Tel-Aviv University

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FROM VARIABLE TO OPTIMAL GRAMMAR:

EVIDENCE FROM LANGUAGE ACQUISITION AND LANGUAGE CHANGE

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TABLE OF CONTENTS

ABSTRACT

This dissertation is concerned with the intermediate grammars and the variability that emerge in the course of linguistic change. It is based on evidence from the acquisition of Hebrew phonology and morphology, and a case study of a historical change affecting the grammar of Modern Hebrew. I propose a unified formal model for intermediate grammars in both language acquisition and (historical) language change, from a synchronic point of view, using the framework of Optimality Theory (Prince and Smolensky 1993).

Linguistic change and variability pose a challenging problem for any linguistic theory that aims to provide a synchronic analysis of linguistic knowledge within a deterministic model. By definition, change is a diachronic process and intermediate grammars are not final. Therefore, the status of change and variation in a deterministic model is obscure. Nevertheless, the understanding of processes involving change is stated among the goals of generative phonology (Halle 1962). The study of linguistic change from a synchronic point of view contributes to the study of linguistic knowledge and to linguistic theory by providing a unique perspective of the significant linguistic properties involved in a particular phenomenon, and of the significant relations between them (Macken 1992).

The topics discussed in this work are based on two different studies: (i) the acquisition path of Hebrew prosodic structure; and (ii) the variation involved in stop-fricative alternation in Modern Hebrew, as a result of historical changes. For both topics I suggest an Optimality Theoretic account of the phenomena, their cause, and their consequences.

The study of language acquisition is based on two interrelated acquisition paths: (a) of prosodic structure of words out of morphological context; and (b) of prosodic structure within paradigms with regular morphophonological alternation, where the acquisition of Hebrew verb inflectional paradigms are examined.

The acquisition path of words out of morphological context shows a pattern of gradual increase in prosodic structure (e.g. the number of syllables), involving a gradual increase in prosodic contrasts (e.g. diverse stress patterns), up until the child's production is phonologically identical to the target forms. The increase in structure and contrast indicates a gradual transition from unmarked structures with input-output disparities (indicating phonological dominance) to marked structures, lacking input-output disparities (indicating lexical dominance).

In the acquisition path of alternating paradigms, not only the child-adult relations are examined, but also the relation between words, where the target language itself exhibits input-output disparities, namely words drawn from alternating paradigms. This acquisition path provides evidence for the child's restructuring of a lexical representation, as well as evidence for the transition from child-adult relation to the child's input-output relation. In addition, I show that the phonological account of the acquisition of inflectional paradigms provides evidence for morphological development. One of the interesting findings in this regard is the emergence of morphological knowledge before actual inflectional suffixes are produced by the children. This finding would not be available without examining the interaction between prosodic and morphological factors.

Another crucial finding dealt with in my study of acquisition is the scope of variation in the course of acquisition. I found that variation in children's production is limited to the acquisition of the lexical contrasts existing in the language, and is not found in the acquisition of alternation resulting from phonological restrictions. The model I suggest for change in the course of acquisition predicts and explains this finding, based on evidence that children do not violate universal restrictions respected in the target language.

The study of language change deals with spirantization in Modern Hebrew, where the alternation between stops and fricatives involves a great deal of opacity and free variation. The analysis suggested is based on a set of paradigms co-existing in the language and contradicting each other. I show that variation is restricted only to certain types of paradigms, conditioned by certain phonological properties. However, I argue that the co-existence of different types of paradigms indicates a change in the language, where the variable grammar is an intermediate phase, and the *in*variable paradigms indicate the direction of change. Similar to the acquisition path of single forms, and unlike the acquisition path of alternation within a paradigm, the direction of change in the case of Modern Hebrew spirantization is towards a loss of phonological generalization (i.e. towards lexical dominance).

Through the investigation of language acquisition and language change, I examine in this work central issues in phonological theory, such as morphophonemic alternation and prosodic structure, in conditions of change. The phenomena investigated here provide insight to the nature of linguistic change in the following aspects: (i) the distinction between phonological properties that undergo change vs. phonological properties that do not undergo change; (ii) the directionality of change; and (iii) the scope of variation in the course of change. I argue that both language acquisition and language change share similar patterns with respect to these issues. Moreover, the change, its directionality and the variation involved, are accounted for by the same theoretical terms that account for the linguistic knowledge of a single ideal native speaker. I show that Optimality Theory suggests an appropriate theoretical framework for a unified generative analysis of this type.

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source in the study of the phonology-morphology interface in acquisition. I also thank Esther Dromi for the longitudinal data of her son, which contributed significantly to my thesis.

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Chapter 1
INTRODUCTION

This dissertation is concerned with the intermediate grammars and the **variability** that emerge in the course of linguistic change. It is based on evidence from the acquisition of Hebrew and on a case study of a historical change affecting the grammar of Modern Hebrew. I will propose a unified formal model for intermediate grammars in both **language acquisition** and (historical) **language change**, using the theoretical framework of **Optimality Theory** (Prince and Smolensky 1993).

The study of linguistic change, from a synchronic point of view, contributes to the study of linguistic knowledge and to linguistic theory by providing a unique perspective of the significant linguistic properties involved in a particular phenomenon, and of the significant relations between them. Macken (1992) points out that "the nature of linguistic structure becomes clear during change much the same way that objects, that appear interlocked when still, separate into distinct forms when one of them moves" (p.254). Furthermore, Skousen (1972) claims that "by just looking at static data, there is no way… to determine what regularities speakers will capture" (quated in Kiparsky 1973a:169). Skousen proposes to look at evidence found in language acquisition and language change in order to determine what sorts of grammar are 'psychologically real'.

Linguistic change and the variability involved pose a challenging problem for any linguistic theory that aims to provide a synchronic analysis of linguistic knowledge within a deterministic model. By definition, change is a diachronic process and intermediate grammars are not final. Therefore, the status of change and variation in a deterministic model is obscure. Nevertheless, the understanding of processes involving change is stated among the goals of generative phonology (Halle 1962, Kiparsky 1968).

In this study I examine central issues in phonological theory, such as morphophonemic alternation and prosodic structure, in conditions of change. The phenomena investigated here provide insight to the nature of linguistic change in the following aspects: (i) a distinction between phonological properties that undergo change vs. phonological properties that do not; (ii) the directionality of change; and (iii) the scope of variation in the course of change. I will argue that both language acquisition and language change share similar patterns with respect to these issues. Moreover, the change, its directionality and the variation involved, can be accounted for by using the same theoretical model that accounts for the linguistic knowledge of a single ideal native speaker. I will show that Optimality Theory offers an appropriate theoretical framework for a unified generative analysis of this type.

1.1 THE TOPICS

1.1.1 LANGUAGE ACQUISITION AND LANGUAGE CHANGE

A correlation between language acquisition and language change has been suggested in the early 1900's (Grammont 1902, Jesperson 1922), and has been further studied within the Prague Circle (Jakobson 1931, 1941), and by many other scholars since. Studies in the field examine child language and phenomena in language change from various points of view, including developmental (Slobin 1977, Baron 1977, Berman 1981, 1993, Locke 1983, Schwarzwald 1983, Ravid 1988, Faingold 1996), social (Labov 1978, Romaine 1988), and biological perspectives (Edmondson 1985).

Beyond the different perspectives, all studies single on the variability of the data as the most significant property that language acquisition and language change have in common. The explanations for the parallel properties, including variation, are naturally provided in accordance with the theoretical approach of each study.

In this study I look at the data of language acquisition and language change from a generative point of view, where the goal is to investigate what constitutes the linguistic knowledge of a single speaker in the course of change. Thus, my goal is to

provide evidence for the appropriateness of integrating the properties of change (i.e. intermediate grammar and variation) into a formal model that represents linguistic knowledge. In the spirit of Macken (1992), the parallels I look for have to do with the change itself, rather than with similar phonological phenomena.

1.1.2 UNIVERSALITY AND CROSS-LINGUISTIC VARIATION

The goals of a theory of linguistic change go together with the essential objectives of linguistic theory since Sapir (1921): to express the universal properties of human language and to determine the possible variabilities among human languages.

Generative linguistics aims to explain and formalize, within a learnable model, the connection between the linguistic properties of a sound, structure, or phenomenon, and its variability among languages, as well as its behaviour in different linguistic fields, such as language acquisition and language change. The linguistic study of universality and cross-linguistic variation is based on empirical findings of language typology (Greenberg 1978, Maddieson 1984), where a wide range of linguistic properties and linguistic phenomena are shown to occur in all languages, while others are shown to be less frequent.

The connection between linguistic properties and their variability among languages is associated in linguistic theory with the notion of **markedness**. This notion was introduced by Trubetzkoy (1939) and followed by Jakobson (1941), within the structuralist view of the Prague Circle, and has since been a central concept in linguistic theories (Anderson 1985, Battistella 1990, 1996).

Within the structuralist view, the terms ‘marked’ and ‘unmarked’ are ascribed to the presence or absence of a linguistic property. Jakobson shows that it is possibile to formulate universal generalizations, such as *if α exists in a given language, then β exists there too*. For example, a language that allows syllables with a coda, also allows syllables without a coda, but not necessarily vice versa. That is, syllables with a coda are marked with respect to syllables without a coda. The universal implications of such generalizations are that the unmarked forms (e.g. a codaless syllable) are present

in all languages. According to the Praguian view, all languages share unmarked elements, whereas marked elements exist in order to allow lexical **contrast**. Languages, thus, differ in the contrasts they display.

Linguistic theories approach markedness (i) from the properties of marked vs. unmarked linguistic elements; and (ii) from the behaviour of marked vs. unmarked elements within a linguistic system. One of the challenges of a generative theory is to integrate markedness within a unified formal model of linguistic knowledge.

The account of linguistic properties that determine markedness is often associated with the relation between **complexity** and universality, a connection which poses a theoretical problem. An unmarked element is seen as less complex than its marked counterpart (e.g. a codaless syllable is considered less complex than a syllable with a coda). However, it is not yet well established, what makes certain structures more complex than others. For example, syllables with an onset are considered unmarked with respect to syllables without an onset, but it is unclear what makes *V* syllables (i.e. onsetless and codaless) more complex than *CV* syllables. It turns out, then, that markedness is a series of hypotheses that determine types of correlations, while the need to *explain* these correlations remains a pivotal challenge (Moravcik and Wirth 1986).

This dissertation follows a view suggested by Menn (1986:253) with respect to language acquisition, that the notion of markedness is a useful descriptive concept, not necessarily an explanatory one. As a descriptive concept, markedness plays a key role in the research of the *behaviour* of linguistic properties within linguistic systems and processes, including the distinction between universality and cross-linguistic variation. I will show that markedness is a key concept in determining the nature and the directionality of change in language acquisition and in language change.

It will be shown that in the course of language acquisition, earlier phases are unmarked with respect to later ones. That is, viewing the acquisition path in terms of markedness reveals a clear movement from unmarked to marked structures. The case of language change explored here shows a similar pattern whereby unmarked forms

change into marked ones. In both cases the transition from the unmarked to the marked forms involves an intermediate phase where variable outputs for the same input are evident.

1.1.3 VARIATION AND CHANGE

One of the main topics of this dissertation is the synchronic variation found in intermediate phases in the course of change.

Variation and change have been addressed by linguists since the nineteenth century, with the *Neogrammarians* and their account of the notion **sound change** (Bloomfield 1933, Hinskens et al. 1997). The central questions associated with variation and change, and which are addressed in this dissertation are (a) does variation always involve change? and (b) should variation be considered as part of the speaker's competence?

The Neogrammarians considered sound change as an automatic, exceptionless procedure, which characterizes the speech and not the grammar. Thus, the neogrammarian sound change is purely phonetic and is associated with what were later termed *parole* (Saussurre 1922) and *performance* (Chomsky 1965). A similar view, supported by Weinrich et al. (1968), distinguishes between variation involved in a change and variation which does not necessarily imply change. However, neither type is considered part of linguistic competence (see Guy 1997).

In this work I deal with variation as a consequence of change. In the discussion of language acquisition (§3), I will argue that the variation occurring in the child's production, in the course of acquisition, indicate the process of the grammatical change involved in the learnability of the target language. In the discussion of language change resulting from historical changes (§4), I will claim that the variation existing in Modern Hebrew indicates the effect of the historical changes on the current grammar. I will argue that in both cases the variation in production reflects the speaker's *competence*, and hence should be represented in the speaker's grammar.

The association of variation and change with the speaker's competence (rather than performance) is not new. Earlier studies, including Wang (1969), Kiparsky (1968, 1988, 1995), Reynolds (1994) and Antilla (1997a, b), have considered variation an inherent part of natural language, whether or not it involves change. The main goal of these studies has been to integrate variation within a formal model of linguistic knowledge, based on the assumption that variation is an inherent component of the grammar.

In the spirit of Reynolds (1994), Antilla and Cho (1998), and others, I will show that Optimality Theory provides the appropriate formal tools for integrating variation within the grammar. I will also show that the inter-phase variation in the course of language acquisition and in the course of language change can be represented in a similar fashion within Optimality Theory, simply because this is the same type of variation, namely variation in the course of change.

1.2 OVERVIEW OF THE DISSERTATION

The dissertation is organized as follows: chapter 2 discusses the theoretical issues related to intermediate grammars in the course of linguistic change, and how they are accounted for by the mechanism of Optimality Theory. Chapters 3 and 4 deal with these theoretical issues as they emerge in the course of language acquisition and language change, respectively. Following is a brief description of these chapters.

1.2.1 VARIABLE AND OPTIMAL GRAMMARS IN OPTIMALITY THEORY (§2)

Chapter 2 begins with a brief presentation of the basic concepts of Optimality Theory (OT) (**§2.1**), followed by the application of the OT mechanism to the main topics of the dissertation.

Section **2.2** provides a representation of universality and cross-linguistic variation within linguistic theory, beginning with the notion of markedness, its role in the grammar and its theoretical representation. It is shown that OT is obligated to

represent **markedness** as an intrinsic part of the theory, and so markedness is defined directly by its mechanism. For example, the unmarked codaless syllable (CV) is not *defined* as unmarked and there is no default rule referring to its occurrences. Rather, there are independent constraints on well-formedness that together represent the properties of the unmarked syllable. Thus, the generalization that an unmarked syllable does not have a coda is represented by the markedness constraint NOCODA. This constraint is universal and as such is present in all grammars, but is not always necessarily satisfied within a grammar. In a grammar where this constraint must be satisfied, only codaless syllables occur. In a language where this constraint can be violated, CV still occurs, but alongside syllables *with* coda (e.g. CVC). In such a language the distinction between CV and CVC is contrastive and, as such, is represented in the lexicon. In the grammar of such a language, the markedness constraint NOCODA is ranked below a conflicting faithfulness constraint which demands identity between lexical and surface forms, in order to preserve the lexical contrast. Markedness and lexical contrasts are thus represented by interaction between constraints. On the basis of these principles, §2.2 continues with an OT account of alternation (§2.2.1) and lexical representation (§2.2.2).

Section **2.3** is devoted to language acquisition, and in **§2.4** I discuss the integration of intermediate grammars and variation within a formal model of linguistic knowledge. These sections show that the mechanism proposed by OT for language acquisition is applicable for any type of linguistic change. Based on the concept of a grammar as a set of ranked constraints, linguistic change is described as change in the ranking of constraints in a particular grammar. This process is termed **reranking**.

In §2.4 the operation of reranking is argued to provide a formal account of the transition from one phase to another, and explain its inevitable consequence, i.e. the variation involved in the process. Reranking and constraint-interaction thus establish the transition between phases as a phase in itself, namely as an intermediate grammar involving **inter-phase variation**.

1.2.2 VARIABLE AND OPTIMAL GRAMMARS IN **LANGUAGE ACQUISITION (§3)**

In **§3** I consider intermediate grammars through the acquisition of prosodic structure in Hebrew.

