012). Presumably this is because the prime is not looked up in full, voiding its ability to prime a semantically related target, though a comprehensive model of overt and masked priming is still wanting. Nevertheless, masked priming does show form priming effects, most notably identity priming (Rastle et al. 2000, 2004). On some level of representation, all masked priming can be thought of as identity priming: the visual form is recognized in one way or another, making it easier for the participant to recognize it when the form appears overtly as part of the target. Table 4.1 schematizes the basics.

Condition	Prime	Target	Overt priming	Masked priming
Identity priming	*dog*	DOG	✓	✓
Form priming	*hog*	DOG	✓	✓/✗
Semantic priming	*cat*	DOG	✓	✗

Table 4.1: An idealization of the difference between overt priming and masked priming.

The picture sketched in Table 4.1 is not entirely accurate. Much work has gone into understanding the kind of form priming effects that obtain: does form priming hold for any orthographic overlap, or must the primed string be linguistically significant (a morpheme)? How long does the prime need to appear for?

The main finding to have emerged is that masked priming is sensitive to morphological constituents (see Rastle et al. 2000 for a particularly enlightening set of results that speak to these questions). For example, while masked priming obtains in regular verbs (*walked* primes WALK), it also obtains for irregular verbs (*taught* primes TEACH), but not for pure form overlap (*brothel* does not prime BROTH). The fact that masked priming has been reported to hold for irregular verbs as well as regular verbs (Crepaldi et al. 2010, 2013) indicates that there is more to it than just form matching: the form must be meaningful – a morpheme, by hypothesis.

The English results leave open the question of what level of representation morphological priming operates on: is priming of the past tense priming of a certain orthographic pattern? Of a phonological pattern, transcribed? Of an abstract morpheme? Of features on a morpheme? This is exactly the kind of question that needs to be addressed in crosslinguistic experimental investigation.

The question of primed features is complicated by masked priming of strings in which there is phonological overlap between prime and target. Such an effect has not been shown for whole written forms (i.e. *typhoid* does not prime TYPHOON, Rastle et al. 2000) but has been reported in masked onset priming of nonword strings: *suf* primes SIB more than *mof* does (Lukatela et al. 2001; Mousikou and Coltheart 2014; Mousiko et al. 2015).

Focusing on Hebrew now, Frost and colleagues conducted a number of masked priming experiments in which nouns primed other nouns sharing the same root (Frost et al. 1997) and verbs primed other verbs sharing the same root (Deutsch et al. 1998). These effects obtained regardless of semantic similarity. This much indicates that the root is plausibly identified as a morpheme.

Even though verbs primed other verbs in the same template (Deutsch et al. 1998), nouns did not prime other nouns in the same pattern (Frost et al. 1997). Deutsch et al. (1998) additionally found that a pseudo-word verb does prime another root in the same template (the non-existent *hgmir* primes HLBIʃ 'dressed') when compared to a control condition in which the prime differed from the target by one root consonant. The exact results depend on the root consonants; a two-consonant representation of the root leads to priming in some cases but not others (Frost et al. 2000a; Velan et al. 2005). Additional studies have supported the claim that this priming effect is morphological in nature, rather than purely formal, i.e. not based on orthographic similarity (Frost et al. 2005; Velan and Frost 2011).

Eye tracking studies have led to comparable results, privileging the root (Deutsch et al. 2000, 2003) and overt verbal templates but not overt nominal patterns (Deutsch et al. 2005). The privileged status of the root in Hebrew was also suggested by experiments using other experimental paradigms. In the cross-modal priming paradigm, participants respond to a visually presented target while hearing an auditory prime. A related root prime facilitated reaction to the target (Frost et al. 2000b). In the picture-word interference paradigm, a written distractor is presented before a target picture which participants need to name. Response to the target was faster when it shared a root with the distractor (Deutsch and Meir 2011; Kolan et al. 2011). Sensitivity to shared roots was found in a pair of fMRI studies as well, localizing activation to several regions in the left hemisphere (Bick et al. 2008, 2010).

Behavioral studies of Modern Standard Arabic have likewise found priming effects for roots and verbal templates that did not hold for nominal patterns or other controls (Boudelaa and Marslen-Wilson 2005, 2011), although orthographic similarity effects have been noted as well (Perea et al. 2015). Evidence from aphasia has also implicated the root as a basic element of morphological processing in Arabic (Prunet et al. 2000; Idrissi et al. 2008).

An auditory EEG study of Arabic showed sensitivity effects for the root after ~160ms and for the nominal pattern after ~250ms, distinguishing the two (Boudelaa et al. 2010). And using magnetoencephalography (MEG), Gwilliams and Marantz (2015) have found that Arabic speakers are sensitive to transition probabilities between different consonants in the root in auditory presentation, but only marginally so to whole-word predictions, indicating that speakers are sensitive to Semitic roots as elements with an internal structure made up of individual consonants.

These results notwithstanding, it has been argued that studies of Hebrew and Standard Arabic introduce a number of confounds: since the writing systems are based on consonants, and since the consonantal root is explicitly taught at schools, these languages bias towards a role for the root that might not have been there before the onset of formal education (Ussishkin 2006; Ussishkin et al. 2015). For these reasons it was necessary to replicate the findings from Hebrew and Arabic in Semitic languages that do not have a Semitic writing system. A study of Moroccan Arabic, a colloquial variant without a standard written form, used subliminal (masked) auditory priming to probe for root and template effects (Schluter 2013). Over the course of ten auditory experiments on colloquial Moroccan, Schluter found evidence for root priming but only limited priming across templates. For example, his Experiment 5 tested the three verbal templates in Moroccan and found that the complex *tXaYeZ* template primed the *XeYYeZ* template but not the *XYeZ* template. Other work from the same group tested Maltese, a Semitic language with heavy Italian influence that uses Latin orthography. In studies of Maltese, both visual and auditory masked priming have found root priming (Ussishkin et al. 2015) but limited template priming (Ussishkin and Twist 2009).

The main findings of these studies can be summarized as follows. The **consonantal root** functions as a morpheme for speakers of Semitic languages: it can be primed and it exists on its own level of representation. The status of the **verbal template** is less clear, however. On the one hand, the template can be primed. On the other hand, the priming behavior is not robust. Not every template can be primed in every Semitic language tested, and even when the template is primed the exact interaction with the root seems to influence the result. For instance, pseudo-words prime real words in the same template, but this template is overt (Deutsch et al. 1998), i.e. it contains a prefix H- and an infix -I-. One possible interpretation is that the prefix is primed. Such an explanation would account for this result, but it would not predict the auditory priming results or make any predictions regarding non-affixed templates (not all templates are overtly represented in the orthography).

Returning to our discussion of masked priming at the start of this section, three possibilities present themselves. Masked priming could be about stored whole word forms, though this interpretation would be difficult to reconcile with the irregular verb results in English. On this view, *worked* primes WORK because both share the string *work*.

The second possibility is that priming could be about an extra level of abstraction: priming a morpheme, not just its orthographic form. Then *taught* would prime TEACH because both share the root $\sqrt{\text{TEACH}}$ (Stockall and Marantz 2006).

Another alternative is that priming could be about the abstract features that make up the morpheme. On this view, a transitive verb would prime an otherwise unrelated transitive verb but not an unrelated intransitive verb. Such a view necessitates a theory of what features make up the experimental items and is returned to in Experiment 2.

All three hypotheses aim to account for what kinds of structures are recognized. We approach this question by asking how Semitic root priming and template priming fit in the picture. With the status of the root fairly well established, the question of how templates are represented remains crucially unanswered, and with it the question of what parts of a visual word get primed. In order to probe this question more fully, Experiment 1 replicates the overt template results using MEG and Experiment 2 investigates the three hypotheses in more detail.

4.3 Methods

4.3.1 Procedure

21 right-handed native speakers of Hebrew participated in the study (11 female, mean age 30.9), all with normal or corrected-to-normal vision. All provided written informed consent to participate in the study and were paid for their time.

Subjects lay in a dimly-lit, magnetically-shielded room and performed a lexical decision task. The subjects saw a string of hash marks (the forward mask, "#####") for 500ms followed by the prime which appeared for 33ms, followed by the target. Stimuli were presented using DMDX (Forster and Forster 2003). Participants were instructed to respond to the target stimulus as quickly and accurately as possible by pressing one button if it they recognized the string as a word in Hebrew, and another if they thought the string was not a valid word in the language. Targets were displayed in 20-point Arial font and primes in 11-point Arial. Hebrew orthography does not employ an uppercase-lowercase distinction, commonly used in masked priming experiments, so different font sizes were used instead (Frost et al. 2005).

The MEG data were recorded using a 157-channel axial gradiometer whole-head MEG system (Kanazawa Institute of Technology, Kanazawa, Japan); see Kastner et al. (2016) for the full details. Experiments 1 and 2 were run concurrently to minimize recording time and make the most use of participants' time, with items from one experiment serving as fillers for the other. Recording lasted approximately 25 minutes.

4.3.2 Analysis

4.3.2.1 Behavioral data

Participants' responses were analyzed for accuracy and reaction time. Subjects whose mean RT was more than 2 standard deviations above the mean RT for all subjects were excluded from the behavioral analysis; this resulted in the removal of one subject. Trials with an RT that was either less than 200ms, greater than 1500ms, or greater than 2 standard deviations away from the mean RT across subjects were also removed from the behavioral analysis. This resulted in the removal of 5.8% of trials in Experiment 1 and 6.4% of trials in Experiment 2.

In order to analyze the correlation of RT with the masked priming manipulation, linear mixed effects models were used (Baayen et al. 2008) with RT as the dependent variable, manipulation (prime frequency; target frequency; root match vs unmatched; template match vs unmatched) as the fixed effect, and subject and item as random intercepts. Results were not qualitatively different when treating frequency as a predictor. The linear mixed effects models were constructed using the lmer function of the lme4 package in R (Bates and Maechler 2009) and p-values were computed via Monte Carlo simulations with 10,000 iterations each.

4.3.2.2 Minimum norm estimates

MEG data were noise reduced (Adachi et al. 2001) in the MEG160 software (Yokogawa Electric Corporation and Eagle Technology Corporation, Tokyo, Japan) and minimum-norm estimates were calculated via MNE (MGH/HMS/MIT Athinoula A. Martinos Center for Biomedical Imaging, Charleston, MA) using the mne-python package (Gramfort et al. 2014). See Kastner et al. (2016) for additional details.

Using the grand average of all trials across subjects, after baseline correction with the pre-target interval (–150, –50 ms)—or, equivalently, the interval (–117, –17 ms) relative to the presentation of the prime—the inverse solution was computed in order to determine the most likely distribution of neural activity. The inverse solution was computed with a free orientation for the source estimates, meaning that the estimates were unconstrained with respect to the cortical surface.

Outlier trials were removed based on an absolute threshold of $\pm$2.5 pT, enforced over the time window (–100, +600 ms) for the noise reduced MEG data. In total, 33.9% of trials were discarded due to excessive noise in Experiment 1 and 33.4% in Experiment 2.

4.3.2.3 Region Of Interest

Two anatomical regions of interest were examined, of which I concentrate on one here (see Kastner et al. 2016 for discussion of the other). The analysis focused on a neural component modulated by the base frequency of the stimulus, identifiable at around 350ms post stimulus onset and so termed the M350, which is sensitive to lexical access (Stockall and Marantz 2006). This component has been localized to the middle and superior left temporal regions (Solomyak and Marantz 2010; Lewis et al. 2011; Fruchter et al. 2013; Fruchter and Marantz 2015), peaking about 350–400ms post stimulus onset. A similar component has recently been found in an ERP study, reflecting semantic effects in the 300–340ms time window (Laszlo and Federmeier 2014).