The acquisition path is described as a process of acquiring the contrasts found in the target language. Each new contrast recognized in the child's production serves as evidence for a more advanced phase in the developmental path. The data presented in this chapter suggest that the transition from one phase to another is a phase in itself, an **intermediate phase**, where multiple outputs for the same target form are produced. The following is an example of a path of acquisition, illustrating the phases in the acquisition of a Hebrew word (cf. Ben-David 2001):

(1) Phases in the acquisition of the Hebrew word *axbáŕ* 'mouse'

I	ba	a monosyllabic word, without a coda
II	**ba ~ a.bá**	**transition to a disyllabic word**
III	a.bá	a disyllabic word
IV	**a.bá ~ a.bár**	**transition to final coda**
V	a.bár	a final coda
VI	**a.bár ~ ax.bár**	**transition to medial coda**
VII	ax.bár	the target form

The example above is merely representative. Children may vary in phases II-V, where two types of transitions are presented: to a disyllabic word and to a final coda. That is, children may produce monosyllabic forms with a coda (e.g. *bar*) and only then disyllabic forms (in this case *a.baŕ*). In any case, for each prosodic property (e.g. number of syllables, syllable structure), the progression is from unmarked forms (e.g. syllables without a coda) to marked forms existing in the language.

The chapter opens with a brief description of Hebrew prosodic structure, with special attention devoted to the verb's inflectional system, explored in the course of acquisition (**§3.1**).

In **§3.2** I discuss the acquisition path of Hebrew prosodic structure. The questions considered are: (i) do the variable forms provide insight to the acquisition process?; (ii) do the variable forms imply an intermediate grammar?; and (iii) do they provide insight as to the motivation for change? The latter question leads to the notion of optimal grammar in a natural language, which is further elaborated in §4, based on data from language change.

The research reported in §3 is based on two interrelated acquisition paths: (i) of prosodic structure (§3.2) and (ii) of alternating morphological paradigms (§3.3). The acquisition path of prosodic structure in view of morphological alternating paradigms is explored in **§3.3** through the acquisition of the Hebrew verb inflection, beginning with the initial stage of morphological development (**§3.3.1**). In this phase the children's data provide evidence of distinction between stems and suffixes, before suffixes productively surface in the corpus. This distinction is only noticeable when considering the prosodic developmental phase at this point:

(2) The initial morphological state:

UNSUFFIXED WORDS		SUFFIXED WORDS	
Target word	Child's output	Target word	Child's output
ba.xá 'cried'	xa ~ baxá	hal.xá (halax-a) 'she walked'	lax (*xa)
ne.ši.ká 'kiss'	ka ~ šiká	zar.ká (zarak-a) 'she threw'	rak (*ka)
pi.já.ma 'pijama'	já.ma	ma.cá.ta (maca-ta) 'you (sg. ms.) found'	ca (*cáta)

It appears that children avoid the production of suffixed words although their phonological knowledge allows them to produce the suffixes. For example, while the unsuffixed verb *baxa´*'cried' is produced as *xa*, the suffixed word *halx-á* 'she went' is not produced as *xa*. In this case only the final syllable of the stem is produced, namely *lax* for *halá́x* 'went'.

This suggests that lexical contrasts have priority over morphological contrasts at this stage. In §3.3.1 I will argue that each developmental path begins with the unmarked surface form: in phonological development, the acquisition of the syllable

structure, for example, begins with codaless syllables (1), and in morphological development, the acquisition of inflectional morphology, for example, begins with suffixless stems (2). I will propose a constraint-based analysis to represent the phonology-morphology interface evidenced in this phase.

This discussion is followed by a consideration of the interaction between phonological and morphological factors where inflectional suffixes start to emerge productively in the children's corpus. The data presented in **§3.3.2** exhibit a change in the way the child resolves the conflict between lexical and morphological contrasts. In terms of prosodic development, the children at this stage produce no more than disyllabic words. Below is a representative example, illustrating the stage where it is evident that morphological contrasts have priority over lexical contrasts:

(3) Evidence for morphological contrast:

Child's output	Target form	
na.fál	na.fál (assumed UR)	'he fell'
fál.ti	na.fál.ti (nafal-ti)	'I fell'

As shown above, the unsuffixed target form is disyllabic and the suffixed form is tri-syllabic. However, both the child's forms are disyllabic. There is no way to produce both the stem (*nafal*) and the suffix (*-ti*) without violating the restriction on the number of syllables. While in (2) the children 'give up' the suffix, here they 'give up' lexical segments (i.e. the first syllable, *na*). Interestingly, still at this stage, the children produce adult-like suffixed forms, which are disyllabic via an alternation existing in the target language:

(4) Adult-like alternation:

Child's output	Target form	
na.fál	na.fál (assumed UR)	'he fell'
naf.lá	naf.lá (nafal-a)	'she fell'

The alternation presented above is *nafal-nafla*́, where a lexical vowel is missing in the suffixed form. The children make no mistakes here. Notice that in prosodic terms, (2) and (3) exhibit the same developmental phase: one where no more than disyllabic words surface. In (3) it is not enough to produce both lexical and morphological material, so the less 'important' (lexical) is sacrificed. In (4), the disyllabic output

with the omission of a lexical vowel happens to be an existing alternation in the language. What does this indicate with regard to the acquisition path, and to the interaction between phonological and morphological factors in acquisition?

In **§3.3.3** I show that structural restrictions, which yield regular alternations in the adults' grammar, are not violated by children. In addition, systematic inter-phase variation, as seen in (1) in the course of acquiring phonological contrasts, is not seen in contexts of regular alternations. Among the questions I address in §3.3.3 are: why are certain types of deviations from the target forms common and others extremely rare? why are variable outputs found in certain linguistic contexts and not in others?

The answers I propose are based on the premises and mechanism of OT, showing that all the phenomena discussed above are expressible by constraint interaction and reranking. The principles I propose for variation, intermediate grammars, conditions for grammatical change, and optimal grammars are shown to be applicable to the phenomena discussed in §4, which deals with language change.

1.2.3 VARIABLE AND OPTIMAL GRAMMARS IN **LANGUAGE CHANGE (§4)**

In **§4** I consider intermediate grammars through a synchronic account of variation existing in Modern Hebrew, as a consequence of historical change.

The theoretical issues addressed in §3 regarding variable forms and variable grammars are further elaborated in this chapter. In a sense, this chapter continues the former, as it shows the conditions for changes in *adult* grammar. It is shown that language acquisition and language change have in common more than merely that *change* occurs in the course of time. The crucial points I emphasize here are the characteristics of change, the conditions for change, and its consequences.

The phenomenon studied in §4 is **spirantization** in Modern Hebrew, where the alternation between stops and fricatives involves a great deal of opacity and free variation. In this chapter I argue that the free variation existing between stops and fricatives indicates grammatical change.

The discussion in §4 is based on a set of paradigms co-existing in the language. The interesting point is that these paradigms contradict one another. Consider the examples below:

(5) Contradictory paradigms in Modern Hebrew:

a. Paradigms with alternation:

bi.tel	'cancelled'	ye.**v**a.tel	'will cancel'
ta.**v**al	'dipped'	yit.**b**ol	'will dip'

b. Paradigms without alternation:

i. **v**i.ter	'gave up'	ye.**v**a.ter	'will give up'
ii. di.**b**er	'talked'	ye.da.**b**er	'will talk'

The paradigms in (5a) and (5bi) are identical in all phonological and morphological aspects. Nevertheless, alternation is found only in the first case (5a), not in the second. This example clearly represents the opacity of alternation between stops and fricatives in Modern Hebrew. In **§4.2** I specify the conditions for alternation in paradigms of type (5a) vs. paradigms of type (5b).

In **§4.3** I describe the consequences of the contradiction exhibited by (5a) vs. (5bi), that is, variation. The variability in the Hebrew data indicates that (i) the variation is not sporadic, i.e. it is restricted and predictable; and (ii) the alternation between stops and fricatives in colloquial Hebrew (see definition in §1.3) is fated. The following examples demonstrate the scope of variation:

(6) Variation in stop-fricative alternation:

	PAST		FUTURE		
	Normative	Colloquial	Normative	Colloquial	
a.	da.**f**ak	*da.**p**ak	yid.**p**ok	~ yid.**f**ok	'to knock'
	ka.**v**ar	*ka.**b**ar	yik.**b**or	~ yik.**v**or	'to bury'
b.	**p**i.zer	~ **f**i.zer	ye.**f**a.zer	*ye.**p**a.zer	*'to spread'*
	bi.keš	~ **v**i.keš	ye.**v**a.keš	*ye.**b**a.keš	*'to request'*
c.	**p**a.gaš	~ **f**a.gaš	yi**f.**goš	*yi**p.**goš	*'to meet'*
	ba.xar	~ **v**a.xar	yi**v.**xar	*yi**b.**xar	*'to choose'*

The data above show, if nothing less, that not all forms are subject to variation. That is, variation is restricted to certain phonological environments. In addition, all the colloquial forms actually form non-alternating paradigms. For example, in (6a) alternation occurs between the invariable form, e.g. *ka.**v**ar* (**ka.**b**ar*) and the normative form *yik.**b**or* 'to bury'. However, the non-normative form in this paradigm, *yik.**v**or*, like the invariable form *ka.**v**ar*, has a fricative. Thus, in the colloquial paradigm no alternation exists.

Section **4.4** provides additional evidence for the state of spirantization in colloquial Hebrew. In this section a distinction is made between variation within the grammar of a single speaker and variation between speakers. It is argued that the coexistence of both types indicates that the language is undergoing change, the variable grammar being an intermediate phase.

1.3 A General Language Background

This dissertation is based on data from Modern Hebrew, spoken by native speakers living in Israel. Detailed descriptions of the specific linguistic domains investigated in this work are presented in §3.1.1 and §4.1.1. In this section I briefly introduce the notion of 'Modern' Hebrew and provide some general information on the language.

Hebrew is a member of the Canaanite languages, a sub-branch of the northwestern Semitic family. The history of the language goes as far back as the ancient Biblical era, referred to as **Biblical Hebrew**. The language has not been spoken as a native language from circa A.D. 200 until the end of the ninetieth century (Rabin 1972). Despite the long cease in the use of the language, Biblical Hebrew is the major source of the vocabulary of current Hebrew (Ravid 1995).

The notion of **Modern Hebrew** is associated with the current Israeli Hebrew spoken by native speakers since the revival of the language at the beginning of the twentieth century, where it was established as the mother tongue of children born in Israel (Sivan 1976, Blau 1981). During this phase of 'revival' the language was

influenced by various sources, not only Semitic, as a result of extralinguistic factors. The most remarkable influence beyond that of Semitic languages (e.g. Arabic, Aramaic) is from Yiddish and Slavic languages (Wexler 1990). In this work, the term Modern Hebrew (MH) refers to what is generally termed 'Israeli Hebrew', or 'Contemporary Hebrew', (Rosén 1973, Schwarzwald 1985), i.e. as the label for the language of the average native speaker.

A common distinction found in the literature on MH is between **normative** (or Standard) Hebrew and **colloquial** Hebrew. This distinction stems from the wide range of disparities between what is officially considered 'correct' Hebrew, and the actual use of the language by the average native speaker. Normative Hebrew is used almost exclusively in high register contexts, such as the official broadcasting network, educational and cultural agents, and teachers specialized in the teaching of standard Hebrew (see Ravid 1995 for background). This distinction is relevant to the discussion of language change (§4), but not to the discussion of language acquisition (§3), because the phenomena considered there do not exhibit any difference between normative and colloquial Hebrew.

The differences between normative and colloquial Hebrew are not manifested in the native speakers' inventory of consonants and vowels, which includes the following phonemes:

(7) The consonants in Modern Hebrew

	bilabial	labio-dental	alveolar	palato-alveolar	palatal	velar	uvular	glottal
stop	p b		t d			k g		ʔ
fricative		f v	s z	š		x		h
affricate			c					
nasal	m		n					
liquid			l				r	
glide					y			

The above inventory does not include the pharyngeal fricatives *ħ* and *ʕ*, which are only uttered by speakers with oriental pronunciation. This pronunciation is not accounted for in the current research (the status of these consonants in MH is

discussed in §4.1.1). In addition, there are several sounds which appear as phonemes only in loan words: the palato-alveolar fricative ž (e.g. *bež* 'beige') and the affricates *č* (e.g. *ček* 'a check') and *ǰ* (e.g. *ǰins* 'jeans').

The vocalic system of MH includes five phonemic vowels. Phonetically, all Hebrew vowels are [-ATR], except the back mid vowel *o*; and the low vowel (*a*) is central (Laufer 1990):

(8) The vowels in Modern Hebrew

	Front	Back
High	i	u
Mid	e	o
Low		a

Chapter 2

VARIABLE AND OPTIMAL GRAMMARS IN OPTIMALITY THEORY

Optimality Theory is a constraint-based theory, according to which a grammar is represented by a set of universal constraints. The interaction between the constraints determines the surface structure of a language, and the particular relations existing in that language between the surface form and its representation in the lexicon. Some of the constraints conflict with respect to one another, and therefore a crucial ranking between them should be determined within a grammatical system. This ranking is on a language specific basis.

The constraints are divided into two basic types: (a) **markedness** constraints, which refer to the surface structure of a language; and (b) **faithfulness** constraints, which refer to the relation between surface forms and their lexical representation. In general, markedness constraints require a structure to be unmarked, e.g. the constraint NOCODA stands for the requirement that syllables should not have codas. Faithfulness constraints require a surface structure to be identical to its related form in the lexicon, e.g. the constraint MAXSEG calls for preservation of all lexical segments in the output. That is, faithfulness constraints preserve lexical contrasts.

This chapter includes the Optimality Theoretic approach to the main topics considered in this dissertation. The central theoretical problems addressed here with respect to language acquisition and language change are highlighted throughout the discussion. The chapter is organized as follows. In §2.1, the basic concepts of Optimality Theory (OT) are summarized, presenting the mechanism of the theory, its terminology and its conventions. In §2.2 I present the application of the OT mechanism on the representation of grammar. Following the OT representation for universality and markedness, the section includes two central aspects of the grammar: alternation

(§2.2.1) and the lexicon (§2.2.2). Section 2.3 is devoted to the OT account of language acquisition, and in §2.4, intermediate grammars and variation are discussed.

2.1 OPTIMALITY THEORY: BASIC CONCEPTS AND CONVENTIONS[1]

As established in Prince and Smolensky (1993), Optimality Theory is a constraint-based grammatical theory. The theory proposes that grammars of all languages consist of a common set of constraints, and hence constraints are universal and present in all grammars. Cross-linguistic variation is explained through the different **ranking** of conflicting constraints.

Due to inherent conflicts between the constraints, there is no natural grammar that could possibly satisfy them all. Therefore, constraints are, by definition, **violable**. However, violation is minimal such that for any given input form, the **optimal output** is the one that best satisfies the constraints. It should be emphasized that the optimal candidate is not required to fulfill all universal constraints in order to surface. Rather, it surfaces by minimally violating the lower ranked constraints in the hierarchy.

The selection of the optimal output results from the parallel operations of the two functions of grammar, **GEN** and **EVAL**. For every input form, GEN produces a set of output candidates. Eval evaluates these candidates according to the constraint hierarchy of the particular language. The winning candidate, the one that actually surfaces, is the optimal candidate. Thus, evaluation of all potential output candidates is performed simultaneously, so that no serial derivation occurs. The nature and the operations of GEN are beyond the scope of this work, and will not be discussed further.

[1] This section presents the mechanism of OT, including the concepts relevant for the discussion in this study. Further details and concepts are presented and discussed in §3 and §4 in the relevant contexts of the analysis provided. A more complete description of OT is given in Prince and Smolensky (1993), McCarthy and Prince (1993a, 1995), and Kager (1999).

As OT is a constraint-based theory, grammatical phenomena (such as segmental and prosodic alternation, assimilation, stress assignment, etc.) are expressed and explained in it through **constraint interaction**. The schematic tableaux in (1) and (2) demonstrate the mechanism of Optimality Theory, regardless of the actual linguistic forms:

(1) **Constraint hierarchy**: C_1 » C_2 » C_3 » C_4

	C_1	C_2	C_3	C_4
a. cand1	*!			
b. cand2		*!		
c. cand3			*!	
d. ☞ cand4				*

'*' = a violation mark; '!' = a fatal violation; '☞' = the optimal candidate

The notation '»' between two constraints stands for a **crucial** ranking; 'C_1 » C_2' indicates that C_1 is ranked higher than C_2. The constraints are listed in the tableau horizontally, read from left to right, the leftmost being the highest ranked, and the rightmost, the lowest. The candidates are listed vertically in an arbitrary order. In the tableau above, four candidates compete, and each candidate violates only one of the constraints, only once (a violation is marked by '*'). However, only cand4 is selected as the optimal candidate (marked by '☞') as it violates the *lowest* ranked constraint (C_4). For the other candidates, any violation of the other constraints is fatal (marked by '!'), as each violates one of the higher ranked constraints satisfied by cand4. The shaded cells indicate the irrelevance of the constraints for the given candidates following a fatal violation. In the following tableau, the notion of *minimal* violation is further clarified:

(2) Minimal Violation

	C_1	C_2	C_3	C_4
a. cand1	**!			
b. cand2	*	*!		
c. cand3	*		**!	
d. ☞ cand4	*		*	**

In the above tableau, all the candidates violate C_1. However, only cand1 is ruled out by C_1, since it violates C_1 twice, while the others only violate it once, and so remain in the competition. Cand2 is ruled out by C_2 since it is the only one to violate it, leaving cand3 and cand4 in the race. Both cand3 and cand4 violate C_3, but since cand3 violates it twice and cand4 only once, cand4 is selected as the optimal candidate. Notice that cand4 wins even though it is the only one to violate C_4, and it has more violation marks than the other candidates (four marks overall, versus three and two marks for the others). Thus, the optimal candidate is selected based on the number of violations of the higher ranked constraints, not by the total number of violations of all constraints in the hierarchy.

2.2 UNIVERSALITY AND MARKEDNESS

The grammar of a particular language is represented in Optimality Theory as a hierarchy of universal constraints. Universality is addressed through two aspects: one is the universality of the constraints, and the other relates to the distinction between universal and language specific structures and sounds. The latter is governed by the theory's representation of markedness and is central to the phenomena discussed in the remainder of the dissertation.

In §1.1.2 I mentioned the connection made in linguistic theory between universality and the notion of markedness, as well as the goal of a generative theory to integrate markedness within a formal model. While in a rule based approach, established in the *Sound Pattern of English* (SPE: Chomsky and Halle 1968), markedness is represented by a set of default rules, external to the set of rules constituting the grammar, in OT, markedness is provided directly by the nature of the constraints and their interaction.

In general, OT distinguishes between two types of phonological constraints, markedness and faithfulness constraints. **Markedness** constraints refer to the phonological well-formedness of surface forms. These constraints, by definition,

reflect universally 'preferred', or unmarked, structures and sounds. For example, the markedness constraint NOCODA reflects the universal generalization that all languages have open syllables and open syllables are unmarked with respect to closed syllables (i.e. with codas). One type of markedness constraints is a set of **alignment constraints** (McCarthy and Prince 1993b), which refer to the principles that account for matching between prosodic and morphological constituents and the phonology-morphology interface (the representation and the application of alignment constraints will be discussed in detail in §3).

Markedness constraints are inherently in conflict with **faithfulness** constraints, which refer to the relations between corresponding forms, and demand identity between them. This identity is the OT way of preserving **lexical contrast** (i.e. the unpredictable distinctions stored in the lexicon).[2]

Languages differ in the violability of the constraints, as reflected by the particular ranking of the constraints in a given language. For example, the markedness constraint that prohibits the production of consonants in coda position is NOCODA. This constraint is inherently in conflict with faithfulness constraints, such as MAX, which prohibits the deletion of lexical elements, and DEP, which prohibits the insertion of elements into a lexical form (McCarthy and Prince 1995). A grammar in which NOCODA is crucially ranked above the conflicting faithfulness constraints can generate *only* (unmarked) codaless syllables. The opposite ranking (whereby MAX and/or DEP dominate NOCODA) can give rise to a (C)V**C** syllable structure, which is marked with respect to coda, as well as to the unmarked syllable structure. Both types of grammars are demonstrated in (4) below, preceded by a definition of the constraints involved (3):

[2] These concepts correlate with similar concepts used in other theories, not necessarily generative. Bernhardt and Stemberger (1998) note that the notion of faithfulness correlates with *activation* levels used in models of psychological processing, e.g. the connectionist model (Dell 1986, Stemberger 1992) and the symbolic model (Levelt 1989). Tobin (2000) compares the conflict between markedness and faithfulness constraints to the basic notions of the theory of Phonology as Human Behavior (Diver 1979), where *human* factors (which correlate with markedness) are in conflict with *communication* factors (which correlate with faithfulness).

(3) Constraints accounting for syllable structure – coda position

a. ***Markedness*** constraint referring to coda position:

NOCODA Syllables do not have a coda.

b. Conflicting ***faithfulness*** constraints

MAX (MAXIMALITY): Every phonological element in the input has a correspondent in the output (i.e. *deletion* is prohibited).

DEP (DEPENDENCY): Every phonological element in the output has a correspondent in the input (i.e. *insertion* is prohibited).

(4) (Un)Markedness of syllable structure – coda position

a. Languages without a coda:
Ranking: NOCODA » FAITH

	MARKEDNESS	FAITHFULNESS
Input: /…$C_1V_1C_2C_3V_2$…/	NOCODA	MAX/DEP
a. $C_1V_1C_2.C_3V_2$	*!	
b. ☞ $C_1V_1.C_3V_2$		* ($\mathbf{C_2}$ is deleted)
c. ☞ $C_1V_1.C_2\mathbf{V}.C_3V_2$		* (**V** is inserted)

b. Languages with a coda:
Ranking: FAITH » NOCODA

	FAITHFULNESS	MARKEDNESS
Input: /…$C_1V_1C_2C_3V_2$…/	MAX/DEP	NOCODA
a. ☞ $C_1V_1C_2.C_3V_2$		*
b. $C_1V_1.C_3V_2$	*! (C_2 is deleted)	
c. $C_1V_1.C_2\mathbf{V}.C_3V_2$	*! (**V** is inserted)	

The ranking of NOCODA above FAITH (4a) ensures that syllables with a coda cannot surface. This type of language prefers to insert a vowel (candidate (c)) or to delete a consonant (candidate (b)) than to have syllables with codas on the surface.[3] In the other type of grammar (4b), the occurrence of syllables with codas is possible due to the dominance of faithfulness constraints over NOCODA. This ranking preserves lexical contrasts regarding coda.

The optimal candidate in (4b) – $C_1V_1C_2.C_3V_2$ – reveals the typological fact discussed in §1.1.2: a grammar which allows syllables with codas, also allows

[3] The choice between the two candidates is provided by a distinction between different input-output relations, on a language specific basis, which is represented in OT by different ranking of the constraints. This distinction is discussed in §2.2.1 below.

syllables without codas. That is, languages may prohibit (4a) or permit (4b) syllables with codas, but this model cannot produce a language that *prohibits* syllables *without* codas. When a markedness constraint is crucially ranked highest, only unmarked structures can surface. When the markedness constraint is crucially ranked below conflicting faithfulness constraints, the unmarked structure may or may not appear – but it is not prohibited.

The example in (4b) demonstrates one of the basic concepts of OT, **the emergence of the unmarked** (McCarthy and Prince 1994a). According to this concept, markedness constraints are effective not only when they are dominant, but also when they are outranked in a certain grammar. That is, in every language there are circumstances in which the unmarked emerges to the surface. This principle follows the generalization that the unmarked is present in all grammars, and in some grammars it exists alongside contrastive marked properties. In OT, this generalization is expressed by constraint interaction where low ranked constraints are not turned off, and hence they potentially affect surface forms.

2.2.1 ALTERNATION

One of the central issues addressed in this work is alternation. In §3, alternation is considered in the course of language acquisition, and in §4, it is considered in the course of language change. The topics discussed below concern the representation of alternation within OT.

Alternation is in fact a case of universal generalization, where unmarked forms surface. Following the concepts presented in §2.2, an unmarked form is expressed in OT through the dominance of a markedness constraint. In addition, alternation is by definition a case in which identity between corresponding forms (e.g. input-output) is not achieved. In OT terms, this means violation of faithfulness constraints. Thus, alternation is expressed by the ranking of a markedness constraint above a conflicting faithfulness constraint.

In rule-based phonology (Chomsky and Halle 1968) alternation is described by a set of linear rules, of the form 'A → B / C __ D', applying in the course of serial derivation. This representation implies that a case of alternation is a case of structural change, which may involve hypothetical intermediate representations in the course of derivation. This mechanism cannot avoid structures that never surface from being represented in some stage of the derivation. The assumption of hypothetical intermediate representations of structures in the process of derivation is a major weakness of a rule-based analysis for phonological alternations. As a constraint-based and derivation-free approach, OT manages to avoid this. However, it has been argued in several OT works (e.g. Hayes 1999, Kager 1999), that the most significant advantage of OT over rule-based theories is its account of the **conspiracy** problem, first introduced by Kisseberth (1970).

The term *conspiracy* relates to instances in which a number of different rules *conspire* to achieve the same phonological goal, although they do not seem to require exactly the same environment. As Kisseberth (1970) notes, there is no formal way to represent the relation between rules that conspire to achieve the same structural results (e.g. avoiding clusters). Thus, the essence of the conspiracy problem is the failure to represent the phonological generalization that triggers or governs the different phonological processes. This problem applies also to cross-linguistic variation, where the same universal generalization (e.g. syllables without a coda) is fulfilled in different ways (e.g. consonant deletion, vowel insertion, metathesis, etc.) in different languages. Moreover, as noted by Kenstowicz and Kisseberth (1977:131), a rule-based theory is focussed on phonological generalizations motivated by alternation, while there are many phonological phenomena (e.g. restrictions on clusters) which are not directly involved in alternations, and yet are not expressible within a rule-based analysis.

In order to demonstrate the conspiracy problem and the OT account of the disadvantages of a rule-based theory as above, I continue the discussion of the example presented in (4a), where a codaless grammar is represented. In (4a), two

ways of avoiding codas in output forms are suggested: consonant deletion and vowel insertion. Below are examples of two languages that restrict coda position, each one applying a different way:

(5) Languages with restrictions on coda

i. SAMOAN (Marsack 1962): consonant deletion

UR	**Unsuffixed form**	**Suffixed form** (*-ia*)	
/sila**f**/	sila<f>	si.la.fia	'see'
/fua**t**/	fua<t>	fua.tia	'weigh'
/sio**m**/	sio<m>	sio.mia	'surround'

ii. PONAPEAN (Rehg & Sohl 1981): vowel insertion (epenthesis)

UR	**Surface form**	
/kitik-men/	ki.ti.k**i.**men	'if you see'
/daur-di/	du.r**i.**di	'they won't go'
/m^{w}esel-saŋ/	m^{w}e.se.l**i.**saŋ	'leave from'

(6) A rule-based account for the data in (5)

a. Consonant deletion in Samoan:

C → ∅ / ___]$_{\sigma}$ CVC → CV

e.g. /silaf/ → si.la *si.laf

b. Vowel insertion in Ponapean:[4]

∅ → V / C]$_{\sigma}$__C CVC → CV.CV

e.g. /kitik-men/ → ki.ti.ki.men *ki.tik.men

In a rule-based analysis, there is no way of expressing the relation between the rules in (6) and the phonological generalization they 'serve', i.e. the fact that they are activated in order to avoid consonants in coda position. In the OT constraint-based approach, the generalization (or 'goal') is expressed by the high ranking of a markedness constraint (NOCODA) above conflicting faithfulness constraints. The

[4] The epenthesis in Ponapean is usually analyzed as activated by CODA-COND(ITION) which refers to the restrictions on coda position (Itô 1989, McCarthy and Prince 1993a), where NOCODA is the most extreme case of restriction on coda. In the current context I do not get into the details of CODA-COND.

different ways of fulfilling this generalization is expressed by different ranking of the constraints, as demonstrated below (cf. (4a)): [5]

(7) Constraint-based solutions for the conspiracy problem

a. Constraints rather than rules

i. The markedness constraint:

NOCODA Syllables should not have codas.

ii. The faithfulness constraints:

MAXSEG Lexical segments should not be deleted.

DEPSEG Non-lexical segments should not be inserted.

b. Different rankings

i. Consonant deletion in Samoan:

Ranking: NOCODA » DEPV » MAXC

Input: silaf	MARKEDNESS	FAITHFULNESS	
	NOCODA	DEPSEG	MAXSEG
a. si.laf	*!		
b. ☞ si.la			*
c. si.la.f**a**		*!	

ii. Vowel insertion in Ponapean:

Ranking: NOCODA » MAXC » DEPV

Input: kitik-men	MARKEDNESS	FAITHFULNESS	
	NOCODA	MAXSEG	DEPSEG
a. ki.tik.men	**!		
b. ki.ti.men	*	*!	
c. ☞ ki.ti.k**i**.men	*		*

The high ranking of NOCODA in both cases represents the motivation for both consonant deletion (7bi) and vowel insertion (7bii). The different result in each case (i.e. deletion vs. insertion) is due to the different ranking. In (7bi), the ranking of DEPSEG above MAXSEG disqualifies the option of vowel insertion (candidate (c)) at the cost of consonant deletion in the optimal output (candidate (b)). In (7bii), the

[5] Kager (1999: 83-4), in addition to the option presented above, presents a case (based on Pater 1996) where two types of alternations exist in the same language (OshiKwanyama) in order to satisfy the same markedness constraint. But since each is applied in different morphological domains, the *same* constraint ranking can render the desired results, by specifying the constraints to morphological domains.

ranking of MAXSEG above DEPSEG disqualifies consonant deletion at the cost of vowel insertion.[6] This way, the markedness constraint represents the 'goal', and its high-ranking forces the fulfillment of this goal. The relation between the alternation and its cause is provided directly by the model.

The difference between the languages discussed above is not evident in the surface forms (as in both languages only codaless syllables surface) but in the input-output relations. In languages like Samoan, lexical consonants are deleted, whereas in languages like Penopean, all lexical consonants are preserved, but non-lexical vowels are inserted. In both cases, the evidence for lexical representations which *differ* from the surface forms is available only in the context of alternation. This issue is further elaborated in the following section.

2.2.2 FAITHFULNESS RELATIONS AND THE LEXICON

As seen so far, the structure of output forms is determined in OT by the interaction between universal constraints on a language specific basis. While markedness constraints refer to the well-formedness of a structure, faithfulness constraints account for the relation between the output form and its input. That is, each output form has a corresponding input form, and faithfulness constraints demand identity between the two. The ranking between markedness constraints and their competing faithfulness constraints determines which elements of the output remain identical to their correspondents in the input. However, while it is quite clear how constraint interaction accounts for the output structure, the way that the input's structure is determined is not as obvious.

In this section, I discuss several aspects of lexical representation. The main distinction I refer to is that between the lexical representation of a single form (§2.2.2.1) and the lexical representation of forms in alternating paradigms (§2.2.2.2).

[6] It should be noted that in (7bii) all candidates violate NOCODA, but candidate (a) is ruled out because it has two violation marks. Candidates (b) and (c) violate NOCODA once and the choice between them is made by the ranking between the faithfulness constraints.

***2.2.2.1 The lexical representation of a single form*:** One of the basic principles in OT regarding the lexical representation is known as the **Richness of the Base** (Smolensky 1996b). According to this principle, there is no specific grammatical restriction on lexical (i.e. underlying) representation. Rather, the grammar (i.e. constraint interaction), which applies to surface forms, is mirrored in the lexicon. For example, in a grammar where NOCODA outranks faithfulness constraints, only codaless syllables surface, regardless of the underlying representation. In a language where faithfulness constraints outrank NOCODA, the contrast between codaless syllables and syllables with coda is provided by the constraint interaction, and this contrast is mirrored in the lexicon.

A formal definition of the relations between constraint interaction, surface forms, and lexical representation, is provided by Prince and Smolensky (1993:192), under the title **Lexicon Optimization**:

(8) Lexicon Optimization:

> "Suppose that several different inputs I_1, I_2 ... I_n, when parsed by a grammar G, lead to corresponding outputs O_1, O_2, ... O_n, all of which are realized as the same phonetic form ϕ - these inputs are all *phonetically equivalent* with respect to G. Now one of these outputs must be most harmonic, by virtue of incurring the least significant violation marks: suppose this optimal one is labeled O_k. The learner should choose, as the underlying form for ϕ, the input I_k."