We investigated, then, the effect of condition on activity in the middle temporal ROI shown in Figure 4.1. The neural activity in this middle temporal region of the left hemisphere was averaged across subjects for each condition. Following Fruchter et al. (2013), the time window of interest was set to the late interval 300–500ms post target onset.

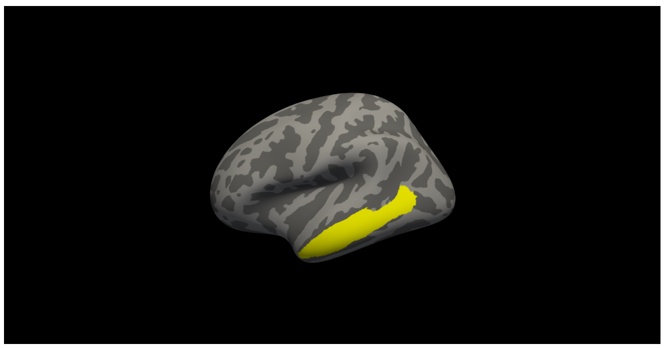


Figure 4.1: Middle temporal ROI.

The technique used for multiple comparisons correction is based on the methods of Maris and Oostenveld (2007), as adapted by Solomyak and Marantz (2009): we first computed Σt, the sum of all t-values within a single temporal cluster of consecutive significant effects in the same direction (where significant is defined by $|t| > 1.96$, $p < 0.05$ uncorrected). The highest absolute value of Σt, for any cluster within the whole time window, was then compared to the results of the same procedure repeated on 10,000 random permutations of the independent variable (i.e., the condition). A Monte Carlo p-value was thus computed, based on the percentage of times a random permutation of the independent variable led to a larger maximum absolute value of Σt than the original maximum absolute value of Σt (as computed on the actual data).

4.4 Experiment 1

The first experiment tested whether priming effects obtain for the root and template in the overt HXYIZ template (pronounced *heXYiZ*). Any model that treats roots on a par with stems and that treats templates on a par with affixes should predict lower activation for targets that share a root or template with the prime, when compared to a control condition. This is a test of whether an overt, prefixed template shows similar behavior to that of an affix in a language like English.

4.4.1 Materials

Each pair of 42 word targets and 42 nonword targets was matched with its own three possible primes, for a total of 252 items. The order of items was pseudorandomized across participants.

Target words were in the HXYIZ template (*heXYiZ*), with primes either matching the template in the Shared Template condition (+T –RT), matching the root in the Shared Root condition (–T +Rt), or being unrelated verb controls in a different template (–T –AS).

(308) a. +/– Rt: Shared root.
 b. +/– T: Shared template.
 c. +/– AS: Shared argument structure.

See Table 4.2. Only transitive verbs were used as targets in order to avoid the complications discussed in §2.3.2.2.

	+T –Rt	–T +Rt	–T –Rt
prime	HXʃIV החשיב *hexʃiv* 'considered'	NZKR נזכר *nizkar* 'remembered'	XLF חלף *xalaf* 'passed'
TARGET	HZKIR הזכיר *hezkir* 'reminded'		

Table 4.2: Conditions in Experiment 1.

All items were common words used in modern-day Hebrew. Surface frequencies were obtained using a 165M-word corpus of Hebrew blogs (Linzen 2009) in order to ensure that the data matched contemporary usage as closely as possible. For additional considerations regarding prime frequencies in Hebrew priming experiments see Frost et al. (2005:1296). Lexical statistics are given in Table 4.3. None of the differences in frequency between conditions approached significance, with the marginal exception of a pairwise comparison between +T –Rt and –T –Rt, $t_{53.7} = 1.76, p < 0.1$.

Condition	Word length	Surface freq per million
+T –Rt	5.0	2.45
–T +Rt	4.19	6.31
–T –Rt	3.76	9.17
Target	5.0	4.6

Table 4.3: Lexical statistics for stimuli in Experiment 1.

Stimuli were presented in "unpointed" or "vowelless" script in order to allow for as natural a reading experience as possible. All verbs were in the third person masculine singular past tense, the standard citation form. All items were chosen such that they would be read unambiguously. Written Hebrew does not mark vowels, leading to a large number of homographs (for instance, HPNIM could either be read as the verb *hefnim* 'internalized' or as the definite noun phrase *ha-panim*, 'the face', so this string was not used). Care was taken to select strings that could only be read as the verb in question. This selection criterion narrowed down the available number of verbs considerably, but ensured that stimuli would be perceived as naturally as possible since pointed script is not used by adult speakers of Hebrew. This self-imposed limitation also meant that matching for frequency was not the first concern, though the conditions did not differ from each other in this respect. In any case, since the same target was matched with different masked primes, any imbalance was not expected to confound the results (Frost et al. 2005).

The nonwords employed were phonologically possible words of Hebrew. Only word trials were included in the analysis.

4.4.2 Results

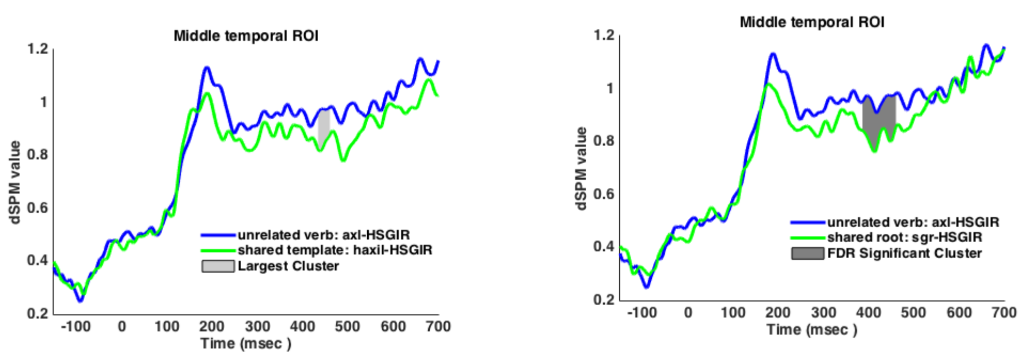
4.4.2.1 Behavioral results

Accuracy at the lexical decision task was at ceiling (>90%). Since the task was only meant to ensure that participants were paying attention to the stimuli, responses were not analyzed further.

RT was marginally facilitated by target frequency, $t_{2444} = 1.9, p < 0.06$. Prime frequency was not significant ($t = 1.6, p < 0.12$). In the +**Template** condition, Shared Template mean RTs (652.3ms) were not significantly different than Unrelated Verb mean RTs (652.9), $t_{1628} = 0.1, p > 0.5$. In the +**Root** condition, Shared Root mean RTs (642ms) were not significantly shorter than Unrelated Verb mean RTs (652.9ms), $t_{1633} = 1.5, p < 0.15$, although the numerical difference (10.9ms) is similar to that seen in previous behavioral work (Deutsch et al. 1998).

4.4.2.2 ROI results

The **Shared Template** condition showed a trend towards significance at M350: 434-460ms, $p < 0.08$ (corrected over 300-500ms). The **Shared Root** condition was significantly lower that the unrelated control at M350 in the window 386-460ms, $p < 0.01$ (corrected over 300-500ms). These results can be seen in Figure 4.2.



(a) Shared Template condition. (b) Shared Root condition.

Figure 4.2: Experiment 1, M350.

4.4.3 Discussion

In this experiment we expected to find priming effects for the template HXYIZ (*heXYiZ*) since it consists of the prefix H- as well as an infix -I-. Following previous work on lexical access in Semitic, we also expected to find priming effects for the root. Given the different nature of Semitic templates to prefixes and suffixes, we did not have more specific predictions and utilized a fairly well attested neural correlate of lexical access post morphological decomposition, the M350. Both predictions were confirmed—for the template and the root—to different degrees.

The Shared Template condition showed a strong trend towards significance for the M350 component, in line with previous findings on affixation in English. Even though the difference between Shared Template and the control failed to reach significance at the $\alpha = 0.05$ level, the $p < 0.08$ trend and the waveform separation throughout the late 300-500ms window are consistent with an affix-like role for the template (or for $\text{Voice}_{\{D\}}$which underlies it; §2.3.2).

In the Shared Root condition, priming was found at the M350 component, in accordance with our hypothesis treating the root as a morpheme accessed during lexical retrieval.

In sum, the results for the overt template found priming at the M350 component. The root and the template were both primed, as expected. With the results for an overt template in place, we next tested a template that is not signaled overtly by the orthography.

4.5 Experiment 2

Experiment 1 provided evidence that in an overt template, the Hebrew root and template show the same priming behavior that is to be expected of morphemes in languages with concatenative morphology such as English. In order to better understand what kind of morphemes these are, as well as what level of representation is targeted by masked priming, Experiment 2 tested the "covert" template *XaYaZ*. This template has no orthographic cues: the reader must know that the string HLX is to be read *halax* and means 'walked' (a verb), that the string BSR is to be read *basar* and means 'meat' (a noun), and that the string KTN is to be read *katan* and means 'small' (an adjective).

All targets were verbs in *XaYaZ*. If masked priming is sensitive to overt affixes and not to covert templates, there should be no priming effect for primes in a related template. Alternatively, in the theory adopted in this dissertation, verbs are minimally made up of a root and a verbalizing little v (plus Voice; Chapter 2). Similarly, nouns are derived by combining a root with little n. If verbs in this template share the v/Voice morpheme, then there should be a priming effect in a shared template condition.

Alternatively, a stronger prediction can be made. It has been found that in nonword strings, phonemic features show masked priming effects: the target BAF was read aloud faster when primed by *piz*, with which it shares a [labial] feature in the onset, than by *suz*, whose onset is unrelated (Lukatela et al. 2001; Mousikou and Coltheart 2014; Mousiko et al. 2015). Some theories of morphology, going back at least to Generative Semantics, have proposed that the verb carries specific features bearing on its argument structure: a verbal construction carries one of the features [CAUSE], [DO] and [BECOME], roughly corresponding to transitive verbs, unergative verbs and unaccusative verbs (Jackendoff 1990; Levin and Rappaport Hovav 1995). Folli and Harley (2006) similarly suggested that v/Voice itself carries one of these features. If these features are part of the makeup of the verb, and if masked priming is as sensitive to features on a morpheme as it is to features on a phoneme, then there should be a priming effect for shared argument structure verbs in the same template. That is, transitive verbs should prime transitive verbs, unergatives should prime unergatives and unaccusatives should prime unaccusatives.

Three diverging predictions thus result from the intersection of the masked priming literature, the theoretical literature and the results of Experiment 1:

- Priming effects for a shared phonological pattern like XYZ (*XaYaZ*), regardless of whether the prime and target are verbs, nouns or adjectives (morphological priming is form priming).
- Priming effects for a shared template (morphological priming is priming of an abstract morpheme, in this case v/Voice).

- Priming effects for shared argument structure (morphological priming is feature priming on an abstract morpheme).

In fact, any priming effect for the shared template would constitute a novel result, as there is no orthographic difference between a shared template verb, on the one hand, and a noun with a similar syllabic shape, on the other: both are pronounced *XaYaZ* and written XYZ.

4.5.1 Materials

Each pair of 42 word targets and 42 nonword targets was matched with its own six possible primes, for a total of 504 items. All items were chosen such that they would be read unambiguously, as in Experiment 1. The order of items was pseudorandomized across participants.

Target words in Experiment 2 were verbs in *XaYaZ*, with primes varying in whether or not they shared the same root, template, and/or argument structure. There was also a prosodically matched, non-verb prime. This made for five total conditions in three pairings, as illustrated in Table 4.4: Shared Template with different argument structure (+T –Rt –AS), Shared Root (–T +Rt –AS), Shared Argument structure (–T –Rt +AS), Unrelated Verb (–T –Rt –AS), and Prosodic Control with identical syllable structure in a non-verbal form (–V).

(309) a. +/– Rt: Shared root.
b. +/– T: Shared template.
c. +/– AS: Shared argument structure.
d. +/– V: Verb or non-verb.

The argument structure of "simple" *XaYaZ* is its morphosyntactic frame: recall from §2.3.1 that verbs in this template can be unaccusative, unergative or transitive (both monotransitive and ditransitive).

	Template comparison		Root comparison		Argument Structure comparison	
	+T –Rt –AS	–V	–T +Rt –AS	–T –Rt –AS	–T –Rt +AS	–T –Rt –AS
prime	CLL צלל *tsalal* 'dove'	BSR בשר *basar* 'meat'	HTRXC התרחץ *hitraxets* 'washed himself'	HTLBʃ התלבש *hitlabeʃ* 'dressed up'	HARIX האריך *he'erix* 'extended'	HTLBʃ התלבש *hitlabeʃ* 'dressed up'
target	RXC רחץ *raxats* 'washed (something)'					

Table 4.4: Conditions in Experiment 2.

Lexical statistics are given in Table 4.5. None of the differences in frequency between conditions approached significance. Any items whose frequency exceeded 500 per million were treated as outliers and discarded from the analysis.

Condition	Word length	Surface freq per million [freq with outliers]
+T –Rt –AS	3.0	11.51 [126.55]
–V	3.0	8.0
–T +Rt –AS	4.50	5.5
–T –Rt –AS	4.71	8.55 [63.26]
–T –Rt +AS	4.48	3.79
Target	3.0	10.1

Table 4.5: Lexical statistics for stimuli in Experiment 2.

4.5.2 Results

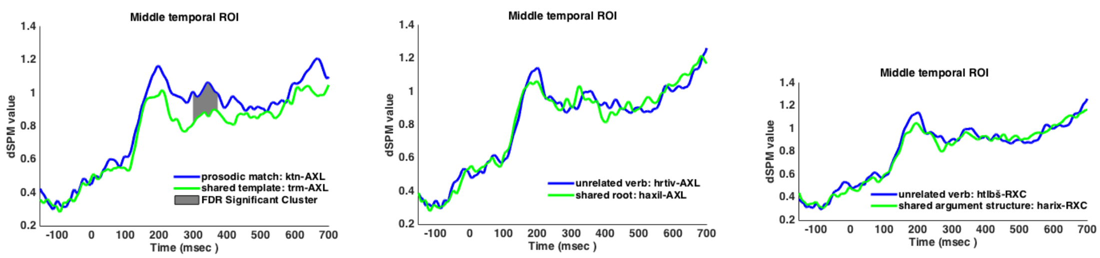
4.5.2.1 Behavioral results

RT showed facilitation by target frequency, $t_{4920} = 6.1, p = 0.001$. Prime frequency was not significant ($t_{4920} = 0.5, p > 0.5$). In the **Template** condition, Shared Template mean RTs (652.3ms) were not significantly shorter than the Non-Verb mean RTs (654.8ms), $t_{1628} = 0.3, p > 0.5$. In the **Root** condition, Shared Root mean RTs (641.6ms) were not significantly shorter than the Unrelated Verb mean

RTs (649.5ms), $t_{1631} = 0.95, p < 0.4$. In the **Argument Structure** condition, Shared Argument Structure mean RTs (649.4ms) were not significantly shorter than the Unrelated Verb mean RTs (649.5ms), $t_{1645} = 0.2, p > 0.5$.

4.5.2.2 ROI results

The **Shared Template** condition showed lower activation with marginal significance at M350 in the time window 300-373ms, $p < 0.08$ (corrected over 300-500ms). The **Shared Root** condition showed no difference from the control at M350 (no clusters found). The **Shared Argument Structure** condition showed no difference from the control at M350 (no clusters found). These results can be seen in Figure 4.3.



(a) Shared Template condition. (b) Shared Root condition. (c) Shared Argument Structure condition.

Figure 4.3: Experiment 2, M350.

4.5.3 Discussion

Neural activation was lower when the prime and target shared the "simple" template pronounced *XaYaZ*, in effect revealing a category split (verbs vs non-verbs) in accordance with the categorizing heads hypothesis. It is striking that this priming effect obtains, given that the Shared Template condition and the control are not obviously different in any other way: their orthographic, phonological and prosodic shapes are similar (XYZ in the orthography, *XaYaZ* in pronunciation). The only distinction is between verbs in a given template on the one hand (Shared Template) and non-verbs on the other (control condition). While many differences between the processing of nouns and verbs have been documented over the years, this kind of category split has not been noted yet, possibly since its distinct morphological characteristics can only be found in a language like Hebrew.

Root priming did not obtain, perhaps surprisingly given the results surveyed above. Note, however, that were this result to obtain it would have been novel: root priming in Hebrew verbs has only been shown to arise in templates marked by overt affixes (like that in Experiment 1), in pseudowords and in some roots containing glides (Deutsch et al. 1998; Frost et al. 2000a; Velan et al. 2005). This pattern remains a puzzling one for studies of lexical access crosslinguistically.

4.6 Conclusion

The theory developed in this dissertation minimizes the formal differences between concatenative and non-concatenative languages. In this chapter I asked whether the morphological systems were different in how they are processed and concluded tentatively in the negative.

Research on morphological decomposition often capitalizes on the distinction between stems and affixes. The former are taken to contain lexical information while the latter are more functional. The behavior of each can be evaluated separately (Rastle et al. 2000) or combined in order to probe their interaction, especially in irregular verbs (Crepaldi et al. 2010; Fruchter et al. 2013). Yet work on decomposition has often limited itself to European languages, save for the notable exceptions mentioned earlier. Those works indicate that in Semitic languages it is possible to equate the root with a stem and the template with an affix, at least as a first approximation.

This study has attempted to take the next step, asking what kind of element each of these units is, and by implication what a morpheme is: is it the form (be it orthographic or phonemic) plus a meaning? Or is it something more abstract, such as a bundle of grammatical features? The latter option falls in line with the theory developed in the earlier parts of this dissertation.

A strong form-based hypothesis is likely to be ruled out. Perea et al. (2015) have obtained recent evidence that priming ignores the uppercase/lowercase distinction. Crepaldi et al. (2010) and Fruchter et al. (2013) have shown that masked priming obtains for irregular verbs, meaning that the morpheme is a link between some surface representation and an abstract representation. In Experiment 2 we found that the morpheme can be covert: on seeing the Hebrew string ZKR, the reader attempts to figure out the lexical category. Here there are only a few options, namely noun, verb or adjective (perhaps preposition as well). Sensitivity to verbal primes but not to comparable nominal or adjectival primes disconfirms the form hypothesis and supports a more abstract representation of the morpheme. In contrast, on seeing the string HZKIR as in Experiment 1, the reader might immediately identify the string as a verbal form and would engage in root lookup.

Semitic languages are a good testing ground for studies of lexical access for two reasons: the decomposition is often non-linear, and the affix, so to speak, might not be visible in the orthography at all (as in our Experiment 2). The fact that root and template priming can be shown to obtain indicates that a nuanced view of the morpheme as the basic compositional unit needs to be adopted; roots are different than stems.

In conclusion, a specific view of morphological priming was tested. Take the English suffix -er: by all accounts it is an affix and a morpheme, but is it orthographic ”-er” or abstract [AGENTIVE NOMINALIZER] that is accessed by the reader during priming? In Hebrew there are many such affixes, taking the form of morphophonological patterns: HXYIZ is both a single form and a collection of heads and features. XYZ is both a single form and potentially a verb, a noun or an adjective. We have found, perhaps counter-intuitively, that when the template is overt, root and template priming obtains, and when the template is covert, template priming obtains. Future studies will need to test whether these results generalize across additional materials, in Hebrew as well as other Semitic languages. Importantly for our current purposes, these results are entirely consistent with the system developed thus far: I have argued for roots and for a certain architecture of functional heads, and the predictions of these claims have by and large been confirmed by the MEG study.

Assuming that we have reached a satisfactory characterization of the synchronic system, we may next ask how this system is acquired.

Chapter 5

ACQUISITION

5.1 Acquiring Semitic

The final contribution of this dissertation outlines how the verbal system of Semitic might be acquired. In this section I synthesize some recent findings on the acquisition of Hebrew and their relevance to the themes of the dissertation. Section §5.2 presents a novel computational model of early learning which can be used to test hypotheses about the acquisition of non-concatenative morphology. Finally, §5.3 outlines how to test which aspects of the system are productive.

When asking what developmental data is relevant to the question of how roots and templates are acquired, two basic empirical domains should be reviewed: what patterns do children produce and what input are children exposed to.

5.1.1 Production data

My brief summary of production data draws on Berman (1982, 1993) and Levy (1988), as discussed by Borer (2004). In this section I am interested primarily in the kinds of mistakes children make when producing different templates.

Patterns in children's mistakes can clue us into the developing grammar. At age 2;2 Hebrew-speaking children produce erroneous verbs by using the correct root in the wrong template. For example, the child might erroneously produce an existing form in *XaYaZ*, in this case *rai-ti* 'I saw', instead of the correct form *her'e-ti* 'I showed' in *heXYiZ*.

(310) ***rai-ti*** *et* *ha-tsiurim* *le-aba*
√SEE.SMPL ACC the-drawings to-dad
'I showed the drawings to daddy'

Not all mistakes go in the direction of *XaYaZ*. Instead of *nixnas* 'entered' in *niXYaZ*, the child Na'ama in the Hebrew CHILDES dataset analyzed by Borer (2004) produced *kines* in *XiY̯eZ*, a form which has a different meaning ('assembled, gathered').

(311) *hu* ***kines*** *la-tanur*
he √ENTER.INTNS to.the-oven
'He entered the oven'

Borer (2004) finds that *XaYaZ*, the most frequent template in adult language, is also the most frequent one in children's production, making up 43.1% of all verbal types in the Na'ama dataset.

Alternatively, the child might also innovate a form in *XiY̯eZ*, here **le-naheg*, instead of using the correct form *XaYaZ*, here *li-nhog* 'to.drive'.

(312) *ani* *rotsa* ***le-naheg*** *ba-fiesta*
I want to-√DRIVE.INTNS in.the-Fiesta
'I want to drive the [Ford] Fiesta.'

As the child grows older, her mistakes change. By age 4 the errors are much more systematic: now, when the child uses the wrong template, their choice obeys the argument structure associated with that template as discussed in Chapter 2. It can be argued that the child uses *XaYaZ* less because it is underspecified for morphosyntactic information (Borer 2004).

(313) a. *niXYaZ* instead of adult *hitparek* in *hitXaY̯eZ*:
lama *ze* *ha-kol* ***nifrak***? [Age 3;11]
why this everything √COLLAPSE.MID
'Why did it all fall apart?'

b. *hitXaY̯eZ* instead of adult *ne'elav* in *niXYaZ*:
ani *nora* ***mit'alev*** *kfe-omrim* *li* *kaxa* [Age 5;2]
I very √OFFEND.INTNS.MID.PTCP when-say to.me like.that
'I become very offended when someone says that to me.'

Borer (2004) shows how at this point in development the child might mix up *niXYaZ* and *hitXaY̯eZ*, or *XiY̯eZ* and *heXYiZ*, but will not make substitutions across these pairings: the syntax would come out wrong.

If this characterization of the facts is correct, it means that children first choose the right root and then place it in a morphophonological template. At an earlier stage, if they are unsure of the template they might opt for the most common one, *XaYaZ*. At a slightly later stage, however, they are already able to match up the template with its correct argument structure, falling back to the underspecified template much less.