Lexicon Optimization requires that the constraints on surface structures be mirrored in the lexicon. In other words, the constraint hierarchy, which accounts for a particular surface structure, also accounts for the lexical representation of this form, providing minimal input-output disparity (or maximal faithfulness). This principle is compatible with former ideas regarding input-output relations, that underlying forms should match surface forms in the absence of evidence to the contrary (e.g. Stampe 1972).

Continuing the above example, in a language where only codaless syllables surface, Richness of the Base allows any syllable structure to be represented underlyingly (in the absence of *direct* restrictions on the lexicon). But following the principles of lexicon optimization, which minimize input-output disparities, there is no reason to assume underlying representations other than codaless syllables.

As long as only single forms are considered, the definition of lexicon optimization in (8) is sufficient. It is, however, challenged when considering alternations.

2.2.2.2 The lexical representation of a paradigm: Alternating paradigms require some modifications to the definition of lexicon optimization (8), since a particular constraint interaction provides alternating forms. Following the definition in (8), there is no way to attain one lexical representation without violating the principle of minimal input-output disparities for at least one of the surface forms. For example, consider the alternation of Samoan discussed above:

(9) Alternating paradigm in Samoan: C ~ Ø

Unsuffixed form	**Suffixed form** (-ia)	
sila	silaf-ia	'see'
fua	fuat-ia	'weigh'
sio	siom-ia	'surround'
lilo	lilo-ia	'hide'

The surface forms in the Samoan paradigm exhibit the alternation C ~ Ø (e.g. *sila* ~ *sila**f**ia*). The question is what would be the optimal input, namely the lexical representation. Following (8), if *sila* is chosen as the underlying form, Lexicon Optimization is violated with respect to the form *sila**f**-ia*. If *sila**f*** is chosen as the underlying form, Lexicon Optimization is violated with respect to *sila*. Lexicon Optimization should then be applied not to individual forms, but to the entire paradigm. Tesar and Smolensky (1996:41) provide the following definition for

paradigm optimization (cf. Inkelas 1995, and Itô et al. 1995, who assume underspecification in some cases of alternation):

(10) **Paradigm Optimization**

> "[P]aradigm-level optimization in phonology proper is typically needed in cases where expected alternation does *not* occur (*anti*allomorphy); Paradigm-level *lexicon* optimization is needed in cases when alternation *does* occur."

The definition in (10) distinguishes between alternating and non-alternating paradigms. The distinction between these two types of paradigms is reflected in constraint-interaction (§2.2.1): the ranking of markedness above faithfulness provides alternation, while the opposite ranking provides identity across the paradigm (see Benua 1995, 1997). As far as lexical representation is concerned, the latter case can be accounted for by the bare definition of Lexicon Optimization (8), since the surface forms themselves exhibit identity across the paradigm. For example, if all cases in Samoan were in the form of the last pair in (10), i.e. *lilo – lilo-ia* 'hide', then there would be no evidence to suggest a lexical representation other than the surface form of the base, *lilo*. The modification provided in (10), which is required for alternating paradigms, is needed since there is no output-output identity across the paradigm. When looking across an alternating paradigm, the definition in (10) requires that the lexical representation be the one which best explains the paradigm as a whole, although it is not (and cannot be) identical to all the surface forms in the paradigm.

The following tableau demonstrates the selection of the optimal input of the Samoan alternating paradigm (cf. (7bi)):

(11) Paradigm-level Lexicon Optimization

Inputs	Overt Forms	NoCoda	DepSeg	MaxSeg
a. /sila/	[si.la]			
/sila-ia/	[si.la.fia]		*!	
b. ☞ /silaf/	[si.la]			*
☞ /silafia/	[si.la.fia]			

The above tableau demonstrates the implication of the OT principle that the constraint ranking of a particular language is mirrored in the lexicon. The ranking of DEPSEG above MAXSEG not only selects the optimal outputs of Samoan (see 7bi)), it also selects their lexicon representation.

As pointed out above, both *sila* (candidate (a)) and *silaf* (candidate (b)) violate Lexicon Optimization. However, assuming *sila* as the underlying form, the violation is fatal, since the surface form *silafia* violates the higher ranked constraint (DEPSEG), whereas assuming *silaf* as the underlying form, the output *sila* violates the lower ranked constraint (MAXSEG). Therefore, the underlying form *silaf* is the one which best explains the paradigm as a whole, although it is not (and cannot be) identical to all the surface forms in the paradigm.

2.3 PHONOLOGICAL ACQUISITION IN OPTIMALITY THEORY

The study of language acquisition in general, and phonological acquisition in particular, is an interdisciplinary study, where each discipline asks different questions, looks for different evidence, and develops different types of theories. Nevertheless, all approaches stem from the distinction between language universals and cross-linguistic variation. They differ in every other respect: what is universal? what is learned? are the universal properties innate or learned?

The basic hypothesis of generative linguistics regarding language universals, is that universal properties are present in all grammars of all human beings and are part of Universal Grammar (UG). Cross-linguistic variation is determined and restricted by UG. The goal of generative linguistics is to represent these universal properties and the cross-linguistic variation within a *learnable* model. This model should be more than merely descriptive. It should represent the child's knowledge throughout the acquisition path. Not less important, but more problematic, is the obligation of a generative model to represent the dynamic process of learning.

The starting point of the study of language acquisition within OT is the universality of the constraints and the specific constraint hierarchies accounting for variation among languages. Given that constraints are universal, the acquisition task involves learning the constraint hierarchy of the target language and its lexicon (Tesar and Smolensky 1993, 1998). The process of learning the specific constraint hierarchy of the target language involves **reranking** of the constraints. Beyond this basic assumption, there is a dispute over the constraint interaction in the initial state and the nature of reranking along the learning path. In this section, I refer to these theoretical issues in the context of the leading topics of this dissertation.

The acquisition path is expressed in OT as a process of reranking of constraints and learning the lexicon (Tesar and Smolensky 1993). Since the child's production is very different from the target forms, it is hypothesized that each disparity between the child's output and the adult output is a case of a different ranking of conflicting constraints. For example, the first syllables produced by children in all languages are codaless syllables. This output differs from target forms in languages that have syllables with codas. This difference is expressed by different rankings: in the child's grammar, NOCODA is ranked above MAXSEG, while in the target language the ranking is the opposite. A child acquiring a language with codas should then rerank these constraints in order to achieve the desired results. Below, I present the theoretical issues addressed by the following questions: (i) what is the organization of the constraints in the initial state?; (ii) what are the relevant faithfulness relations in acquisition?; and (iii) is reranking systematic?

2.3.1 THE INITIAL STATE

Beyond any theoretical framework, it is widely agreed upon that the child's production in early stages of acquisition is unmarked with respect to the target forms. Considering the relations mentioned earlier regarding markedness and universality, it is also widely agreed upon that the initial production of children acquiring different languages has much in common. For example, syllables such as *pa, ma, bu* and *da* are

found among the first words in the corpuses of children acquiring various languages (Jakobson 1962). From this point on, the child's production gradually increases and exhibits more and more contrasts.

The implications of the above description are that children start with a certain organization of the grammar, which generates unmarked forms with minimal contrastiveness.[7] Following this assumption, it has been suggested in several works (e.g. Gnanadesikan 1995, Demuth 1995, Tesar and Smolensky 1998, Levelt and Vijver 1998) that the initial ranking consists of the high ranking of markedness constraints and the low ranking of faithfulness constraints. This view differs from an earlier proposal (Tesar and Smolenky 1993) suggesting that all constraints are initially unranked with respect to one another. The weakness of this latter view is that it predicts random outputs in the initial state, whereas the data of acquisition, as have been noticed since Jakobson (1941/1968), are rather systematically unmarked.

In this dissertation, based on data from the acquisition of Hebrew (discussed in §3), I adopt the view that markedness constraints outrank faithfulness constraints in the initial state of acquisition. For example, according to this view of the initial state, the unmarked syllable CV is the only syllable structure generated by children acquiring different languages, as a consequence of the following ranking of the relevant constraints:

(12) The unmarked syllable in the initial state

a. The constraints referring to the syllable:

i. Markedness constraints:

NOCODA	Syllables do not have a coda.
ONSET	Syllables have an onset.
*COMPLEX	Syllables do not have clusters.

[7] An alternative view in OT, represented by Hale and Reiss (1997), attributes the disparity between a child's production and target forms to non-grammatical restrictions such as perceptual and articulatory factors. This view is naturally rejected by phonologists (Hayes 1999, Smolensky et al. 2001) basically because it implies that there is no phonology in early acquisition.

ii. Faithfulness constraints:

MAXSEG Lexical segments are not deleted.

b. The ranking (a comma indicates *equal ranking*):

MARKEDNESS FAITHFULNESS

NOCODA, ONSET, *COMPLEX » MAXSEG

c. The tableau (a dotted line indicates *equal ranking*):

Input: CCVC	MARKEDNESS			FAITHFULNESS
	NOCODA	ONSET	*COMPLEX	MAXC
a. CCVC	*!		*	
b. CVC	*!			*
c. VC	*!	*		**
d. V		*!		***
e. CCV			*!	*
f. ☞ CV				**

The example above indicates that the crucial ranking of the markedness constraints, as a group, above the conflicting faithfulness constraint, explains the exclusive surfacing of the unmarked syllable. These markedness constraints are adduced as equally ranked. This type of constraint interaction is found in the final state grammar as well, in cases of *absence of evidence for ranking*.

It should be noted that the above ranking represents in fact three pairs of markedness - faithfulness conflicts. Evidence for this decomposition is available only in the course of reranking (see §2.3.3 below), where, for example, CVC but not CCV surface in the child's production. Such an example indicates that NOCODA, but not *COMPLEX, has been reranked with respect to MAXSEG. The three pairs are presented below, as they are presumably ranked in the initial state:

(13) The pairs of constraints indicated by the ranking in (12)

a. NOCODA » MAXSEG

b. ONSET » MAXSEG

c. *COMPLEX » MAXSEG

The example discussed above is only partial, as it does not consider all the markedness and faithfulness constraints involved in generating the unmarked syllable (see for instance the examples in §2.2). It is partial, also, as it ignores the 'input'. This issue is discussed in the next section.

2.3.2 FAITHFULNESS RELATIONS IN ACQUISITION

One of the major problems arising within the study of language acquisition is the status or the scope of 'faithfulness'.[8] In adult grammar, faithfulness refers to input-output correspondence where input represents the lexical underlying representation. It also refers to output-output correspondence, which includes, among other relations, the relation between words in a paradigm, base - reduplicants, and base - truncated forms relations (McCarthy and Prince 1995, Benua 1995, 1997).

When considering faithfulness relations in acquisition, the notions 'input' and 'output' are not as straightforward. Direct evidence is available with respect to two types of outputs, i.e. the child's production and the adult production. The scope of the child's 'input' is however, rather vague. In most analyses of acquisition data, it is assumed that the child's input is similar to the adult output (e.g. Smith (1973), but cf. Ingram (1974) for other view). This assumption relies on experimental findings that perception and comprehension precede production (e.g. Locke 1983). These findings do not show that the child's input is identical to the adult output in all phonological representations, but that it implies significant relations between them.

The principles of Richness of the Base (Smolensky 1996b), discussed in §2.2.2, provide explanatory arguments for the disparity between what is assumed to be perceived by the children and what is actually produced. The argument is as follows: in the initial state, markedness constraints outrank faithfulness constraints, and therefore only unmarked forms can surface, regardless of the input. The input itself is not restricted. The only thing that matters is the constraint interaction. Based on this

[8] In fact, this problem often arises in adult grammar as well (see §2.2.2), especially in cases of variation and language change (see §2.4 and §4 below).

principle, analyses of acquisition data can assume that the child's input is similar to the adult output in the absence of evidence to the contrary, and that faithfulness refers to the adult surface structure. In practice, such a view tackles paradoxes only in cases of alternation in adult production (Hayes 1999).

Smolensky (1996a) poses a more complex problem regarding the initial state, known as the *comprehension/production dilemma.* This problem results from one of the basic assumptions of OT, that input and output forms are subject to the same constraint ranking. If one assumes full comprehension of phonological information while production is very partial, how can the same constraint ranking account for both the comprehended and the produced forms? It cannot. According to Smolensky (1996a), different structures compete in comprehension and production: in the former case underlying structures and in the latter surface structures. This issue requires, however, further research and evidence, which are beyond the scope of this work (see Hayes 1999, Smolensky et al. 2001, Escudero and Boersma 2001).

This dissertation deals with faithfulness relations in the context of lexical representation in acquisition, as evidenced in two types of acquisition paths. One path follows the acquisition of single lexical forms, which are assumed to fulfill input-output faithfulness in the final state (i.e. the adult outputs). The other path follows the acquisition of alternating paradigms, where input-output faithfulness is not fulfilled in the final state. I will argue that only the acquisition path of alternation provides insights to faithfulness relations in the course of acquisition, while the investigation of the acquisition path of single forms is limited to the study of child-adult faithfulness relation.

2.3.3 RERANKING IN THE ACQUISITION PATH

Regardless of the different views on the organization of the constraints in the initial state, it is agreed upon that the consecutive phases along the acquisition path are represented by different rankings of certain constraints. These different rankings, as argued in Tesar and Smolensky (1993), result from the **reranking** of conflicting

constraints. The notion and application of reranking have implications beyond language acquisition, since they provide a formal account of the dynamic nature of language and establish this dynamic nature as a component of linguistic knowledge.

Assuming that reranking is an integral component of the linguistic mechanism, a question that arises in this respect is whether reranking is systematic. The answers researches propose to this question are often related to their view on the motivation for change, i.e. for reranking.

In the learning algorithm of Tesar and Smolensky, the **Constraint Demotion** algorithm plays a key role. According to this algorithm, constraints are always demoted below conflicting constraints, never promoted. This proposal is based on the idea that the *violation* of a constraint, rather than its satisfaction, provides the learner with the evidence for reranking. Thus, a violable constraint is demoted. Recall that according to Tesar and Smolensky (1993), in the initial state, all constraints are unranked with respect to each other. This enables reranking to involve the demotion of both markedness and faithfulness constraints. However, according to their later view (see also Demuth 1997, Smolensky et al. 2001), demotion refers to markedness constraints only.

Other models of acquisition, such as those suggested in Gnanadesikan (1995), Levelt (1995), Levelt and Vijver (1998), Ben-David (2001), propose that reranking involves *promotion* of constraints. Since in these models the initial state is characterized by the initial high ranking of markedness constraints, promotion can only refer to faithfulness constraints. Thus, the ranking of the target language is learned by the *satisfaction* of constraints rather than by their violation.

Boersma (1997) proposes an alternative learning algorithm to account for variation in the course of acquisition, suggesting that reranking involves both demotion and promotion of both markedness and faithfulness constraints. According to Boersma, only this mechanism can account for variability in the early stages. In §2.4 I discuss a different account of variation in acquisition.

The view I adopt on reranking is compatible with the rationale of Tesar and Smolensky that violable constraints are demoted, and with Demuth's (1995, 1997) application of this assumption on data from acquisition. Assuming the initial dominance of markedness constraints over faithfulness constraints, I will argue in §3 for a systematic process of reranking involving an exclusive demotion of markedness constraints. It should be emphasized, however, that the controversy over the direction of reranking in acquisition has not yet been resolved.

According to this model, an initial high ranked markedness constraint is demoted below a conflicting faithfulness constraint, if the markedness constraint is violable in the target language. In the example below, the conflict between NOCODA and MAXSEG is demonstrated:

(14) The process of reranking

a. Initial ranking:

MARKEDNESS » FAITHFULNESS

e.g. NOCODA » MAXSEG

Input: $C_1V\mathbf{C_2}$	MARKEDNESS	FAITHFULNESS
	NOCODA	MAXSEG
a. $C_1V\mathbf{C_2}$	*!	
b. ☞ C_1V		*

b. Constant input of syllables with codas evokes **reranking**:

Reranking: NOCODA » MAXSEG → MAXSEG » NOCODA

Input: $C_1V\mathbf{C_2}$	FAITHFULNESS	MARKEDNESS
	MAXSEG	NOCODA
a. ☞ $C_1V\mathbf{C_2}$		*
b. C_1V	*!	