This progression means that the child is learning the grammatical details of the templatic system after learning which roots exist. The next question is, what information is needed to progress from stage to stage?

5.1.2 The input

In an illuminating recent study of the input, Ravid et al. (To appear) examined the spoken input to two children aged 1;8–2;2 as well as a collection of children's books. Their findings support a view of gradual acquisition of the system, from roots to templates, and can be summarized as follows. All data here are reproduced from their paper, rounded to the closest integer.

5.1.2.1 Roots

For roots in the spoken input, 64% of all root types were regular and the rest were in one of the irregular root classes such as those mentioned in Chapter 3. See Table 5.1.

	Regular	$\sqrt{\text{XYj}}$	$\sqrt{\text{XwZ}}$	$\sqrt{\text{XYXY}}$	$\sqrt{\text{nYZ}}$	$\sqrt{\text{ʔYZ}}$	...
Root types	64%	8%	7%	6%	3%	1%	
Root tokens	26%	24%	8%	1%	7%	6%	

Table 5.1: Root types and tokens in the spoken corpus.

When looking at tokens, only 26% of the roots are regular and 24% are /j/-final, including a number of high frequency verbs such as *kara* ‘happened’ and *ratsa* ‘wanted’. Similar patterns obtain in the written texts.

The authors also show that most irregular roots are heard fairly early on. The child does not hear many new irregular roots as time progresses: the increase is linear, growing very slowly over the four-month-long recording period and effectively plateauing fairly early on. On the other hand, the number of regular roots to which the child is exposed starts off high and keeps increasing throughout the period of data collection. This means that the input contains, for the most part, regular morphophonology, and that new forms are usually regular.

5.1.2.2 Templates

Looking to templates, 36% of all types in the spoken corpus are in *XaYaZ* and another 40% are distributed fairly evenly between the active templates *heXYiZ* and *XiY̯eZ*. The token count is different, with 72% of the input in *XaYaZ* (the template in which the most frequent verbs are), 14% in *heXYiZ* and 9% in *XiY̯eZ*. See Table 5.2. These findings are consistent with the production data in that *XaYaZ* is the most frequently attested template.

	XaYaZ	*XiY̯eZ*	*heXYiZ*	*hitXaY̯eZ*	*niXYaZ*
Template types	36%	22%	18%	16%	7%
Template tokens	72%	14%	9%	3%	2%

Table 5.2: Template types and tokens in the spoken corpus.

At this stage the investigators only tallied the counts for verbs; nominal and adjectival patterns would round off the picture. The written corpus shows similar patterns.

An interesting question for our purposes has to do with the number of templates each root is instantiated in. In the spoken corpus, 72% of all roots are instantiated in only one template, 25% in two templates and 2% in 3 templates. The written corpus shows very similar ratios. I do not know, however, what the ratios are like for the language in general. Going back to the list in Ehrenfeld (2012), I calculated how many roots appear in one template, two templates, three templates and four or more. The comparison is given in Table 5.3. These figures are presented only for rough comparison; the dataset contains many forms that are not frequently attested.

	N	1	2	3	4+
Templates per root, spoken	521	72%	25%	3%	<1%
Templates per root, written	744	69%	23%	8%	<1%
Templates per root, database	1876	24%	30%	25%	21%

Table 5.3: Templates per roots in the different corpora.

The authors note that of the 40 most frequent forms in the corpus, three are verbs with existing alternations, all in *XaYaZ* and *heXYiZ*. They are given in (314).

(314) Transparent alternations in *XaYaZ* ∼ *heXYiZ*:

ba	'came'	∼	hevi	'brought'
raa	'saw'	∼	hera	'showed'
jatsa	'exited'	∼	hotsi	'took out'

The important point about (314) is that these alternations are predictable, unlike the less-predictable forms we also saw in Chapter 2:

(315) Some opaque alternations in *XaYaZ* ∼ *heXYiZ*:

sagar	'closed'	∼	hesgir	'turned someone in'
pakad	'counted'	∼	hefkid	'deposited'

Ravid et al. (To appear) make the reasonable assumption that the transparent alternations ease the learner into the full system. In fact, the authors argue that one member of the two-template "family" is usually highly frequent, forming a good cue for the learner. The same patterns are said to hold for three-template families as well. Impressionistic reports make the same claim for the regularity of the phonology in these alternations, though no quantitative data is available at this point.

The authors put forward the following hypothesis in conclusion: as morphological families grow—that is, as novel verbs in different templates appear in roots to which the child has already been exposed—these families become less semantically cohesive. Yet the formal similarities will become clearer as more data (more alternations) are encountered. The child thus first learns a verb in *XaYaZ*, and through this verb can learn the different tenses (alternations within a root and template). Then, additional templates offer more regular phonological alternations across tenses. This process is further boosted, according to the authors, when children learn the writing system.

5.1.3 Summary

The developmental data indicate that infants encounter a substantial number of morphophonologically regular roots in the first few years of life. They start off using these roots in the most frequent (and structurally underspecified) template, gradually expanding their morphosyntactic system based on the alternations and the additional templates they are exposed to. By age 4 they seem to have good control not only of the template as a morphophonological object but also of its syntactic and semantic properties; they are learning the actual functional heads in the structure.

Our root-centric syntactic model is fully compatible with the findings described above. It would be too ambitious at this point to make concrete predictions about the acquisition of specific functional heads like those in Chapter 2, or of ranking arguments like those in Chapter 3, based on these findings. What is clear is that the exposure to the complexities of the morphological system is gradual and can be argued to begin with the root, progressing from it to an expanded system of morphosyntactic primitives.

In future work a direct link will need to be formulated between the input and the synchronic system so that we can better understand how the grammar guides the learning process and what can be learned purely from frequency distributions. In the next section I hypothesize that roots are learned first because, being consonantal strings, they are easy to pick out from the input stream.

5.2 Modeling acquisition through consonants

This section approaches the question of acquisition through the lens of *segmentation*, the task of dividing the speech stream into individual phonological words. This task consists of placing word boundaries in the input, forming the base for the next stages of acquisition. Many phonological, syntactic and semantic generalizations are made over phonological words. Without knowing what the words in her language are, the infant would find it difficult to learn the rest of the grammatical system.

Even though the importance of this process for our understanding of language acquisition is established, it is less clear how segmentation varies from language to language. Different languages have different sound systems, different grammars and different surface structures. Can one and the same segmentation strategy be applied to all kinds of input? Does the word segmentation mechanism differ cross-linguistically?

The work presented here is based on Kastner and Adriaans (2016); I thank my collaborator for permitting me to include it in this dissertation. The segmentation problem was approached by contrasting Arabic with English. For both languages we adopted a view of segmentation as statistical learning performed by the learner over the input. In our attempt to test whether the same segmentation algorithm can be used for both languages, we are in effect asking whether English and Arabic learners track the same distributions.

The hypothesis tested here gives a two-headed answer to this question. Yes, the same segmentation algorithm is used in all languages. But crucially, the learner might attune to different aspects of the input in different languages. Specifically, it is hypothesized that if the learner divides the input into separate phonological representations ("tiers") of consonants and vowels, acquisition of Arabic would be facilitated. The learner of Arabic may concentrate on the **consonants** at early stages of acquisition, while the learner of English will attune to **both consonants and vowels**. The segmentation algorithm itself remains identical across languages; only the representation of the data changes.

Under this hypothesis, the learner can acquire the different roots of the language by simply focusing on the consonants in the input. The vowels can then be re-integrated into the learned representations, deriving the full set of words and grammatical patterns. The findings support a general model of acquisition in which the learner transitions from considering the entire input at face value to generalizing over consonants and finally re-introducing the vocalic material, as hypothesized based on the acquisition data in §5.1. I will argue that this is a cognitively plausible hypothesis in §5.2.1 and lay out the segmentation problem in §5.2.2. Two computer simulations are presented in §§5.2.3–5.2.4. Section §5.2.5 discusses implications for acquisition and §5.2.6 wraps up.

5.2.1 Consonants and vowels

Before testing the hypothesis it is necessary to ensure that this task is feasible for a human learner. There is evidence from artificial language learning experiments that human learners are indeed able to separate consonants from vowels, rendering our hypothesis cognitively plausible. A landmark study by Newport and Aslin (2004) found that adult learners are able to track consonant-to-consonant transitional probabilities, as well as vowel-to-vowel transitional probabilities, in a continuous stream of CV syllables. Low transitional probabilities between phonemes indicate potential word boundaries, so the ability to track such probabilities in the speech stream allows learners to make considerable progress in word segmentation. Importantly, Newport and Aslin's study provides evidence that co-occurrence probabilities can be learned when segments are not immediately adjacent but are separated by intervening vowels or consonants.

In a similar study, Bonatti et al. (2005) found that learners were able to exploit consonant probabilities, but not vowel probabilities, for segmentation. Their findings indicate that learners might in fact pick up consonantal word roots from the speech stream, rather than complete words consisting of consonants and vowels. Keidel et al. (2007), however, argue that the preference for consonantal patterns may have been driven by the structure of the participants' native language, French. It thus remains unclear to what extent segmentation relies on consonants or vowels, and to what extent this reliance is language-specific. It should be noted that developmental studies have shown that consonants and vowels are learned at different ages (Werker and Tees 1984; Polka and Werker 1994) and that they might play different roles in early language acquisition: consonants for concepts and vowels for grammar (Hochmann et al. 2011).

It is worthwhile asking whether this ability to distinguish consonants from vowels enables the learner to make progress in the acquisition of natural languages as well. We answer in the affirmative.

5.2.2 The segmentation problem

The segmentation problem has mostly been tackled with an eye to one specific language, usually English (Goldwater et al. 2009; Phillips and Pearl 2015b) but on occasion Dutch as well (Adriaans and Kager 2010). Only recently have attempts been made to examine the crosslinguistic validity of segmentation algorithms (Phillips and Pearl 2015a). In their study, Phillips and Pearl compared the performance of a number of segmentation algorithms on datasets in English, Farsi, German, Hungarian, Italian, Japanese and Spanish. Their results showed that the same algorithm does not do as well for all datasets. However, the question of *how* the languages are different was not explored beyond basic lexical statistics. What is it about the phonology or morphology of these different languages that influences how the algorithm performs? Given a formal understanding of Semitic morphology, our hypothesis was that a learner of Semitic would perform better on a segmentation task if it focused on a representation containing only consonants.

To evaluate performance of the segmentation algorithm we followed Goldwater et al. (2009) in adopting a number of measures from information retrieval—Precision, Recall and F-Measure—to be explained below. Our segmentation algorithm postulates word boundaries in the input and these measures evaluate how well the algorithm performed. A segmentation of the input results in a "proto-lexicon" of hypothesized word forms in the language. The second step of evaluation consists of asking to what extent this proto-lexicon can assist in the next stages of acquisition. This question is dealt with in Simulation 2, when the proto-lexicon is evaluated based on its contribution to the calculation of basic phonological patterns in Arabic.

I now turn to the two simulations testing our hypothesis: that the learner of Arabic is aided by focusing on the consonants in the input, leading to improved segmentation. Simulation 1 tested the learner's performance on a standard segmentation task. Simulation 2 tested whether the induced proto-lexicon can be used as a stepping stone towards additional statistical learning.

5.2.3 Simulation 1: Segmentation

Simulation 1 asked to what extent a language-specific representation aids in segmenting the input stream. We contrasted datasets in two languages, English and Arabic, running the same segmentation program on different representations of the same corpus in each language.

5.2.3.1 Data

Our dataset for English was the subset of CHILDES, the corpus of child-directed speech (CDS) used in previous segmentation work (Bernstein-Ratner 1987; Goldwater et al. 2009). Only data uttered by the caregiver was used. Statistics for this dataset are given in Table 5.4 under "English".

	English	Arabic
Utterances	9790.0	8403.0
Tokens	33,399.0	30,931.0
Types	1,421.0	8,395.0
Tokens/utterance	3.41	3.68
Token length in phonemes	3.24	5.34

Table 5.4: Statistics for the different datasets in Experiment 1.

In many Arab societies a well-documented case of diglossia can be observed, in which Modern Standard Arabic is used as the written language and in formal occasions, while the local dialect is used for everyday speech. In our experiments we made use of a corpus of natural vernacular speech, the EMALAC corpus of Emirati Arabic CDS (Ntelitheos and Idrissi 2015). To the best of my knowledge, this corpus is the most recent and most well curated corpus of CDS in Arabic. Statistics for this corpus are given in Table 5.4 under "Arabic".

It can be seen from the table that the English dataset is slightly larger. The Arabic tokens are longer, but importantly the number of tokens per utterance is remarkably similar across the two datasets. The corpora may be treated as comparable.

Local dialects of Arabic diverge from the standard variety in a number of ways. In order to provide a full comparison between English and Modern Standard Arabic an additional comparison was conducted by running the same simulations on Arabic subsets of Gigaword (Graff 2003), a newswire corpus, matched for size. The documents in this text-only corpus were automatically parsed using MADAMIRA, a state-of-the-art morphological parser for Arabic (Pasha et al. 2014). Where the results differ substantially between Emirati Arabic and Standard Arabic, this is discussed in the main text.

For each of these datasets two "representations" were constructed: one regular consisting of consonants and vowels and one consisting only of consonants. Table 5.5 gives a number of examples. Examples are given in orthography (English) or transliteration (Arabic) purely for ease of exposition; the data were all phonemically transcribed. The input data were unsegmented; periods were added in the table to facilitate reading.

English	Full	you.want.to.see.the.book
	C-only	y.wnt.t.s.th.bk
Arabic	Full	yallah.lʕbuu.lʕbuu.ʃatˁriin
	C-only	yllh.lʕb.lʕb.ʃtˁrn

Table 5.5: The two representations constructed for each dataset.

The Arabic example is glossed in (316).

(316) *jallah* *lʕb-uu* *lʕb-uu* *ʃatˤr-iin*
go.ahead play.IMP-PL play.IMP-PL clever-M.PL
'Go ahead and play, play, you clever ones.'

Each unsegmented representation was fed in turn to the segmentation model described in §5.2.3.2. Performance was compared between representations. The following three metrics were used to evaluate how well the model postulated word boundaries:

- **Precision:** percentage of correct word boundaries out of all boundaries found by the algorithm.
- **Recall:** percentage of correct word boundaries found out of all true boundaries in the corpus.
- **F-measure:** harmonic mean of Precision and Recall, $\frac{2 \cdot Prec \cdot Rec}{Prec + Rec}$.

For example, say the model postulated 100 word boundaries. Out of these only 30 were correct. Its precision is thus $\frac{30}{100} = 30\%$. Say now that in total, there were 60 word boundaries that needed to be found. We've already assumed that only 30 of these were found. The model's recall is $\frac{30}{60} = 50\%$. As the model guesses more boundaries, its recall will rise since it is more likely to get all of the boundaries, but its precision will suffer since it is guessing more and more loosely. In contrast, if the model is very conservative and does not posit many boundaries, its precision will be high since it will not be wrong very often, but its recall will be below because its overall coverage will be low. It is customary to take the F-measure as the best indicator for trade-off between precision and recall, in our toy example $\frac{2 \cdot 30 \cdot 50}{30+50} = \frac{3000}{80} = 37.5$.

5.2.3.2 Model

We adopted the Bayesian model of segmentation described by Goldwater et al. (2009), the unigram GGJ model. This is a generative model which infers a lexicon out of which the observed data (the corpus) are assumed to have been drawn. This model was chosen since it represents a well-documented and well-tested Bayesian framework for segmentation (see additional discussion in Phillips and Pearl 2015a,b). The specific assumptions made by the model are not crucial since it was used mostly as proof of concept; the general effects of language-specific representation should hold regardless of the exact algorithm employed.

For each utterance, the model generates the word forms w_1, w_2, ..., w_n sequentially using a Dirichlet Process (Ferguson 1973). The probability of the word being generated w_i depends on two parameters and on the number of times this word has appeared previously; this is a "rich-get-richer" algorithm:

$$P(w_i|w_1, \dots, w_{i-1}) = \frac{n_{i-1}(w_i) + \alpha P_0(w_i)}{i - 1 + \alpha} \tag{5.1}$$

In Eq 5.1:

- n_{i-1} is the number of times our word w_i has already appeared within the previous $i-1$ words.
- α is a parameter of the model specifying how likely it is that w_i is a new word. In the GGJ simulations its value was set at 20, a value we retained. It can be seen that as α approaches zero, the model is less likely to generate a new word, favoring a smaller lexicon.
- P_0 is a parameter of the model describing the "base distribution" of the word w_i, that is, its internal phonemic makeup. P_0 is the probability that the novel word will consist of the phonemes $x_1, \dots, x_m$:

  $$P_0 = P(w_i = x_1, \dots, x_m) = \prod{}_j P(x_j) \tag{5.2}$$

  It can be seen that as the word is shorter (smaller m), its probability will be higher.

See Kastner and Adriaans (2016) for additional details.

Next, the word boundaries must be identified through an inference procedure. GGJ uses Gibbs sampling (Geman and Geman 1984) with 20,000 iterations, a value we retained. The Gibbs sampler uses Markov Chain Monte Carlo methods to decide on the value of each potential word boundary, i.e. whether a word boundary should be inserted between each two phonemes. The learner iterates through the input, guessing the value of each possible boundary based on the value of all other potential boundaries.

The model eventually converges on a set of word boundaries, leading to a segmented dataset and a proto-lexicon.

The implementation provided by Goldwater et al. (2009) generates Recall, Precision and F-Measure scores for the segmentation produced by the model. These are presented next.

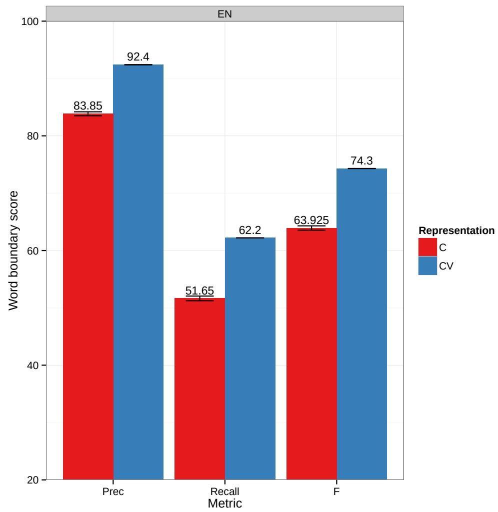
5.2.3.3 Results

The following plots present the results of running the segmentation algorithm on each of the representations for each of the two languages. Error bars give standard deviations over five runs of the GGJ model (the model is non-deterministic as it uses a random seed for the initial distribution of word boundaries in the inference procedure). Variance is low, as could already be seen in the original experiments of Goldwater et al. (2009).

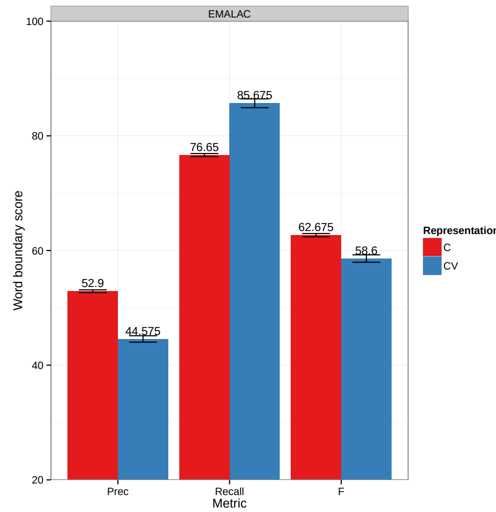
Starting with English in Figure 5.1a, the segmentation based on the full representation ("CV", blue, on the left of each pair) outperforms the segmentation based on the consonant-only representation ("C", red, on the right of each pair) for each of the three metrics: Precision, Recall and F-Measure. Precision drops from 92.4 to 83.9 (±0.34) when using the C-only representation. Recall drops from 62.2 to 51.7 (±0.4) and F-Measure drops from 74.3 to 63.9 (±0.38).

In Arabic, the opposite pattern can be seen in Figure 5.1b: the consonant-only representation aids segmentation when compared to the full representation, as hypothesized. Using the C-only representation boosts precision from 44.6 (±0.56) to 52.9 (±0.24). Recall takes a slight hit, dropping from 85.7 (±0.77) to 76.7 (±0.26). Crucially, F-Measure rises from 58.6 (±0.65) to 62.7 (±0.29).

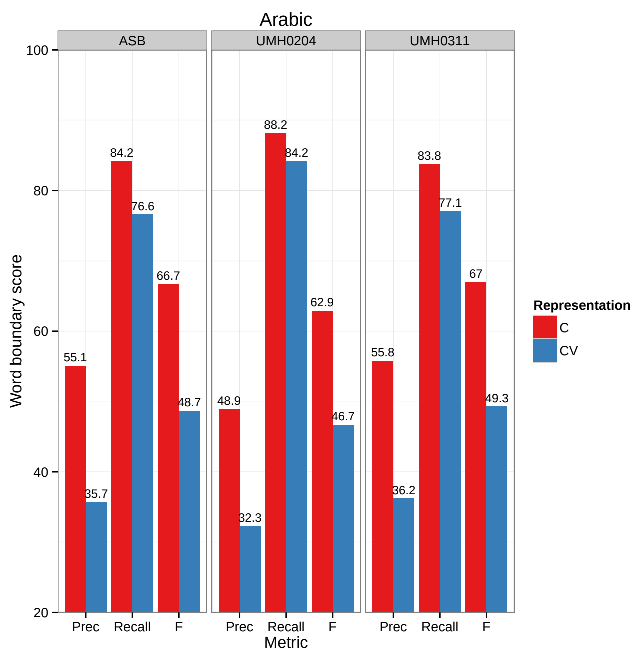
The findings are even more pronounced for the newswire corpus in Figure 5.1c, where the differences between the two representations are much larger. I return to differences between the CDS corpus and the newswire corpus in §5.2.5.1.



(a) Simulation 1 results for English (CDS).



(b) Simulation 1 results for Arabic (CDS).



(c) Simulation 1 results for Arabic (selected newswire datasets).

Figure 5.1: Simulation 1 results.

5.2.3.4 Discussion

Simulation 1 supported our hypothesis: using language-specific representations helps the learner in a basic segmentation task. In particular, attuning to the consonants in the input aids the learner of Arabic but hinders the learner of English.

Let us take a closer look at the results, taking one representative utterance. The example from (316) is repeated as (317). *lʕb-uu* is a second person plural imperative with the root $\sqrt{\text{lʕb}}$. In *ʃatˤr-iin*, *ʃatˤr* is a noun meaning 'clever one', root $\sqrt{\text{ʃtˤr}}$. Inserted in the pattern *XaYZ*, this root instantiates the participial form *ʃatˤr*.

(317) *jallah* *lʕb-uu* *lʕb-uu* *ʃatˤr-iin*
go.ahead play.IMP-PL play.IMP-PL clever-M.PL
'Go ahead and play, play, you clever ones.'