The above example illustrates the conflict within a single pair of conflicting constraints. Recall, however, the example in (13) where three pairs were demonstrated simultaneously. In the initial state, the markedness constraints outrank faithfulness constraints as a group, but in the course of acquisition, they are not demoted as a group. In the course of reranking, it becomes evident which markedness constraint is demoted below which faithfulness constraints. Which of the markedness constraints is

demoted depends on the target language: only in languages which allow codas, NOCODA is demoted, and only in languages which allow clusters, *COMPLEX is demoted. In languages that prohibit codas but allow clusters, only *COMPLEX is demoted, and so on.

In languages where all these three markedness constraints are eventually ranked below faithfulness constraints, not all children necessarily rerank them in the same order. Levelt and Vijver (1998) show different acquisition paths for 12 children acquiring Dutch. The different orders are, however, not completely random. All 12 children produce syllables with codas before syllables with clusters (i.e. NOCODA is demoted before *COMPLEX), and variation among the children is found only in the acquisition path of the more complex syllables. In any case, the reranking of the constraints presented in (13), in a language that allows both codas and clusters is represented as follows:

(15) Reranking pairs of conflicting constraints

a. The initial state: MARKEDNESS » FAITHFULNESS

NOCODA » MAXSEG

*COMPLEX » MAXSEG

b. Reranking: demotion of markedness constraints

i. NOCODA » MAXSEG → MAXSEG » NOCODA

ii. *COMPLEX » MAXSEG → MAXSEG » *COMPLEX

c. The final state: FAITHFULNESS » MARKEDNESS

MAXSEG » NOCODA

MAXSEG » *COMPLEX

In §3, I present evidence from the acquisition of Hebrew for some cases of reranking where markedness constraints are demoted, and others where markedness constraints remain at the top of the hierarchy. The latter are cases of alternation in the final state (i.e. the target language). In §4, I present evidence from adult language

change, involving demotion of markedness constraints. In both §3 and §4, the demotion of markedness constraints is triggered by input data where the demoted constraints are violated. In these sections, the process of reranking is shown to create intermediate grammars involving variation. The representation of these intermediate grammars and the variation involved are discussed in the next section.

2.4 INTERMEDIATE GRAMMARS AND INTER-PHASE VARIATION

The focus of this dissertation is on the variability involved in intermediate grammars in the course of language acquisition (§3) and language change (§4). The term **inter-phase variation,** which is associated here with the variability of intermediate grammar, denotes variation involving change. In this section, I will claim that no additional components beyond those presented so far (i.e. constraint interaction and reranking) are required in order to represent variable grammars. This claim is supported by the empirical data analyzed in §3 and §4.

So far, the terms variation and variability were mentioned with respect to OT only in the context of cross-linguistic variation. In OT, cross-linguistic variation is represented by different (language specific) rankings of universal constraints. The different rankings constitute different grammars. In the current section, as well as in the remainder of this work, variation within a *single* grammar is addressed.

In OT, variation among grammars is reflected by different strict rankings of conflicting constraints. For example, the difference between (a) languages which allow syllables with codas and (b) languages which have only codaless syllables, is represented as two different fixed rankings: (a) MAXSEG **»** NOCODA and (b) NOCODA **»** MAXSEG (see (4) above). A variable grammar with respect to codas is such that the same speaker produces both CV and CVC for the *same* target form.

In a rule-based theory, variability of forms is represented by **optional** rules, and language change is represented by rule addition or rule loss, where lexical restructuring (i.e. a change in the underlying representation) may be, but is not

necessarily, involved (Chomsky and Halle 1968, Kiparsky 1968). Optionality of rules seems to be problematic in several senses. As Antilla (1997b) argues, it is rather random to specify a rule as optional in a certain environment and obligatory in other environments. In addition, as Kisseberth (1970) shows, a rule-based approach lacks the ability to connect between a process – in this case a change – and its cause or goal (see discussion in §2.2.1). Thus, in a rule-based approach the motivation for change is not expressible and the representation of variation is problematic. In what follows I discuss the OT account of variation and change.

In OT, *constraint interaction* accounts for all linguistic phenomena within a single determinate grammar. Prince and Smolensky (1993:51) raise the possibility that a pair of conflicting constraints could hypothetically be **crucially unranked**, where "neither can dominate the other; both rankings are allowed". They point out, however, that in the absence of empirical evidence, they assume that all non-rankings are non-crucial, i.e. equal ranking (see (12)). Nevertheless, it is proposed in several subsequent works (Kiparsky 1993, Reynolds 1994, Antilla 1997b, and others), that natural languages do provide empirical evidence for crucial unranking, that is, in cases of **variation**. For example, variation between CV and CVC in a single grammar of a single speaker is represented in OT as follows:

(16) Crucial non-ranking (marked with '~')

a. The ranking: NOCODA ~ MAXSEG

b. The interpretation: grammar G_i varies with grammar G_j

G_i: [NOCODA **»** MAXSEG] **~ G_j: [**MAXSEG **»** NOCODA]

c. The tableaux (broken line indicates crucial non-ranking)

i. A single representation of the variable grammar

Input: C_1VC_2	NOCODA	MAXSEG
a. ☞ C_1VC_2	*	
b. ☞ C_1V		*

ii. The representation of $\mathbf{G_i}$: NOCODA » MAXSEG

Input: C_1VC_2	NOCODA	MAXSEG
a. C_1VC_2	*!	
b. ☞ C_1V		*!

iii. The representation of $\mathbf{G_j}$: NOCODA » MAXSEG

Input: C_1VC_2	MAXSEG	NOCODA
a. ☞ C_1VC_2		*
b. C_1V	*!	

The above example demonstrates a grammar where the constraints NOCODA and MAXSEG are crucially unranked with respect to each other. Since each of the candidates violates one of the conflicting constraints only once (16ci), the competition between the candidates is not resolved and both are selected as optimal. In other words, crucial non-ranking is a type of constraint interaction that represents a variable grammar. This variability reflects a competition between two grammars ((16cii) vs. (16ciii), where in each only one candidate wins.

It should be noted that in many cases the term *partial ranking* is used instead of *crucial non-ranking* (see Kager 1999). However, the term partial ranking is often associated with cases of long-lasting variation (e.g. Antilla 1997b), probabilities and preferences (Boersma 1997), and variation in the initial state of acquisition where markedness constraints are unranked with respect to each other (Demuth 1997). In this work, I use the term crucial unranking referring specifically to variation involved in the transition from one phase to another in the course of change (cf. Bernhardt and Stemberger (1998) who use the term 'unstable ranking' for this type of variation).[9]

In the subsequent chapters, I will argue that a variable grammar is an intermediate grammar in which reranking is involved. For example, as seen in (15) above, a child acquiring a language with CVC syllables, starts with the crucial ranking of NOCODA above MAXSEG and during the acquisition process, NOCODA is demoted below MAXSEG. In §3, I will show that each case of constraint demotion (i.e. reranking) involves an intermediate phase, in which multiple outputs surface for the same target

[9] It is tempting to suggest a formal distinction between long-lasting variation and variation as a consequence of change. However, this issue requires further research and evidence beyond the scope of this current work, which focuses on only one type of variation.

form. These multiple outputs are termed inter-phase variation. In other words, reranking does not immediately yield an opposite fixed ranking. There is a phase in between. The process is demonstrated below:

(17) Conditions and consequences of an intermediate (variable) grammar

a. Initial state: NoCoda » MaxSeg

Target: CVC Child's output: **CV**

b. Reranking: NoCoda » MaxSeg ↓ →

c. Intermediate phase: MaxSeg ~ NoCoda

Target: CVC Child's output: **CV ~ CVC**

d. Final state: MaxSeg » NoCoda

Target: CVC Child's output: **CVC**

The acquisition data presented in §3 show that intermediate grammars and their consequences, i.e. variation, are evident only where reranking is required. Thus, the variable outputs in the intermediate grammars represent former and subsequent phases. Further examples, explanations, and discussions are provided in §3. Support for the process presented in (17) is provided in §4 through empirical evidence from adult data which indicate language change. In the context of change, variation is addressed with respect to a single variable grammar of a single speaker, and with respect to variation among speakers.

To conclude, I have claimed in this section that variation and change can be accounted for by the same mechanism that accounts for the final-state grammar of a single speaker and for language acquisition. Different constraint interactions represent different linguistic phenomena and reranking represents change.

2.5 SUMMARY

In this chapter, I presented a few cases to illustrate how the mechanism of OT accounts for the principles that govern language universals, cross-linguistic variation, language acquisition, and intermediate grammars.

The essence of the distinction between universal and variable structures in languages is made in OT through the distinction between markedness and faithfulness constraints, and the interaction between them. Markedness constraints refer to structural well-formedness. A structure which respects these constraints is expected to exist in all languages. However, if all and only markedness constraints are always respected, the fundamental requirement for linguistic contrast cannot be achieved. The different ways to achieve contrasts are the source of cross-linguistic variation and are expressed in OT by the different ranking of markedness and faithfulness constraints.

Constraint interaction and the nature of constraints have also been shown to be appropriate for representing phonological alternation as well as the motivation for alternation. This aspect of OT is important when considering phonological phenomena in the course of change, since it provides an explanatory representation of phonological processes.

Grammatical change is represented through the mechanism of reranking. This provides an intrinsic theoretical account of intermediate grammars and variation involved in change. The following chapters propose OT analyses of phonological phenomena of the type discussed above, in the course of language acquisition (§3) and language change (§4).

Chapter 3
VARIABLE AND OPTIMAL GRAMMARS IN LANGUAGE ACQUISITION

This chapter is concerned with intermediate grammars in the course of language acquisition, based on data from the acquisition of Hebrew prosodic structure. *Prosodic structure* refers here to syllable structure, the number of syllables in a word, and the stress pattern. The acquisition of Hebrew prosodic structure is addressed from two interrelated perspectives, the phonological path and the morphological path.

The discussion of the phonological path (§3.2) considers the structural properties of the child's production and the types of disparities between child and adult outputs. The child's grammar throughout this acquisition path is evaluated regardless of the morphological relations between words.

The discussion of the morphological path (§3.3) investigates the acquisition path of alternating paradigms. This acquisition path is viewed differently from the acquisition of single forms, for the following reasons: first, alternation is evident within morphological context, so the interaction between prosodic and morphological properties is crucially relevant. Second, the input-output relation is not limited to child vs. adult productions; the child's lexical representation (i.e. underlying representation) is considered also on the basis of output-output alternation.

Hebrew words, verbs as well as nouns, exhibit a great degree of prosodic alternation conditioned by affixation. However, nouns are inappropriate for the study of alternation in acquisition, due to their range of diversity and lexicalization (see Bat-El 1989). The acquisition path of alternating paradigms can be better captured when considering a relatively restricted and regular system as that of the Hebrew verb inflection. The Hebrew verb inflectional system exhibits a relatively limited morphological set of alternating paradigms, involving regular prosodic alternations. This regularity serves as an appropriate test case for exploring the alternation in

acquisition, and provides another type of evidence for the theoretical issues addressed in this work.

This chapter is organized as follows. §3.1 provides a brief description of the prosodic structures in Hebrew, focussing on verb inflectional paradigms. In §3.2, I present the acquisition path of the prosodic structure, from the initial to the final state, providing an OT account of each phase and of the variation existing in the transitional phases. Section 3.3 reviews the path of acquisition in view of alternating paradigms.

3.1 INTRODUCTION

In this section, I briefly describe the common prosodic patterns in Hebrew, focussing on the verb inflectional system (§3.1.1). This review is followed by an OT account of the Hebrew prosodic structure through the analysis of alternating paradigms within the verbal system (§3.1.2). The sources of the data, on which this research of acquisition is based, are presented in §3.1.3.

The prosodic structure of Hebrew verbs is significantly more restricted than that of nouns and adjectives. This difference derives from the structural nature of the Hebrew verbal system, which consists of only five morphological classes, traditionally termed *binyanim* (see Gesenius 1910, Rosén 1977, Berman 1978, Bat-El 1989, Aronoff 1994 and references cited therein), which are typical of Semitic languages. Every Hebrew verb obligatorily matches one of the binyanim, whereas nouns are not restricted. Bat-El (1994a, to appear) points out that unlike verbs, new nouns that enter the language may introduce new phonological shapes. For example, the noun *faks* 'fax' entered Hebrew as is, however, as a verb it is modified in order to conform to the phonological structure of a binyan, i.e. *fikses* 'to fax' (Bat-El 1994a). Once a verb enters a particular binyan, its inflectional paradigm is predictable and so are the phonological alternations it undergoes (Ornan 1972, Aronoff 1994, Schwarzwald 1996).

Following Bat-El's studies, I view the Hebrew verbal system as a case of principled interaction between phonology and morphology. A formal account of the phonology-morphology interface in the Hebrew verbal system is given in §3.1.2. But first, I review the various prosodic patterns found in the language, focussing on the verbal system.

3.1.1 LANGUAGE BACKGROUND: PROSODIC STRUCTURE IN HEBREW

The inventory of prosodic structures found in Hebrew is relatively restricted. Syllable structure is very limited, length is not distinctive (i.e. there are no long vowels and geminates), and restrictions are posed on tautosyllabic clusters. Complex codas are rather rare, appearing mostly in loan words and in the feminine singular form of verbs in the past tense (e.g. *hala**xt*** 'you [sg. fm.] walked'). Complex onsets, though much more common, are mostly found in word-initial position (Rosén 1973; Bolozky 1972, 1978a; Bat-El 1989). The examples in (1) include nouns with the different syllable structures:

(1) Syllable structure in Hebrew nouns

Onset		Coda	
(C)V		V**C**	
bu.bá	'doll'	ar.náv	'rabbit'
á.ba	'father'	af	'nose'
CCV(C)		CV**C**	
gvi.ná	'cheese'	más.tik	'chewing gum'
psan.tér	'piano'	tar.gíl	'exercise'
CCCV(C) (rare)		CV**CC** (rare)	
štrú.del	'strudel'	neft	'oil'
špric	'splash'	bank	'bank'

My main concern in the current chapter is the prosodic structure of Hebrew words in terms of the number of syllables and the stress pattern. Most Hebrew words consist of two to four syllables, but as shown below, the language includes structures that vary from minimal monosyllabic to quadrisyllabic words.[10]

[10] Forms with five syllables like *ka.ri.ka.tú́.ra* 'caricature' or *ma.te.má.ti.ka* '*mathematics*', and forms with six syllables like *bi.yo.tex.no.ló́g.ya* 'biotechnology' or *tri.go.no.mét.ri.ya* 'trigonometry' also exist, but are rather rare.

As for the stress pattern, most Hebrew words have either ultimate or penultimate stress. Forms with antepenultimate stress exist, but are much less common (see Bat-El 1993, Melčuk and Podolsky 1996, Graf 2001):

(2) Prosodic structure in Hebrew words

Number of Syllables	**Stress pattern**		
	Ultimate	Penultimate	Antepenultimate
1σ	dag 'fish'		
	kof 'monkey'		
2σ	sa.pá 'couch'	sá.ba 'grandpa'	
	bo.kér 'cowboy'	bó́.sem 'perfume'	
3σ	su.kar.yá 'candy'	si.gár.ya 'cigarette'	mú.zi.ka 'music'
	a.vi.rón 'airplane'	miš.ké.fet 'binoculars'	té.le.fon 'telephone'
4σ	hi.po.po.tám 'hippopotamus'	he.li.kóp.ter 'helicopter'	kos.mé.ti.ka 'cosmetics'
	me.la.fe.fón 'cucumber'	ka.du.ré.gel 'football'	po.lí.ti.ka 'politics'

As shown above, the number of syllables and the stress pattern in Hebrew nouns are diverse, exhibiting contrastive structures (see §3.2 below for a disucussion of the acquisition path of these contrastive structures).

The prosodic structure of Hebrew verbs is much more restricted than that of nouns. This is manifested in the number and types of syllables as well as in the stress pattern. The prosodic characteristics of the Hebrew verbal system are described below.