Let us see how the segmentation algorithm fared on this trial. The result of using the full representation and the consonant-only representation is given in Table 5.6. The full representation leads to a segmentation generating individual word forms such as *buu*, *ʃa* and *riin*, which have no independent status in the language. In contrast, the consonant-only representation in effect singled out the two roots $\sqrt{\text{lʕb}}$ and $\sqrt{\text{ʃtˤr}}$, exactly as a linguist would. This is a welcome result, assuming that these patterns need to be acquired by the learner if she is to master the morphology of her language. Recall in addition that the model favors shorter words; this might be the reason why the full-representation segmentation includes a number of very short postulated word forms such as ʃa and *tˤ*. Yet this bias does not trip up the C-only representation in our example, allowing it to postulate the two roots.

Full representation	yallah	lʕ	buu	lʕ	buu	ʃa	tˤ	riin
C-only representation	yllh	lʕb		lʕb		ʃtˤr		n

Table 5.6: Segmentations produced by the model for different representations.

Needless to say, this is but one datapoint among many; not all pairwise comparisons between the two outputs showed this division so neatly. Nevertheless, the contrast exemplifies how the overall quantitative results reflect a qualitative aspect of the grammar of Arabic. Attuning to the consonants in the input allows the learner to make headway on both acquisition tasks at once, since the morphological and phonological patterns are highly correlated. In this way we formalized the intuition that the child begins to cluster together combinations of consonants as roots.

5.2.4 Simulation 2: Phonotactics

The results of Simulation 1 support a view on which the learner of Arabic performs better by considering only the consonants in the input, to the exclusion of vowels. A segmentation algorithm produces a proto-lexicon of hypothesized word forms in the language. It is thus instructive to ask whether this proto-lexicon reflects the learner's knowledge of the language (Phillips and Pearl 2015a). Simulation 2 tested whether the segmented lexicon supports the learning of basic phonological patterns in the language, focusing now solely on Arabic.

We concentrated on the **Obligatory Contour Principle (OCP)**, the phonological principle which restricts the co-occurrence of elements that share certain features (Greenberg 1950; McCarthy 1989; Berent and Shimron 1997). In particular, *OCP-Place* states that sequences of consonants sharing place of articulation (homorganic consonants) should be avoided (McCarthy 1988). Words violating the OCP are generally underattested crosslinguistically, famously so in Semitic.

- ***dadam***: strongly under-represented
- ***madad***: possible, under-represented
- ***tasaba***: possible, under-represented

The OCP has been shown to affect listeners' behavior in a variety of tasks. For example, Berent and Shimron (1997) found that native Hebrew speakers dispreferred nonwords with a hypothesized $\sqrt{\text{XXY}}$ root, in which the first two consonants violate the OCP. Similar results were obtained in a study of Arabic: novel roots which obeyed the OCP were judged to be more word-like than novel words which violated it (Frisch and Zawaydeh 2001).

Recent work has argued that the OCP can be seen as a constraint that emerges from abstraction over word forms (or roots) in the lexicon. In an analysis of OCP-Place in Arabic, Frisch et al. (2004) defined a gradient constraint whose degree of violation is a function of the similarity between consonant pairs. This similarity was calculated in terms of shared natural classes. As expected, highly similar homorganic consonants turned out to be strongly underrepresented in the lexicon of Arabic roots, whereas relatively dissimilar pairs are underrepresented to a lesser degree. Frisch et al. (2004) proposed that during language acquisition, speakers learn an abstract phonotactic constraint as a result of generalization over statistical patterns in the lexicon.

The degree of support for such a generalization is quantified using the **observed/expected ratio** (O/E): considering all the word forms in the lexicon (by type), how frequently do two given consonants occur adjacent to one another (the observed value) versus how often would they occur if their distribution were normal (the expected value). If the distribution is not constrained by any extrinsic principles, the O/E ratio should be around 1: the phoneme pair appears as often as would be expected, given no reason to think otherwise. O/E ratios higher than 1 show that the string is overattested; ratios lower than 1 indicate underattestation.

What Frisch et al. (2004) showed was that the O/E ratios can be generalized across biphones into distinct classes—places of articulation—and eventually generalized to the abstract constraint. In other words, OCP-Place can be learned from the lexicon.

If the segmented proto-lexicon can be used to deduce the OCP, its viability as an intermediate step in the acquisition process is strengthened. Furthermore, if the segmented proto-lexicon that is based on a consonant-only representation then leads to better learning of the OCP, this result would constitute additional support for the hypothesis of language-specific representations.

5.2.4.1 Methods

Four different proto-lexicons were compared in Simulation 2, all the result of different segmentation strategies applied to the Arabic CDS corpus. The four segmentations were:

- The result of segmenting the consonant-only representation, as in Simulation 1: yllh.lʕb.lʕb.ʃtˤr.n
- The result of segmenting the full representation, as in Simulation 1: yallah.lʕ.buu.lʕ.buu.ʃa.tˤ.riin
- An unsegmented baseline in which each utterance was treated as an entire word: yallahlʕbuulʕbuuʃatˤriin
- The correct segmentation (the gold standard): yallah.lʕbuu.lʕbuu.ʃatˤriin

For each of the four proto-lexicons, O/E ratios were calculated for pairs of non-identical labials, coronals and dorsals across intervening vowels.

5.2.4.2 Results

The O/E ratios for each representation are given in Figure 5.2, divided by place of articulation (labials, coronals and dorsals). In each place of articulation the three segmentations are plotted as bars with the gold standard represented as a horizontal line.

For the three labial consonants of Emirati Arabic (/b/, /f/ and /m/), the gold standard as would be induced from the true lexicon for the corpus is 0.143. The C-only representation comes closest with 0.145 ($\pm$0.003), slightly before the full representation with 0.146 ($\pm$0.027) and ahead of the unsegmented baseline with 0.284.

A slightly different pattern can be seen for the 11 coronals. The gold standard O/E is 0.405, showing that OCP-Place is somewhat less stringent for coronals than for labials, a pattern similar to the one

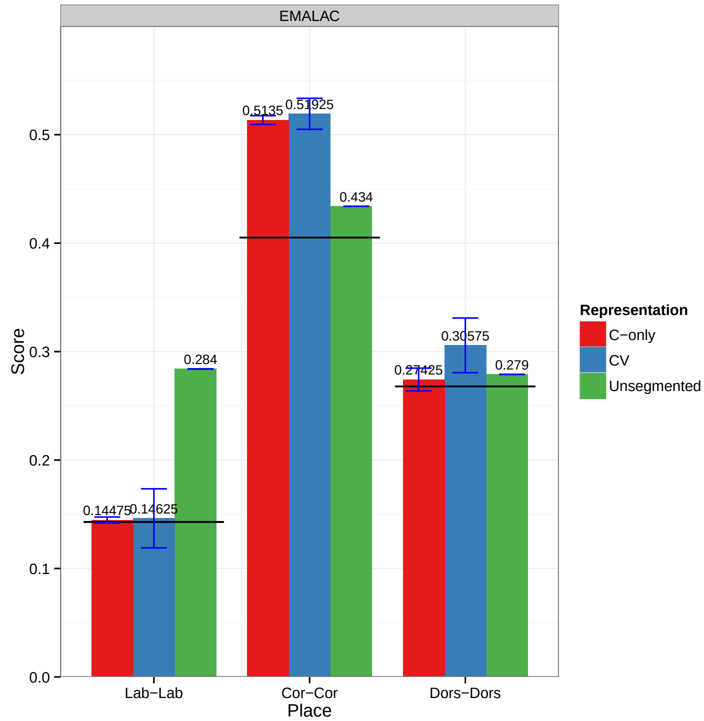


Figure 5.2: Simulation 2 results for Arabic (CDS).

noted by Frisch et al. (2004). Here, the unsegmented baseline is closest to the ideal with an O/E of 0.434. The C-only representation performs slightly better than the full representation, which once again shows greater variance: 0.514 (±0.004) for C-only vs 0.519 (±0.014) for the full representation.

Turning to the five dorsals, the C-only representation is once again closest to the gold standard. A true segmentation leads to an O/E of 0.268. The C-only representation results in an O/E of 0.274 (±0.011), closer than the full representation (0.306±0.025) and similar to the unsegmented baseline (0.279).

Results for the newswire dataset are more clear-cut and are given in Figure 5.3.

For completeness, Figure 5.4 presents the results of running a similar calculation on the English dataset. It can be seen that none of the representations distinguishes itself from the others.

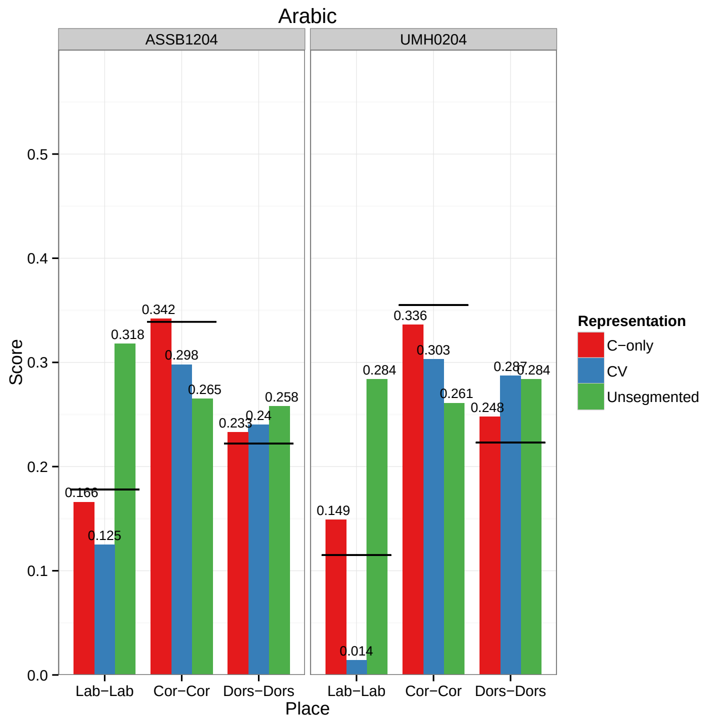


Figure 5.3: Simulation 2 results for Arabic (selected newswire datasets).

5.2.4.3 Discussion

The results of Simulation 2 support the hypothesis that a consonant-only representation can benefit the learner of a Semitic language. If basic phonological generalizations such as OCP-Place are learned from the lexicon, then the proto-lexicon that emerges from a segmentation based on consonants facilitates this aspect of learning the language better than proto-lexicons resulting from other segmentations.

These results do face a potential objection: even if the C-only representation outperforms other representations, what is a substantial difference? Is the difference of 0.032 O/E points between 0.274 and 0.306 substantial when the gold standard is 0.27? Unfortunately, there is no straightforward answer to this question. Since there is very little work on segmentation crosslinguistically, and little work on quantitative evaluation of acquisition in Semitic in general, there is no accepted benchmark for tests such as those carried out in this experiment. We adopt the view that this result is consistent with our hypothesis

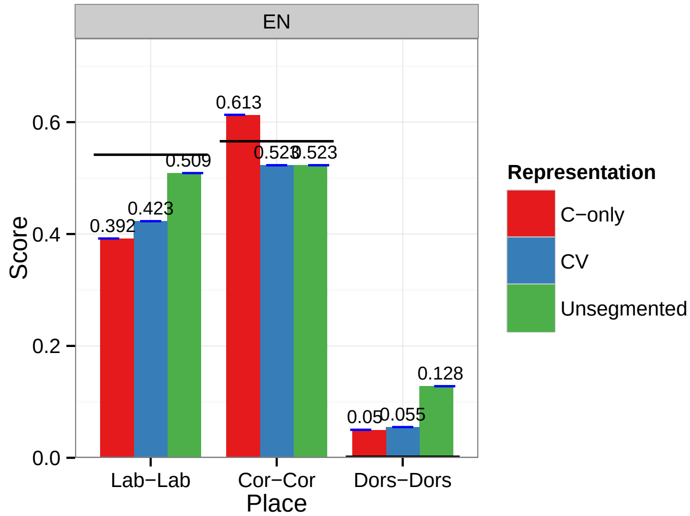


Figure 5.4: Simulation 2 results for English.

as a working assumption that awaits further exploration, even if its exact cognitive and developmental correlates are unclear. At the very least, however, it seems that using a consonant-only representation does not lead to deviant behavior on this task. As we return to presently, the overall goal of getting the learner to attune to consonantal patterns is important for the acquisition of Semitic beyond the goals of Simulation 2.

Another important question for any approach to acquisition is whether the learning of phonotactics feeds segmentation or is dependent on it. This simulation was set up as though at least one aspect of the phonotactics is learned after basic segmentation and a formation of the proto-lexicon. This assumption follows from the findings of Frisch et al. (2004) and admittedly suffers from a lack of data on infants' violations of (or adherence to) the OCP in Arabic. Yet it has been argued that since phonotactics are acquired early, they can be used as part of the segmentation algorithm (Adriaans and Kager 2010). A holistic model of early phonological and lexical learning will need to reconcile these opposing claims; it is quite likely that actual acquisition proceeds in tandem. The current findings provide an additional testing ground for future segmentation models by extending the empirical domain to a Semitic language.

5.2.5 Discussion

5.2.5.1 The computational model and acquisition

This dissertation has repeatedly emphasized the role of the consonantal root in Hebrew, and in this section – in Arabic as well. Returning to example (317) and Table 5.6, the root $\sqrt{\text{lʕb}}$ underlies a number of related word forms in Arabic. These include all conjugations of the verb 'play' but also *malʕab* 'field', *laʕib* 'player' (the identical *XaYiZ* pattern as in *ʃatˤir* 'clever' from the same utterance), *laʕʕab* 'caused to play' in all its conjugations, and *laaʕab* 'played with' in all its conjugations (Al-Kaabi 2012). Learning which roots exist in the language and how they fit into grammatical frames is thus an important goal for the child.

For example (317), one of the segmentation strategies is able to isolate the string l-ʕ-b: it is the segmentation based on the consonant-only representation. This section has argued that a consonant-only representation of the Arabic input stream is empirically superior to a representation containing both consonants and vowels with regards to two tasks: segmentation and phonotactic learning. This is a welcome result, since such a learning strategy would also enable the learner to identify consonantal roots, an integral part of the morphological system of the language.

In §5.1 I discussed how the learner might go from the input to roots and then to templates and the entire morphological system. The differences between the Emirati CDS corpus and the newswire corpus are relevant in this regard; they show an "apparent time"-like effect in which the newswire corpus is more adult-like than CDS.

Generally speaking, the findings identified in the CDS corpus are all amplified in newswire: for all newswire datasets, the C-only representation results in a greater improvement in segmentation performance when compared to the full representation. Similarly for learning the OCP, the difference between the C-only representation and the full representation is more pronounced and leans clearly in favor of the former. These results are clearer than in the CDS corpus.

This comparison underscore two differences between the two corpora. First, the newswire corpus uses Modern Standard Arabic which has nine verbal templates. Although Emirati Arabic does make use of nine verbal templates as well, some of these templates are used much more sparingly and the dialect mostly employs only the three or four most frequent templates. As a result, the newswire corpus can be seen as morphologically more complex.

Second, CDS is simplified on both grammatical and lexical levels when compared to newswire. This can be seen by the average number of tokens per type: 3.68 in the CDS corpus and 4.23 in the newswire dataset UMH_ARB_200311 (1999 utterances; 36,856 tokens; 8,715 types; average token length 7.67). The lexicon used in newswire is simply larger. To the extent that MSA newswire can be seen as more morphologically "complex" (in the senses outlined above) than Emirati CDS, this difference correlates with the difference in performance showed by our model: since the model aims to learn the deep morphological patterns of the language, it would find more of these in more "grown up" datasets.

In a sense, the difference reflects the systems as the learner posits them at different time points. The contrast between consonants and vowels is not yet solidified for the child as an organizing principle of the grammar. By the time she is an adult, however, the entire system falls into place based on a sharp contrast between consonants and vowels, roots and templates.

5.2.5.2 Prosodic structure

One potential interpretation of the findings holds that the reason Arabic showed different behavior than English is not due to the root-centric morphology of the former. Rather, it is other phonological features of the language that gave rise to the "consonantal advantage" seen for Arabic. I discuss two potential prosodic confounds through two additional languages.

It might be contested that the phonemic inventory of the language is what gave rise to the different results for Arabic and English. MSA has three vowels and Emirati Arabic has five, compared to the 15 phonemic vowels of English distinguished by Goldwater et al. (2009). Consider Spanish, then, which like

Emirati Arabic has five phonemic vowels. If the results are driven by number of vowels, Spanish should pattern like Arabic and unlike English in that a C-only representation would be more beneficial to the learner than the full representation. Nevertheless, we suspect that in fact Spanish will pattern with English and unlike Arabic due to the morphological nature of the language. While this prediction remains to be tested, it should be noted that even if Spanish ended up patterning similarly to Arabic with regards to the two tasks in this paper, the learner of Arabic would still need to acquire the consonantal roots. The C-only learning strategy would thus be beneficial for the Arabic learner regardless of its feasibility for non-Semitic languages.

Another alternative interpretation of the facts would hold that the prosodic structure of Arabic words biases the results: Arabic syllables are strongly CV(V), meaning that more information would be inferred from consonants in Arabic than in a language with a looser metrical structure such as English. In this case, our comparison would be with a language such as Japanese, which is also strongly CV-shaped. Like English, Japanese does not base its morphology on roots and patterns. If our findings are the result of the prosodic structure of the word, Japanese should pattern with Arabic and unlike English. But if we are correct in attributing the difference between English and Arabic to the nature of the morphological system, Japanese would pattern with English.

Nevertheless, there is reason to believe that the crosslinguistic contrast goes beyond metrical differences. Aldholmi (2016) reports on a recent experiment in which participants were asked to judge whether two nonce words were identical or different. English speakers were equally likely to identify a difference between the stimuli when the words differed by one vowel or by one consonant. In contrast, Arabic speakers were much more likely to detect a consonantal difference than a vocalic one. The findings support a view on which speakers of Semitic attune to consonants in the input over vowels.

5.2.6 Summary of the computational simulations

This study tested a hypothesis according to which acquisition relies on learning mechanisms that operate on language-specific representations. On this view, the learning mechanisms themselves are invariant crosslinguistically; we took the example of an algorithm that segments the input stream into phonological words in Simulation 1 and of a statistical learner that explores distribution probabilities for biphone pairs in Simulation 2. These models are consistent in how they operate for different datasets (different languages) but they might operate on different representations: on consonants rather than consonants and vowels.

I suggested that separating consonants from vowels is beneficial for the learner when learning a Semitic language and have provided an explicit model of how the learner would attune to consonants over vowels. The result is a "less-is-more" situation in which withholding certain information (the vowels, in this case) helps focus the learner on the signal (Newport 1990; Phillips and Pearl 2012). Two evaluation methods were provided for this model, evaluating performance on segmentation and on learning OCP-Place.

Like Nespor et al. (2003), we speculate that the learner might first assign consonantal "chunks" to objects before augmenting the rest of the grammar with vowels. Our model provides a basis for future formalizations of this idea, learning roots in preparation for learning templates. This section presented the first computational test of this hypothesis on natural language data; we are now in a position to ask further questions about how to best understand actual developmental data.

Future work will need to develop a model that integrates the vowels back into the system. The goal there would be to model how the rest of the morphological system is learned, namely the different verbal templates, and integrated with the information acquired about the roots. To the extent that this model turns out to be plausible, it should extend to languages with concatenative morphology as well.

5.3 Quantifying productivity

In the final part of this chapter I consider the adult's knowledge one last time, aiming to make precise what information state the learner would need to reach. My goal here is to collect the different opportunities throughout the dissertation in which I pointed out that a certain question could be addressed by a behavioral experiment. What these experiments can provide us with, individually and as a whole, is a measure of how productive different corners of the system are. This is not solely a Hebrew-internal issue: every language can combine roots and affixes to different degrees.

5.3.1 Semantic relatedness within a root

In the discussion above, I noted informally that alternations such as those in (314) are transparent whereas those in (315) are more opaque. The examples are repeated here.

(318) Transparent alternations in *XaYaZ* ∼ *heXYiZ*:

ba	'came'	∼	hevi	'brought'
raa	'saw'	∼	hera	'showed'
jatsa	'exited'	∼	hotsi	'took out'

(319) Some opaque alternations in *XaYaZ* ∼ *heXYiZ*:

sagar	'closed'	∼	hesgir	'turned someone in'
pakad	'counted'	∼	hefkid	'deposited'

I noted early on, in Chapter 1, that I treat alternations as sharing roots even if the alternation is not transparent. This claim should be supported experimentally: do the forms in (319) share the same root $\sqrt{\text{sgr}}$ and the same root $\sqrt{\text{pkd}}$?

Moscoso del Prado Martín et al. (2005) provide one attempt to evaluate this hypothesis. They find that "families" of forms sharing a phonological root but differing substantially in semantic content do pattern differently: reaction times for families with less cohesive semantics are slower. Frost et al. (2000b) found a strong root priming effect in cross-modal priming for semantically related primes sharing a root as a target, and slightly weaker but still significant priming for primes sharing a root but judged as more distantly related semantically. In more recent work, Heller and Ben David (2015) found in a cross-modal priming task that a phonologically related root does not prime a target that is semantically different, e.g. *xalifa* 'suit' does not prime *maxlef* 'interchange'. This result is useful in constraining our theory since it sharpens the question of whether we are dealing with one root $\sqrt{\text{xlf}}$, two roots $\sqrt{\text{xlf}}_1$ and $\sqrt{\text{xlf}}_2$, or some kind of gradient which we cannot yet properly characterize (Embick 2012 makes a similar point about English $\sqrt{\text{SLUG}}$).

In order to probe this question I will conduct a reanalysis of the MEG data from Chapter 4. In that experiment, semantic overlap in morphological families (the Shared Root conditions) was not originally controlled for. By grouping the data in two bins (+Root +Transparent vs +Root –Transparent) we will be able to see whether the two kinds of families pattern alike.

A behavioral experiment can also be designed. We started off Chapter 1 with the observation in Schwarzwald (1981b) according to which not all alternations are transparent. The examples collected in that article can serve as a starting point for experimental materials. First, a measure of similarity will need to be calculated between verbal forms, perhaps using a variant of Latent Semantic Analysis (Landauer and Dumais 1997). Then, a standard overt priming task can be conducted. As a first pass, I hypothesize that RT should be modulated by degree of semantic similarity between prime and target.

Alternatively, a nonce-root study could be conducted. Participants would be given wug verbs, some of which participate in transparent alternations and some in less transparent alternations, coupled with made-up meanings. The task would be to rate similarity of different verb pairs. Depending on how the materials are set up, it may be possible to dissociate semantic relatedness from root relatedness.

5.3.2 Productivity of templates

Shifting our view back to templates, I envision two nonce word studies that can test the productivity of different parts of the system.

On the phonological side of things, Chapter 3 provided a number of constraints for the lexical exceptionality of different root classes. It is not well understood, however, how speakers produce novel forms in these classes. Is any generalization made from single, high-frequency alternations such as *natan* 'gave' $\sim$ *jiten* 'will give'? The study will consist of forms in a carrier phrase in one tense which participants will then need to produce in another tense. Tenses will be crossed between speakers (see Moore-Cantwell 2013 for a similar set-up). The working assumption is that alternations with a high enough type count will generalize (Albright and Hayes 2003), but the study remains to be fleshed out.