3.1.1.1 The prosodic structure of verb stems: The prosodic structure of every Hebrew verb matches the structure of one of the language's binyanim. These five binyanim are named *paʔal* (B1), *nifʔal* (B2), *hifʔil* (B3), *piʔel* (B4) and *hitpaʔel* (B5).[11] Their structure in the past and the participle forms is presented in (3) below.

[11] It should be noted that traditionally it is proposed that the MH verbal system includes seven binyanim, where the additional ones are *hufʔal* and *puʔal*, the passive forms of *hifʔil* and *piʔel*, respectively (see for example Berman 1978). In this dissertation I follow Horvath (1981) and Bat-El (1989) who do not consider these categories as independent binyanim, since they are regularly derived from *hifʔil* and *piʔel*.

Notice that some of the binyanim consist only of a stem, and others are prefixed. The stems are in bold:

(3) The binyanim in Hebrew (Bat-El 1989; to appear)[12]

	Past		**Participle**	
Binyan	*morphological constituents*	*Surface structure*	*morphological constituents*	*surface structure*
B1 paʔal	**CaCaC**	Ca.CáC ga.már 'finished'	**CoCeC**	Co.CéC go.mér 'is finishing'
B2 nifʔal	n-**iCCaC**	niC.CáC niš.bár 'was broken'	n-**iCCaC**	niC.CáC niš.bár 'is broken'
B3 hifʔil	h-**iCCiC**	hiC.CíC hix.nís 'entered'	m-**aCCiC**	maC.CíC max.nís 'is entering'
B4 piʔel	**CiCeC**	Ci.CéC ki.bél 'received'	me-**CaCeC**	me.Ca.CéC me.ka.bél 'is receiving'
B5 hitpaʔel	hit-**CaCeC**	hit.Ca.CéC hit.la.béš 'dressed up'	mit-**CaCeC**	mit.Ca.CéC mit.la.béš 'is dressing up'

The above table shows that all forms have several prosodic properties in common: (i) all stems are disyllabic and stress is always stem-final; (ii) no verb consists of more than three syllables (i.e. prefix + stem); and (iii) only CV and CVC syllable structures exist. Bat-El (1994a) shows that verbs comprising 5 and 6 consonants, exhibit more complex syllables. These are disyllabic denominative verbs, which preserve all the consonants originating from the nominal base. For example, from the noun ***ps****an.ter* 'piano' derives the verb ***ps****in.ter* 'played a piano' in binyan piʔel (B4). The noun's complex onset is preserved in the verb.[13]

[12] (a) The representation of consonants in this table is schematic only, since Hebrew verbs may consist of more than 3 consonants. (b) The names of the binyanim are historically with the consonant *ʕ*, which is merged in MH with *ʔ*. (c) The numbering of the Binyanim (i.e. B1, B2 etc.) is based on Bat-El (1989) and her subsequent works. In other works (Berman 1978, Aronoff 1994, Schwarzwald 1996) a different numbering system is used.

[13] See further discussion and views regarding Hebrew denominative verbs in Ornan (1972), Schwarzwald (1974) Yannai (1974), Bolozky (1978b, to appear), Fox (1994), and Ussishkin (1999, 2000).

3.1.1.2 The prosodic structure of inflected verbs: Hebrew verb inflection is encoded by affixation, triggering segmental and prosodic alternations in the stems, i.e. vowel lowering and vowel deletion respectively (Bolozky 1978a, Bat-El 1989, 1998, Schwarzwald 1996). Although in this study I only consider the prosodic alternations relevant to prosodic acquisition, examples of various types are provided below in order to establish familiarity with the system (a full presentation of the system is given in the appendix).

Hebrew inflectional suffixes indicate person, gender and number. The type of prosodic alternation is determined by the initial segment of the suffix, whether it is a vowel-initial (e.g. in participle: *–im* 'pl. ms.'), or consonant-initial (e.g. in the past tense: *–ti* '1st. sg.'). Vowel-initial suffixes trigger prosodic alternation (i.e. vowel deletion), whereas consonant-initial suffixes trigger segmental alternation (i.e. vowel lowering). Examples of the former are provided in (4), and of the latter in (5).

(4) Prosodic alternation in inflected verbs with vowel-initial suffixes

Stem	Suffix	Inflected Form	
Ca.CáC ha.láx 'walked'	**-a** past 3rd. sg. fm.	CaC.Cá hal.xá	'she walked'
	-u past 3rd. pl	CaC.Cú hal.xú	'they walked'
Co.CéC ho.léx 'is walking'	**-im** participle pl. ms.	CoC.Cím hol.xím	'are [ms.] walking'
	-ot participle pl. fm.	CoC.Cót hol.xót	'are [fm.] walking'
Ci.CéC xi.pés 'searched'	-a	CiC.Ca xip.sá	'she searched'
	-u	CiC.Cu xip.sú	'they searched'
meCaCéC me.xa.pés 'is searching'	-im	me.CaC.Cím me.xap.sím	'are [ms.] searching'
	-ot	me.CaC.Cót me.xap.sót	'are [fm.] searching'
hit.Ca.CéC hit.la.béš 'dressed'	-a	hit.CaC.Cá hit.lab.šá	'she dressed'
	-u	hit.CaC.Cú hit.lab.šú	'they dressed'
mit.Ca.CéC mit.la.béš 'is dressing'	-im	mit.CaC.Cím mit.lab.ším	'are [ms.] dressing'
	-ot	mit.CaC.Cót mit.lab.šót	'are [fm.] dressing'

In all the forms above, the stem's final vowel is absent in the suffixed form. Stress, in the unsuffixed forms, falls on the stem's final syllable (e.g. *xip**e**ś* 'searched'), but on the suffix in the inflected forms (e.g. *xips**á*** 'she searched'). Notice that vowel deletion allows the prosodic structure of the inflected form to be disyllabic and stress-final, like the stem.

Among the regular verbs (i.e. excluding defective and monosyllabic verbs, which are not discussed here), this alternation does not take place in binyan hifʔil (B3), nor does it occur in forms ending with the feminine participle suffix *-et*. In the case of hifʔil, vowel deletion would result in a sequence of three consonants (e.g. *hilbi͡š* 'dressed' ↛ **hil.bšá,* 'she dressed'), which is always avoided in inflectionally derived structures. There are similar cases in which a sequence of three consonants is avoided through vowel reduction (*o* → *e*) rather than through complete avoidance of change (e.g. *yišb**o**ŕ* 'will [sg. ms.] break'→ *yišb**e**rú* 'will [pl.] break'). Vowel reduction, as well as vowel deletion, are accompanied by stress shift to the right edge. In hifʔil, where neither alternation occurs, stress remains on the stem. Bat-El (1998) proposes that this is due to featural considerations, whereby high vowels are not changeable (i.e. neither deleted, nor reduced, and do not lose stress).

The case of the suffix *-et* (e.g. *holéxet* **holxet* 'is [sg. fm.] walking') is more vague, since there is no straightforward explanation for the exclusion of a form like **holxét* which has the same prosodic structure as *holxót* 'are [pl. fm.] walking'. The suffix *-et* does not seem to follow any general pattern. Instead of triggering vowel deletion and stress shift (like the suffix *-ot*), the stem remains unchanged: the vowel is not deleted and the stress does not shift. In this sense, binyan hifʔil and the suffix *-et*, exhibit a behavior similar to that of verbs with consonant-initial suffixes discussed below.

The following examples show that the attachment of a consonant-initial suffix does not involve prosodic alternation (all the vowels of the stem are present in the inflected form), but rather a vocalic alternation:

(5) Vocalic alternation in inflected verbs with consonant-initial suffixes

Stem	Suffix	Inflected Form	
Ca.CáC ha.láx ‘walked’	**-ti**: past 1st. sg.	Ca.CáC.ti ha.láx.ti	‘I walked’
	-tem: past 2nd. pl.	Ca.CáC.tem ha.láx.tem	‘you [pl.] walked’
hiC.C**í**C hig.díl ‘enlarged’	-ti	hiC.C**á**C.ti hig.dál.ti	‘I enlarged’
	-tem	hiC.C**á**C.tem hig.dál.tem	‘you [pl.] enlarged’
Ci.C**é**C xi.pés ‘searched’	-ti	Ci.C**á**C.ti xi.pás.ti	‘I searched’
	-tem	Ci.C**á**C.tem xi.pás.tem	‘you [pl.] walked’
hit.Ca.C**é**C hit.la.béš ‘dressed’	-ti	hit.Ca.C**á**C.ti hit.la.báš.ti	‘I dressed’
	-tem	hit.Ca.C**á**C.tem hit.la.báš.tem	‘you [pl.] dressed’

In the examples above, all stems’ syllables are present in the inflected forms, but in all cases the stems’ final vowel is lowered to ***a***, and this vowel is stressed. The structures of the inflected verbs in (5) differ from those in (4) in terms of the number of syllables (only disyllabic in (4), and polysyllabic (i.e. more than two syllables) in (5)), and of the stress pattern (ultimate in (4), penultimate in (5)). In addition, only in (4), where vowel deletion occurs, stress shift is triggered. Thus, the forms in (4) and (5) exhibit the following alternating paradigms:

(6) (A sample of) alternating paradigms in the Hebrew inflectional system

	Inflected Forms			
	Vowel-initial suffix		Consonant-initial suffix	
Stem		alternation		alternation
CaC**á**C ha.láx ‘walked’	CaCCá hal.xá	a ~ ∅	Ca.CáC.ti ha.láx.ti	a ~ a
hiC.C**í**C hix.nís ‘entered’	hiC.Cí.Ca hix.ní.sa	i ~ i	hiC.C**á**C.ti hix.nás.ti	i ~ a
CiC**é**C xi.pés ‘searched’	CiC.Cú xip.sú	e ~ ∅	Ci.C**á**C.tem xi.pás.tem	e ~ a
hit.Ca.CéC hit.la.béš ‘dressed’	hit.CaC.Cá hit.lab.šá	e ~ ∅	hit.Ca.C**á**C.ti hit.la.báš.ti	e ~ a

The paradigms presented in (6) are explored in §3.3 where the acquisition process is analyzed in view of alternating paradigms. These paradigms have been chosen because they exhibit regular and straightforward prosodic alternation with respect to the aspects discussed in the acquisition path in §3.2. Furthermore, they appear productively in the children's corpus early enough, before they are fully faithful to the adults' prosodic structure. This provides an opportunity to evaluate child-adult disparities found during acquisition, vs. input-output and output-output disparities found at the *final* state of alternating paradigms.

3.1.2 PHONOLOGY-MORPHOLOGY INTERFACE IN HEBREW VERBAL SYSTEM

The phonology-morphology interface in morphological systems like the binyanim (i.e. templatic morphology) was first expressed within a generative framework in studies on Semitic morphology (McCarthy 1979, 1981) and on reduplication (Marantz 1982). The observations regarding prosodic restrictions on morphological forms led to the introduction of the theory of Prosodic Morphology (McCarthy and Prince 1986, 1990). Within this theory, morphological forms are defined in terms of prosodic constituents, forcing the surface form of each morphological word to respect prosodic requirements for well-formedness.

The basic concepts and principles of Prosodic Morphology are adapted by and integrated into Optimality Theory (McCarthy and Prince 1993a, 2001). Within OT, prosodic units and their interaction with morphological constituents are represented by constraint interaction (McCarthy and Prince 1994a,b). Thus, prosodic templates are too a result of constraint interaction, rather than independent restrictions.

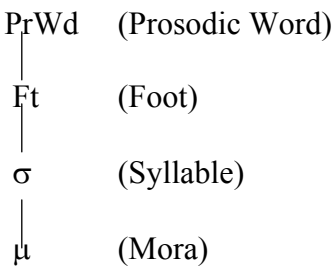
The study of the phonology-morphology interface in Hebrew has notably benefited from the pioneer comprehensive studies of Bat-El (1989, 1994a, to appear), who provides phonological analyses for diverse morphological phenomena in Hebrew, including reduplication (1984), denominative verbs (1994a), acronyms (1994b), blends (1996), vocalic alternation (1998) and truncation (2000, 2001). Bat-El

consistently shows that morphological structure in Hebrew is subject to phonological analysis, and that the analysis is grounded in universal restrictions on structural well-formedness found in various languages, not necessarily Semitic. A similar approach was recently taken by Ussishkin (1999, 2000).[14] In the spirit of these studies, I present below a formal account of the prosodic structure of the Hebrew verbal system, which serves as the basis for the analysis of the acquisition data.

3.1.2.1 A prosodic phonological approach to Hebrew verb structure: According to Bat-El (1989, 1994a, to appear), the Hebrew binyanim are defined in terms of the 'Minimal Word' and syllable structure.

'Minimal Word' (McCarthy and Prince 1986) refers to the preferred structure of a prosodic word, which is defined in terms of the prosodic hierarchy (Selkirk 1980, Nespor and Vogel 1986). According to the prosodic hierarchy, the universal prosodic categories are hierarchically organized, such that the prosodic word dominates a foot, a foot dominates syllables, and a syllable dominates moras, as illustrated below:

(7) The prosodic hierarchy:



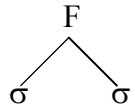
The observation that many languages avoid words smaller than a binary foot, where binarity is satisfied either on the syllabic (8a) or on the moraic (8b) level, led to the notion 'Minimal Word'. Below are the representations of the well-formed foot:[15]

[14] Phonological analyses of topics in Hebrew morphology are also found in Inkelas (1990), Sharvit (1994), Fox (1994), and Dor (1995).

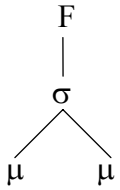
[15] The universal validity of the minimal word is supported by studies such as Prince (1980), Steriade (1982), Itô (1986, 1989), and Mester (1990).

(8) Foot binarity:

a. Syllabic foot:



b. Moraic foot:



Together, the prosodic hierarchy and foot binarity derive prosodic words consisting of two syllables (8a) or two moras (8b). In the Prosodic Morphology framework, McCarthy and Prince (1986, 1990) define morphological templates (such as Semitic binyanim) in terms of the Minimal Word, where the binary foot is not only a minimal prosodic word, but also a maximal prosodic word. Thus, a well-formed prosodic word in Semitic consists of no less and no more than a foot, which must be binary at some level of representation.

Bat-El (1989, 1994a) shows that the Hebrew binyanim are in the form of the Minimal Word in its templatic interpretation, i.e. a Hebrew verb consists of no more and no less than a binary foot. For example, the structure of a verb derived from a noun satisfies the Minimal Word regardless of the prosodic structure of the base (i.e. the noun from which it derives), or the number of consonants it contains. When the base consists of less than two syllables, a syllable is added (e.g. *faks* 'a fax' → *fikses* 'to fax'). When the base consists of more than two syllables, a syllable is omitted (e.g. *telefon* 'a telephone' → *tilfen* 'to phone').[16] According to Bat-El, in the absence of contrastive vowel length and syllable weight in Hebrew, there is no direct evidence that moras play a role in the language's prosody. Foot binarity is hence fulfilled at the syllabic level.

Bat-El (1998) and Ussishkin (2000) show that the Minimal Word requirements play a role not only in Hebrew verb stems, but also in inflected verbs involving suffixation. This approach is discussed below within the framework of OT.

[16] For a full account of the process and other considerations involved, see Bat-El (1994a) and Ussishkin (2000).

3.1.2.2 An OT account of prosodic alternation in Hebrew verbs: The restriction on the number of syllables in the Hebrew verbal system triggers prosodic alternations (i.e. vowel deletion), as described in (4). Vowel deletion is blocked where the result would conflict with other restrictions (i.e. a sequence of three consonants), as described in (5).

In this subsection, I present an OT analysis of the alternations discussed above, in the spirit of Bat-El (1998) and Ussishkin (2000). Because this study deals with these alternations only, and not with other types existing in the system, I will only present the constraints relevant to them.

The markedness constraint responsible for restricting the number of syllables in a prosodic word, is based on the definition of the Minimal Word:

(9) The Minimal Word constraint

PRWD=FTBIN

A prosodic word is a binary foot (under syllabic analysis).