Similarly for morphosyntax, in §2.3.2 I suggested that the *heXYiZ* template is fairly productive for new causative verbs but not productive for inchoative verbs. This claim can be put to a similar test in a wug study, presenting nonce verbs in two kinds of carrier phrases. The most straightforward task seems at this point to pair each phrase with a drawing depicting an event and ask participants to rate how well might the phrase describe the drawing. If inchoatives are not productive in this template, participants would give low ratings to drawings depicting inchoative events.

5.3.3 Generalizations in the input

Finally, in §3.4.2 we saw a case in which two distinct generalizations could be made about an inflectional paradigm: one went by morphosyntactic features (tense and subject agreement) and the other by morphophonological patterns (C-initial or V-initial verbal suffixes). While we concluded that the morphosyntactic analysis was to be preferred, the possibility remains that the learner might make an initial generalization based on surface forms and then revise it based on structural information.

Two tacks could be taken here. On the Hebrew-centric tack, the experimenters would devise 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 this experiment may be contrasted with that of Gagliardi and 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 active in the grammar of the language. The 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.

In all the cases illustrated here, the basic question remains the same: what does the child learn from the input, and what does the child bring to the acquisition problem so that it can form a rigid syntax around an input of phonological alternations and semantic similarities.

Chapter 6

SUMMARY AND CONCLUSIONS

6.1 Summary

This dissertation made the case for a specific theory of syntactic elements, lexical items and interpretation mechanisms. The theory is primarily meant to explain the Hebrew verbal system but is applicable to other languages as well, drawing on proposals put forward for a number of non-Semitic languages. In this final chapter I summarize the contributions of the dissertation to the study of Hebrew and review their importance for our understanding of grammatical systems beyond Semitic.

6.1.1 Summary by chapter

In **Chapter 1** we acquainted ourselves with the main issues: empirically, the seven verbal templates of Modern Hebrew exhibit argument structure and meaning alternations which are at times transparent and at times completely opaque. The role of lexical roots in determining meaning is similarly not easy to predict: a root might have a stable meaning in two templates, and then a related but markedly different one in a third. I took this unpredictability to be emblematic of how lexical and functional material combine in the grammar. Our theoretical sights were set on the way in which structure is generated by the syntax, combined with lexical roots, constrained by the grammar and interpreted at the interfaces with semantics and phonology.

The theory was developed in **Chapter 2** which argued for a number of functional elements: the verbalizer v, the Voice heads Voice, Voice$_{\varnothing}$ and Voice$_{\{D\}}$, the preposition licensors p and $p_{\varnothing}$, the agentive modifier $\sqrt{\text{ACTION}}$ and the passive head Pass. The combinatorics of these elements, as given in Table 6.1, served to derive the argument structure alternations in the language. The result for Hebrew is that the verbal templates are no longer seen as holistic morphemes but as combinations of functional heads, each with its own predictable behavior.

Heads				Syntax	Semantics	Phonology	Section
	Voice			(underspecified)	(underspecified)	*XaYaZ*	§2.3.1
	Voice	$\sqrt{\text{ACTION}}$		(underspecified)	Action	*XiYeZ*	§2.3.3
Pass	Voice	$\sqrt{\text{ACTION}}$		Passive	Action	*XuYaZ*	§2.3.4
	Voice$_{\{D\}}$			EA	(underspecified)	*he-XYiZ*	§2.3.2
Pass	Voice$_{\{D\}}$			Passive, EA	(underspecified)	*hu-XYaZ*	§2.3.4
	Voice$_{\varnothing}$			No EA	(underspecified)	*ni-XYaZ*	§2.2.1
	Voice		$p_{\varnothing}$	EA = Figure	(underspecified)		§2.2.2
	Voice$_{\varnothing}$	$\sqrt{\text{ACTION}}$		No EA	Action	*hit-XaYeZ*	§2.2.1
	Voice	$\sqrt{\text{ACTION}}$	$p_{\varnothing}$	EA = Figure	Action		§2.2.2

Table 6.1: The requirements of functional heads in the Hebrew verb.

This analysis maintained a separation between syntactic features, such as those on Voice$_{\{D\}}$, Voice$_{\varnothing}$ and $p_{\varnothing}$, and interface requirements, namely those associated with roots. In this framework roots do not have syntactic features. Any information they carry is interpreted purely at the interfaces. Such a setup limits the ways in which the root can be idiosyncratic: its influence can only be post-syntactic, licensing a certain construction. I introduced a number of tentative claims about the way roots with different lexical semantics might license different kinds of constructions, summarized in Table 6.2.

I have also proposed a modification to the so-called Arad/Marantz Hypothesis—according to which the first categorizing head combining with the root selects its meaning—to the effect that a semantically contentful head may select the meaning of the root if a lower head has not already done so. This amendment is in line with a theory of linearization in which adjacent elements may condition special behavior of each other within a cycle only if no overt third element intervenes.

Morphology	Section	Verb type	Root type
hitXaY̯eZ	§§2.2.1.1, 2.2.4.1, 2.2.6	Reflexive Inchoative	Self-oriented Other-oriented
hitXaY̯eZ	§§2.2.4.2, 2.2.6	Reciprocal Figure reflexive	Naturally reciprocal Naturally disjoint (Other-oriented)
heXYiZ	§2.3.2	Alternating unaccusative Alternating unergative	Change of color Emission
XiY̯eZ	§2.3.3	Pluractional object Pluractional event	Other-oriented Self-oriented (activity)
Passive participle	§2.3.5	Resultative adjective	Change of state
XaYaZ	§2.3.1	Underspecified	(all)

Table 6.2: The requirements of root classes in the Hebrew verb.

The predictions of this theory of linearization were tested in **Chapter 3**, a treatment of the morphophonological component of the grammar. It was argued that allomorph selection is local between adjacent elements, when adjacency is computed over overt elements. If a third element does intervene overtly, the would-be targets of allomorphy show syncretism to a common unmarked form. This pattern has been argued for in discussion of many languages with concatenative morphology. The fact that it can be shown to hold in non-concatenative morphology as well strengthens both the empirical claim and the syntactic analysis developed in Chapter 2.

Specifically for Hebrew, the argument was made that verbal templates are not individual morphemes but are instead emergent from the combination of two independent processes: Vocabulary Insertion from the functional heads in the structure, in combination with general phonological requirements of the language in cyclic spell-out.

In support of my view of roots and templates, **Chapter 4** tested whether adult speakers of Hebrew represent roots and templates in their mental lexicon. Two neurolinguistic experiments used magnetoencephalography to prime roots, templates and argument structure alternations. Roots and templates were sensitive to masked primes, consistent with our view of roots and functional heads.

Finally, **Chapter 5** took a step back to consider how the child might acquire the Semitic system. I proposed a model in which the infant starts off noticing consonantal roots in the input, gradually incorporating templatic cues and matching them up with the target grammar until she reaches an adult-like state. Support for this model came from novel computational simulations which learn basic distributional properties of a Semitic language by focusing on the consonants in the input. These simulations are complemented by a number of developmental findings on the input children receive and their production data.

Before concluding I will attempt to illustrate the overall picture by inverting the order of exposition, outlining a model of linguistic acquisition, competence and production for Hebrew.

6.1.2 The dissertation, in reverse order

How does a child learn the morphology of a language? Consider the following narrative, based on the arguments put forward in this dissertation.

The infant hears a stream of consonants and vowels as her input. If the input is a Semitic language, some of these consonants cluster together in groups that appear again and again interspersed with certain vowels. If the input is not a Semitic language, recurrent patterns still appear in the input; likewise for sign languages, where instead of consonants and vowels certain handshapes, hand locations and hand movements combine.

Suppose the language is a Central Semitic one like Hebrew or Arabic. The child notices that the patternings of consonants with certain vocalic patterns correspond to differences in meaning and function: tense, agreement, transitivity and so on (presumably provided by the grammar). At this point she has acquired roots as phonological elements. She will then begin to associate these groupings of consonants with general semantic fields, and the vocalic patterns with individuated grammatical information. This is where Chapter 5 leaves us.

At this point the child is identifying individual functional heads and the morphophonology of templates as a whole. She has also associated roots with different collections of meanings, and she knows to pay attention to consonants in the input in order to guide perception.

This state of affairs means that once the grammatical system is stable, the mental lexicon distinguishes roots from templates and is able to look both of them up. Chapter 4 reviewed the evidence that this is indeed what adult speakers of Hebrew do.

The synchronic phonological system needs to account both for the general phonotactic patterns and for the specific lexical items of the verbal system: consonantal roots, consonantal affixes and vocalisms. In chapter 3 we saw that such a system is not only internally consistent but also directly reliant on the identity of the lexical items. The consonantal roots lie at the base of the structure and the other elements are arranged atop them hierarchically. This organization was explored in Chapter 2.

And we return to the three questions that set us on this path in Chapter 1.

6.2 Conclusions

6.2.1 Three problems

Empirically, this dissertation concerned itself with **Semitic morphology** as instantiated in Modern Hebrew. I asked what the correct characterization is for the role of the consonantal root in the grammar and for the role of the verbal template.

The findings indicate that the consonantal root is the element containing all idiosyncratic information for a given lexical item. In Hebrew this root can be identified through its consonants, e.g. $\sqrt{\text{ktb}}$, whereas in other languages we might notate it using a representative orthographic form, e.g. $\sqrt{\text{WRITE}}$, but in both cases the element itself is an abstract collection of phonological and semantic material

The morphophonological template was argued to be an epiphenomenon. Instead of each template being a primitive of the system (a morpheme), distinct functional heads in the syntax generate argument structure. When the speaker knows a template, what they know is the syntactic work, the semantic interpretation and the phonological spell-out of individual functional heads. But they must also know how these elements combine.

This question is theoretically broad: how does **syntax feed into the interfaces**. I have developed an argument to the extent that the same locality constraints on interpretation hold at the semantic and phonological components, based on the syntactic structure. Once the structure is sent to interpretation, string-adjacent elements may condition special interpretation of each other: special meaning at LF and allomorphy at PF. If an overt element intervenes between the two elements, interpretation is predictable: strict compositionality at LF and syncretism at PF.

Finally, it is always important to ask how the synchronic system is **acquired by the learner**. I sketched a model in which language-specific patterns can be noticed in the input, so that the learner can proceed from phonological roots to abstract roots and functional heads, guided gradually by the grammar.

6.2.2 Three themes

In conclusion, I summarize the three themes which pervaded the discussion. On the Semitic front, the dissertation contrasted analyses that were based on **the root** with those that attempted to make do without it. The theory presented in this dissertation not only utilizes the root as a syntactic primitive—and consequently as a morphological, phonological and semantic primitive—it also showcased a range of empirical phenomena that can be explained by appealing to the root. I take this claim to be consistent with crosslinguistic work on argument structure that makes similar reference to abstract roots. We have also seen that roots are individually represented in the mental lexicon of the speaker and are acquired as discrete elements.

I have contrasted analyses that employ **syntactic heads** with those that treat each template as its own morpheme. I backed the claim that the range of empirical patterns is best explained by treating templates as collections of individual functional elements rather than holistic morphemes. Here the connection with theories of argument structure crosslinguistically is evident in that the proposed heads have crosslinguistic validity. I have also briefly shown how acquisition of these heads might be facilitated by the nature of the system.

Last but by no means least, I have made repeated reference to the division of labor between **functional material and lexical material**: what is rigid in the grammar and where does idiosyncrasy arise. The theory specifies how the structure is set up, how the idiosyncrasy of individual roots fits into it and what constraints hold on the interpretation of the two jointly. This issue, I believe, lies at the $\sqrt{\text{root}}$ of any attempt to formally model the grammar of a language: the intersection of form and meaning.

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