According to PRWD=FTBIN, a prosodic word consists of no more and no less than a single binary foot. In Hebrew this means a disyllabic word (8a). This constraint includes the independent constraint FTBIN, which requires a foot to be binary. The equation PRWD=FT in itself is comprised of a number of **alignment constraints** (McCarthy and Prince 1993b), which refer to the relation between the prosodic word and the foot. These constraints are presented below, although I do not discuss here their independent validity:[17]

(10) The alignment constraints comprising PRWD=FT

a. The prosodic word with respect to the foot:

i. ALIGN PRWD-LEFT Align (PrWd, Left, Ft, Left)

Every prosodic word begins with a foot

[17] See Ussishkin's (2000) analysis of the Hebrew verbal system for evidence of the independent validity of these constraints.

ii. ALIGN PRWD-RIGHT Align (PrWd, Right, Ft, Right)

Every prosodic word ends with a foot.

b. The foot with respect to the prosodic word:

i. ALL-FT-LEFT Align (Ft, Left, PrWd, Left)

Every foot stands at the left edge of the prosodic word.

ii. ALL-FT-RIGHT Align (Ft, Right, PrWd, Right)

Every foot stands at the right edge of the prosodic word.

The following is a hypothetical demonstration of the application of the constraints in (9) and (10), indicating which types of structures violate which of these constraints ('( )' indicates a foot; '[ ]' indicates a prosodic word):

(11) Hypothetical demonstration of Minimal Word constraints[18]

	PRWD = FTBIN	FTBIN	ALIGN PRWD-L	ALIGN PRWD-R	ALL-FT-L	ALL-FT-R
[(σ)]	*	*				
[(σσ)]						
[σσ]	*		*	*		
[(σσσ)]	*	*				
[σ(σσ)]	*		*		*	
[(σ)(σσ)]	*	*			*	**
[(σσ)(σ)]	*	*			**	*
[(σσσσ)]	*	*				
[(σσ)(σσ)]	*				**	**
[σσ(σσ)]	*		**		**	
[(σσ)σσ]	*			**		**

The general constraint PRWD=FTBIN is violated when one of the other constraints is violated. It is fully respected only in the case of a footed disyllabic word.

Throughout this chapter, I assume that all syllables are parsed into feet (e.g. [(σ)(σσ)] rather than [σ(σσ)]), but do not get into the types of parsing (e.g. whether it is [(σ)(σσ)], [(σσ)(σ)], or [(σσσ)]), since they all violate PRWD=FTBIN by violating

[18] Alignment constraints are gradient and violation marks are counted on an n-1 basis see (Kager 1999). For example, violations of alignment of a foot are counted by syllables (i.e. the number of syllables from the edge referred to by the constraint).

at least one of the constraints listed in (10). Therefore, for the sake of simplification, henceforward, I will not indicate feet. Any footing of more (or less) than two syllables violates at least one of the above constraints.

The constraint PRWD=FTBIN conflicts with the faithfulness constraint MAXV, which requires every vowel in the input to be present in the output. In the absence of moras in Hebrew, MAXV equals MAXσ, since every vowel stands for a syllable head. The data in (4) provide evidence for a crucial ranking of PRWD=FTBIN above MAXσ:

(12) **PRWD=FTBIN » MAXσ**

Input: patax-a 'she opened'		PRWD=FTBIN	MAXσ
a.	pa.ta.xá	*!	
b.	pa.tá.xa	*!	
c. ☞	pat.xá		*

A few questions remain, however, regarding other possible candidates: (a) why is the second rather than the first vowel omitted, i.e. why not **ptaxa*? and (b) why is stress ultimate rather than penultimate, i.e. why not **paíxa*? Following Bat-El (1994a, 1998), **ptaxa* is excluded since in Hebrew verbs complex onsets are ill-formed, unless they derive from a nominal base including a cluster which is to be preserved. A constraint against complex onset is therefore required ((13ai) below). It should be noted, however, that this constraint does not cause the deletion of one of the consonants. Therefore, a faithfulness constraint requiring all the input consonants to surface is necessary as well (13aii). Bat-El (1995) shows that in the Hebrew verbal system, the preservation of input consonants is more crucial than the preservation of input vowels. This observation is reflected by the constraint interaction in ((14) below).

According to Bat-El (1989, 1993), Ussishkin (2000) and Graf (2001), stress in Hebrew is ultimate. It is, however, penultimate in cases like *pataxti* 'I opened' (5). The form *pataxti* also violates the high ranked constraint PRWD=FTBIN, as it consists of three syllables. The additional constraints required to exclude the ill-formed candidates for *patxá* (12), and to account for forms like *pataxti*, are definedin (13):

(13) Additional constraints

a. Constraints referring to consonants

i. Markedness constraint:

***$_{\sigma}$[CC**

No complex onset.

ii. Faithfulness constraint:

MAXC

Every consonant in the input has a correspondent in the output

i.e. consonants should not be deleted.

b. Markedness constraints referring to stress[19]

i. **RIGHTMOST** Align (σ́, R, PrWd, R)

The stressed syllable is rightmost in the prosodic word.

ii. ***LAPSE**

Adjacent unstressed syllables are prohibited.

These constraints interact with each other and with PRWD=FTBIN as follows:

(14) Constraint interaction: crucial rankings

MAXC **»** PRWD=FTBIN

*LAPSE **»** MAXV (=σ)

PRWD=FTBIN **»** MAXV

*$_{\sigma}$[CC **»** MAXV

*LAPSE **»** RIGHTMOST

The tableau below demonstrates how these interactions account for the data in (4), where only disyllabic forms surface:

[19] Adapted from Ussishkin (2000:66, 80) who argues for the relevance of these constraints to the Hebrew verbal system.

(15) Disyllabic inflected verbs (data in (4))

Input: patax-a		*LAPSE	MAXC	*σ[CC	RIGHT MOST	PRWD =FTBIN	MAXV
a.	pa.ta.xá	*!				*	
b.	ta.xá		*!				*
c.	pta.xá			*!			*
d.	pa.tá.xa				*!	*	
e.	pát.xa				*!		*
f. ☞	pat.xá						*

The first three candidates (a-c) are ruled out for violating one of the highest ranked constraints. Candidate (a) violates *LAPSE since its first two adjacent syllables are unstressed, i.e. ***pa.ta**.xá*. Candidate (b) violates MAXC since the input consonant *p* is missing in the output, and candidate (c), having an initial cluster, violates *σ[CC (***pt**axá*). Candidates (d, e) are ruled out for violating RIGHTMOST. Candidate (f) wins since it violates only the lowest ranked constraint, namely MAXV. The tableau in (16) below shows how the same ranking of these constraints accounts for trisyllabic verbs as well:

(16) Trisyllabic inflected verbs (data in (5))

Input: patax-ti		*LAPSE	MAXC	*σ[CC	RIGHT MOST	PRWD =FTBIN	MAXV
a.	pa.tax.tǐ	*!				*	
b.	tax.tǐ		*!				*
c.	táx.ti		*!		*		*
d.	ptáx.ti			*!	*		*
e.	pat.xtǐ			*!			*
f. ☞	pa.táx.ti				*	*	

Trisyllabic verbs surface when vowel deletion causes the violation of constraints which are ranked higher than PRWD=FTBIN. Candidate (b), even though it has exactly the same prosodic structure as the optimal candidate in (15), is nevertheless ruled out as it violates the high ranked constraint MAXC. Candidate (f) is the only candidate that does not violate any of the highest ranked constraints. Therefore, it is the optimal candidate although it violates both RIGHTMOST and PRWD=FTBIN.

The data discussed in this section are re-addressed in §3.3 with respect to acquisition. In the following sections, I follow the interaction between the constraints presented above in the course of the acquisition of Hebrew prosodic structure. Most of the constraints presented here are also directly relevant to the initial state of prosodic acquisition, and they all appear to be relevant along the acquisition path. It will be argued that markedness constraints, which are obligatorily demoted in order to produce Hebrew nouns (§3.2), are not demoted when it comes to verbs (§3.3). Evidence for this claim, and its developmental and theoretical implications are provided throughout the chapter.

3.1.3 DATA SOURCE

The acquisition data considered in the subsequent sections of this chapter consist of published as well as unpublished sources. Considering the difficulties involved in the documentation of phonetic and phonological properties of children's speech, my analysis is based on data taken from several sources. The data is considered to be reliable evidence only if the same pattern or structure is found in more than one source.

The major part of the Hebrew data presented in this chapter is taken from (i) published studies on the acquisition of Hebrew, mainly Dromi (1987), Armon-Lotem (1997), Berman and Armon-Lotem (1997), and Ben-David (2001); (ii) two databases provided to me by Esther Dromi (Tel-Aviv University); and (iii) a database provided to me by Ruth Berman (Tel-Aviv University).

The first of Dromi's databases includes data of her son Or, collected between the ages 1;4-2;0. Or's data, which were recorded, transcribed and analyzed acoustically (see Dromi et al. 1993), are used in this work to account for the initial state (§3.2.1). The second Dromi's database includes spontaneous data as well as data elicited by structured tests, from 15 normally developing children between the ages 2;6-3:6. These data are taken from a cross-linguistic study, which focusses on the inflectional morphology of children with specific language impairment compared to that of

normally developing children. The study was directed by Laurence Leonard (Purdue University) and Esther Dromi (see Dromi et al. 1999, 2002, and Leonard et al. 2000).[20] The data of the **normally** developing children are used here for my study of the phonology-morphology interface in the acquisition of Hebrew verb inflection (§3.3).

The database provided to me by Ruth Berman (Tel-Aviv University), includes longitudinal data of four children, collected between the ages 1;06-3;00. The data were collected by the Language Acquisition Project in Tel-Aviv University for a cross-linguistic study directed by Ruth Berman and Juergen Weissenborn (MPI, Nijmegen) (see Berman and Weissenborn 1991, and Armon-Lotem 1997).[21] The data from this project are used for my study of the phonology-morphology interface in the acquisition of Hebrew verb inflection (§3.3).

Additional data for the initial state (i.e. the first words discussed in §3.2.1) were collected during my work on this dissertation from two girls: Noga, between the ages of 1;3-2;0 and Yuli between the ages of 1;6-2;0, and one boy: Yonatan, between the ages 1;4-1;10. The data from Noga and Yuli were collected by their parents, under my instructions and close supervision. The data from Yonatan (my nephew) were collected by me.[22]

3.2 THE PROSODIC WORD IN THE ACQUISITION PATH

[20] The project was supported by NIH grant no. 5 R01 DC 00 458.
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This section focusses on the acquisition path of Hebrew prosodic structure, regardless of alternation in morphological contexts. The acquisition data are viewed with respect to the target forms, focussing on the disparities between the child and the adult outputs.

It will be shown in §3.2.1 that in the initial state, the child's prosodic structure lacks any of the prosodic contrasts existing in the target language (see §3.1.1), as only monosyllabic words surface. The acquisition path discussed in §3.2.2 indicates that the extent of the child-adult disparities gradually decreases as the number of prosodic contrasts increases in the child's outputs. These child-adult disparities are claimed to be a consequence of the interim dominance of unmarked structures in the child's production. I argue in this section that the child's outputs differ from the adult's outputs only in the degree of markedness. The child's outputs will be shown to be less marked than the adult's outputs (see §2.3 for the discussion of this claim). Section 3.2.3 is devoted to the transition phases along the acquisition path. In it, I discuss the dynamics of the development from one phase to another, and the variation involved in the process.

3.2.1 THE INITIAL STATE

The term 'initial state' in acquisition will henceforward refer to the children's first **outputs**, which are perceived as words existing in the target language. This is obviously not the initial state in acquisition (see §2.3.1), but these forms serve as the first evidence available for the prosodic analysis of raw data.

It has been reported in studies on the early acquisition, that the first words children produce are, in most cases, monosyllabic and codaless (see Ingram (1989) for English, Fikkert (1994) for Dutch, Demuth and Fee (1995) for Dutch and English, Garrett (1998) for Spanish, Grijzenhout and Joppen (1999) for German, and Ben-David (2001) for Hebrew). Monosyllabic codaless outputs are very simple to describe, but not as simple to explain. Firstly, where the child's output relates to polysyllabic target

forms, which of the target syllables is produced, and which are omitted (see Gerken 1994, Kehoe and Stoel-Gammon 1997)? Secondly, if the acquisition path begins with unmarked structures (§2.3), are monosyllabic monomoraic words unmarked with respect to the Minimal Word (see (8) in §3.1.3.1), which appears only at a later stage (see Demuth 1995, Demuth and Fee 1995, Garrett 1998)? These questions are addressed below.

3.2.1.1 The first words in the acquisition of Hebrew: Studies on early acquisition show **consistent** faithfulness to the input's stressed syllable (Garret 1998) and/or final syllable (Berman 1977, Faingold 1990, Fikkert 1994, Ben-David 2001). Faithfulness to the stressed and final syllables and omission of unstressed non-final syllables in early acquisition is often associated with perceptual saliency (e.g. Ingram 1974, Peters 1977, 1983, Echols 1987, Cutler 1990, Echols and Newport 1992). That is, the child's faithfulness to stressed and/or final syllables is explained by their perceptual saliency as opposed to non-final and/or unstressed syllables. And yet, my research's findings (presented in (17) below) indicate that among the first words children produce, there are monosyllabic words whose faithfulness to the target forms is prosodically indeterminate. That is, in some words, the children produce the stressed syllable, in other words they produce the final (unstressed) syllable, and in others still, neither the stressed nor the final syllable (i.e. the unstressed and non-final syllable is produced):

(17) Monosyllabic words in the first productions:

Faithfulness to *final* syllable				Faithfulness to *non-final* syllable				
Stressed		Unstressed		Stressed		Unstressed		
Child	Target	Child	Target	Child	Target	Child	Target	
bú	bak**bú**k ‘bottle’	bú	óto**bu**s ‘bus’	bá	**bá**mbi ‘Bambi’	bá	**ba**lón ‘ballon’	Or 1;4-1;5
bá	bu**bá** ‘doll’	tá	sávt**a** ‘grandma’	ná	**ná**al ‘shoe’			
dá	to**dá** ‘thanks’			bú	d**ú**bi ‘Teddy bear’			
tú	xi**tú**l ‘diaper’			pú	**plú**to ‘Pluto’	bá	**ba**lón ‘balloon’	Yuli 1;5-1;6
bá	bu**bá** ‘doll’			tú	**tú**tim ’straw-berries’	pá	**pa**rá ‘cow’	
						gá	gamád ’dwarf’	
						ká	**ka**dúr ‘ball’	
bá	bu**bá** ‘doll’	ká	múzika ‘music’	má	**má**im ‘water’	ká	**ka**dúr ‘ball’	Noga 1;3-1;4
tú	xi**tú**l ‘diaper’					ká	**ka**pǐt ‘spoon’	
pú	ta**pú**z ‘orange’	ám	rá’**am** ‘thunder’	má	**má**im ‘water’	bá	**ba**rák ‘lightning	Yonatan 1;3-1;6
kú	kiš**ú** ‘zucchini’	ká	múzika ‘music’			ká	**ka**létet ‘cassette’	

The children’s first words are limited to one syllable, regardless of the number of syllables in the input, showing no evidence of prosodic contrast in the child’s grammar. The child is faithful to one of the target syllables, but this may be either the **stressed** syllable (e.g. *bá* for ***ba****mbi* ‘Bambi’), the **final unstressed** syllable (e.g. *bú* for *óto****bu****s* ‘bus’), or *the* **initial unstressed** syllable (e.g. *ka* for ***ka****dúr* ‘ball’). So while the output is prosodically consistent (monosyllabic), the child-adult relation does not seem to be consistent with any noticeable prosodic principle.

The only consistency observed at this stage is, in fact, segmental: it appears that the only vowels the children produce are *a* (low) and *u* (high rounded) and that these vowels are consistently faithful to those of the target syllables they choose to produce.

For example, Or produces *ba* for *baloń* 'balloon' (unstressed non-final), for *baḿbi* 'Bambi' (stressed non-final) and for *bubá* 'doll' (stressed and final). This example indicates that the child-target relations are affected, at this stage, by the vowels' segmental features, rather than by the word's prosodic structure, such as stress or word edges.

For the purposes of this study, I will not elaborate on the segmental issue, as my analysis concentrates on prosodic structure. However, it should be noted that the data in (17) is consistent with Levelt's (1994) arguments for the dominance of vowel features in early acquisition and for their relation with higher prosodic levels, such as the syllable and the prosodic word. Interaction between segmental features and prosodic faithfulness in early acquisition is explored in several earlier studies as well, although the proposed analyses concentrate on the consonants' rather than the vowels' features (see Macken 1979).

The data in (17) do not bear evidence of prosodic structure or prosodic contrast, since only one syllable surfaces for each target form, and the relation between this syllable and the target form is prosodically unpredictable. In §3.2.2, I show that the target forms' stressed and final syllables are indeed dominant in children's productions, but only when disyllabic forms are being produced alongside monosyllabic forms. Therefore, I claim that consistent faithfulness to target syllables is preceded by the phase discussed above, where prosodic faithfulness is indeterminate.

The following subsection addresses the theoretical question regarding the representation of monosyllabic words in early acquisition, and the way it is expressed within OT.

3.2.1.2 The initial prosodic word: The data in (17) show that children's prosodic words are monosyllabic at the onset of their prosodic development. This finding seems to contradict the basic assumptions presented earlier: (i) the disparities between the children's productions and the target forms exhibit unmarked constituents (§2.3);

and (ii) the unmarked prosodic word consists of a binary foot, namely the Minimal Word (§3.1.3.1).

Demuth and Fee (1995) propose that the initial prosodic word is a sub-Minimal Word, suggesting that children do not possess foot structure at this stage. That is, the syllable is parsed directly by the prosodic word rather than by a foot (see also Demuth 1996a, b). Following this view, monosyllabic words are not necessarily marked. Given that binarity is a requirement on the well-formedness of the foot, in the absence of a foot, binarity is not violated. What is violated in this case is the prosodic hierarchy, as the syllable is directly dominated by the prosodic word rather than by a foot. Such a violation is not unique to child language. Itô and Mester (1992) introduce the notion *weak layering* in this context, arguing for cases in which syllables are parsed by the prosodic word, rather than by the foot. These cases, however, are a consequence of a competition between the prosodic hierarchy requirements, and other requirements on the well-formedness of the prosodic word.

Within the framework of OT, all phases of acquisition are expressed by constraint interaction, including that which allows only monosyllabic words to surface. Recall that the Minimal Word is achieved in OT not through a single constraint, but through a number of alignment constraints (see (10) in §3.1.3.2), some of which are in conflict. Similarly, the direct domination of the prosodic word over the syllable (rather than over the foot) is achieved through alignment constraints requiring the right and left edges of a syllable to be aligned with the right and left edges of a prosodic word (McCarthy and Prince 1993b). These constraints conflict with alignment constraints which define the prosodic hierarchy (e.g. Align **PrWd**, L/R, **Ft**, L/R (10a)).

I follow Demuth's (1995) formulation of these constraints, whereby a single constraint is composed of alignment constraints and defines the prosodic word as monosyllabic. The formulation below is consistent with the Minimal Word constraint ((9) in §3.1.3.2) presented above: [23]

[23] See a similar application of this constraint in Garrett (1998).

(18) The monosyllabic prosodic word

PRWD=σ

A prosodic word is a syllable.

The children's data provide evidence for an initial ranking of this constraint above MAXσ, which requires identity in the number of syllables in the input and the output. This ranking is demonstrated below:

(19) Monosyllabic outputs

a. The ranking:

PRWD=σ » MAXσ

b. Adult's output (= child's input): dúbi Child's output: dú

Input: Dúbi	MARKEDNESS	FAITHFULNESS
	PRWD = σ	MAXσ
a. dú.bi	*!	
b. du.bǐ	*!	
c. ☞ bí		*
d. ☞ dú		*

As discussed in §3.2.1.1 above, segmental considerations would select candidate (d) and not candidate (c). But as far as prosodic structure is concerned, both are equally optimal. The disyllabic candidates (a) and (b) are ruled out at this phase by the highest ranked constraint. Disyllabic words and the emergence of the foot are possible only if reranking takes place, and PRWD=σ is outranked by MAXσ.

The following subsection tackles the question of the initial ranking of PRWD=σ with respect to PRWD=FTBIN. I argue that initially, these constraints are equally ranked together with the constraints referring to stress. The ranking of all these markedness constraints above MAXσ cannot allow the production of more than one syllable in a prosodic word.

3.2.1.3 The initial ranking: To conclude this section, I summarize the constraints which are relevant to the discussion that follows, and the initial ranking of the

conflicting constraints. In (20) and (21) I list the constraints that will be pursued along the acquisition path, and present in (23) the initial ranking as reflected by the first words produced by children acquiring Hebrew (see (17)):

(20) Markedness constraints:

a. The prosodic word

PRWD=σ	A prosodic word is a syllable.
PRWD=FTBIN	A prosodic word is a binary foot (syllabic in Hebrew).

b. Stress

RIGHTMOST	The stressed syllable is rightmost in the prosodic word.
LEFTMOST	The stressed syllable is leftmost in the prosodic word.
*LAPSE	Adjacent unstressed syllables are prohibited.

The stress constraints LEFTMOST and RIGHTMOST (first presented in (13)) are included above, although no evidence for either of them has been shown yet. In the initial state, in which only monosyllabic words surface, there cannot be any direct evidence for the actual ranking of stress constraints. Direct evidence for their ranking with respect to each other and with respect to other constraints is available only when disyllabic forms begin to surface (§3.2.2.1 below). However, given that they conflict, only a monosyllabic prosodic word satisfies both of them. The tableau below demonstrates the ranking of the constraints in (20), where all markedness constraints are equally ranked, and they all outrank the faithfulness constraint MAXσ:

(21) Adult's output (= child's input): dúbi Child's output: du

Input: Dúbi	MARKEDNESS				FAITHFULNESS
	RIGHT MOST	LEFT MOST	PRWD = σ	PRWD = FTBIN	MAXσ
a. dú.bi	*		*!		
b. du.bǐ		*	*!		
c. ☞ bi				*	*
d. ☞ du				*	*

The tableau shows that in the initial state, monosyllabic words cannot provide evidence for crucial ranking between the different markedness constraints. Disyllabic

outputs are ruled out since they bear two violations, while the monosyllabic candidates bear only one.

When polysyllabic words begin to surface, RIGHTMOST and LEFTMOST interact with a faithfulness constraint more specific than MAXσ, i.e. FAITHTσ́, which requires the stressed syllable of the input (i.e. of the target form) to be present and stressed in the output. The following lists the faithfulness constraints that conflict with the markedness constraints in (20):

(22) Faithfulness constraints

MAXσ	Every syllable in the input has a correspondent in the output (i.e. input syllables are not deleted).
FAITHσ́	The stressed syllable in the input is **present and stressed** in the output.

In the absence of long vowels in Hebrew, faithfulness to a syllable is equivalent here to faithfulness to a vowel. Thus, MAX**σ** = MAX**V**, and FAITH**σ́** = FAITH**V**. MAXσ and FAITHσ́ differ in that FAITHσ́ relates to a specific syllable, i.e. the input's stressed syllable (namely, the stressed vowel), whereas MAXσ relates only to the number of syllables. For example, when a child produces *ba* for *bubá* (18) only MAXσ is violated. But when *ba* is produced for *balón*, both MAXσ and FAITHσ́ are violated. In both cases, neither RIGHTMOST nor LEFTMOST are violated. The initial ranking is therefore as follows:

(23) The initial ranking

a. Pairs of conflicting constraints

PRWD=σ » MAXσ	(MARKEDNESS » FAITHFULNESS)
PRWD=FTBIN » MAXσ	(MARKEDNESS » FAITHFULNESS)
*LAPSE » MAXσ	(MARKEDNESS » FAITHFULNESS)

b. No evidence for ranking

RIGHTMOST, LEFTMOST

PRWD=σ, PRWD=FTBIN

RIGHTMOST, LEFTMOST, FAITHσ́

In each of the conflicting pairs above, faithfulness constraints are outranked by markedness constraints. This ranking will be pursued in the acquisition path presented throughout this section.

In what follows I will show the acquisition path of Hebrew prosodic words, up until the final state. The phases I propose are as follows: *Pre-Minimal Word*, where disyllabic words surface alongside monosyllabic words (§3.2.2.1); *The Minimal Word*, where only disyllabic words surface (§3.2.2.2); and the transition from the Minimal Word to the final state, where all prosodic structures existing in the language surface (§3.2.2.3).

3.2.2 THE ACQUISITION PATH OF HEBREW PROSODIC WORDS

The acquisition path of prosodic structure is described in several studies on prosodic development as the gradual expansion of the prosodic word in terms of the number of syllables, the syllable structure, and the stress pattern (see Fikkert 1994, Demuth and Fee 1995, Demuth 1995, and Ben-David 2001). This gradual expansion represents, in fact, the gradual acquisition of the contrasts existing in the target language.

Following earlier studies (Allen and Hawkins 1978, 1980, Fikkert 1994, Gerken 1994, Archibald 1995), I will show that the number of syllables and the stress pattern are closely interrelated throughout the acquisition path. In the pre-Minimal Word phase (§3.2.2.1), disyllabic words surface only with penultimate stress. In the Minimal Word phase (§3.2.2.2), maximally disyllabic words surface, with penultimate as well as ultimate stress. In the subsequent phases (§3.2.2.3), I will show that trisyllabic words with penultimate stress surface prior to trisyllabic words with ultimate stress.

Within the theoretical framework adopted in this study, the prosodic contrast, and the interaction between prosodic structure and the stress pattern, are described in

terms of constraint interaction (§2.3). The expansion of prosodic structure during acquisition is described and explained as a consequence of constraint reranking. The interaction between prosodic structure and the stress pattern is represented by the interaction between the markedness constraints presented so far (i.e. PRWD=σ and PRWD=FTBIN) and the constraints referring to the position of stress (i.e. RIGHTMOST, LEFTMOST and FAITHσ́).

3.2.2.1 The pre-Minimal Word phase: In the phase discussed in §3.2.1, monosyllabic words are exclusively produced and child-target relation is prosodically indeterminate. This is followed by a phase exhibiting more diverse structures and a determinate child-target relation. This phase provides evidence for the first prosodic contrast in the children's grammar. The data below represent the phase where disyllabic words (24b) surface in addition to monosyllabic words (24a), and indicate that the syllables the children produce are consistently faithful to the stressed and final syllables of the target forms:[24]

(24) First prosodic contrasts

a. Monosyllabic words

Child: σ	Target		
dúr	ka.**dúr**	2σ	'ball'
yón	ba.**lón**		'balloon'
bón	sa.**bón**		'soap'
gór	lis.**gór**		'to close'
xél	o.**xél**		'is eating'
ón	a.vi.**rón**	3σ	'airplane'
ká	ne.ši.**ká**		'kiss'
dér	le.sa.**dér**		'to arrange'
tám	hi.po.po.**tám**	4σ	'hippopotamus'

b. Disyllabic words

Child: σ́σ	Target

[24] The transcription authentically includes segmental disparities between the child's outputs and the target forms. For example, the absence of initial onsets (e.g. *uka* for *muzika*), and the violation of consonant identity (e.g. *fefe* for *sefer*). However, in my analysis, which concentrates on prosodic constituents, I ignore all segmental disparities (see Ben-David (2001) for a detailed account of segmental acquisition in Hebrew).

fé.fe	sé.fer	2σ	σ́σ	‘book’
é.rer	své.der			‘sweater’
ná.na	ba.**ná.na**	3σ	σσ́σ	‘banana’
é.tet	šar.š**é.ret**			‘necklace’
dé.det	la.**ré.det**			‘to get down’
ká.xat	la.**ká.xat**			‘to take’
é.vet	la.**šé.vet**			‘to sit’
é.xet	la.**lé.xet**			‘to walk’
gó.ax	lif.**tó.ax**			‘to open’
té.fon	**té**.le.**fon**		σ́σσ	‘telephone’
ú.ka	**mú**.zi.**ka**			‘music’
bé.de	**bé**.ga.le			‘bagel’
ká.do	a.vo.**ká.do**	4σ	σσσ́σ	‘avocado’
tí.na	kle.man.**tí.na**			‘tangerine’

The data in (24) show progress with respect to the initial state in two aspects. First, the prosodic structures of words produced by the children are diverse: the forms in (24a) are monosyllabic, and those in (24b) are disyllabic. Second, a determinate and consistent relation exists between the target and the output forms: the children’s outputs, whether monosyllabic or disyllabic, are faithful to both the stressed and the final syllables of the target. For example, in (24a) the child produces the syllable *dúr*, which is both stressed and final in the input (i.e. the target) *ka.**dúr***. In (24b) the child produces the syllables *é.tet*, which are the stressed and the final syllables of the input *šar.**šé.ret***.

The data in (24) show evidence of prosodic contrasts in the children’s grammar, which were not evident in the initial stage (17). The most significant change relates to the number of syllables in the children’s outputs. In order to produce disyllabic forms such as those in (24b), PRWD=σ needs to be demoted below MAXσ. However, if PRWD=σ is ranked below MAXσ, why does the data in (24a) include only monosyllabic words? The answer to this question has to do with the interaction of the stress constraints with the other constraints. This will be further elaborated below. Before that, I address the consistent faithfulness of the children’s outputs to the target forms’ stressed and final syllables.

The consistent faithfulness to the stressed syllable can be simply explained by the

high ranking of FAITHσ́, which causes the stressed syllable to surface (cf. the segmental choice in (17)). The disyllabic forms in (24b) provide evidence for the crucial ranking of FAITHσ́ above RIGHTMOST. For example, the target word *banána* is produced as *nána* and not **baná*. Notice that *baná* does not violate FAITHσ́, only LEFTTMOST.

In addition, there is consistent faithfulness not only to the stressed syllable, but also to the final one. For example, the output for *mú.zi.ka* is *ú.ka*, and not **ú.zi*, although *u.ká* does not preserve the input's sequence of syllables.[25] This is consistent with Garrett (1998) and Ben-David (2001), in which children's outputs are more faithful to certain positions than others, implying the relevance of **positional faithfulness** proposed by Beckman (1997). While Beckman suggests the constraint MAX-POSITION, the positional faithfulness constraint I use is more general, and belongs to the **anchoring** family of constraints (McCarthy and Prince 1995, 1999):

(25) Faithfulness by position:

ANCHOR-Rσ

Any syllable at the right edge of the input has a correspondent at the right edge of the output

i.e. no deletion or insertion of segments at the right edge.[26]

It turns out, then, that the demotion of PRWD=σ below MAXσ (which enables the production of disyllabic words), reveals the faithfulness priorities, which were not evident as long as only monosyllabic words could surface. The data in (24b) provide evidence for the crucial ranking of ANCHOR-Rσ (in addition to FAITHσ́) above RIGHTMOST. The conflict between these constraints results from the requirement of

[25] Grijzenhout and Joppen (1999) and Ben-David (2001) show evidence from German and Hebrew respectively, for the high ranking of segmental CONTIGUITY in early acquisition. However, Ben-David provides evidence that prosodic considerations, such as faithfulness to the final syllable, have priority over CONTINGUITY. In the current study, I do not elaborate on the discussion of this constraint, as it is heavily based on the interaction between segmental and prosodic constituents, which is beyond the scope of this work.

[26] Notice that ANCHOR-Rσ, in fact, comprises MAXσ and DEPσ at a specific prosodic position (i.e. the right edge of the prosodic word). Therefore, deletion or insertion of segments at the right edge of the word violates ANCHOR-Rσ.

ANCHOR-Rσ to preserve the input's final syllable whether it is stressed or not. That the final syllable is preserved in words like *fefe* for *sefer*, even though this violates RIGHTMOST, indicates that ANCHOR-Rσ is dominant. The rankings of the pairs of constraints which account for the disyllabic outputs are provided in (26) below, and are followed by a demonstration of the dominance of the prosodic faithfulness constraints in the child's grammar, as evidenced from the data in (24).

(26) Ranking

MAXσ » PRWD=σ	(as a consequence of reranking)
FAITHσ́ » RIGHTMOST	(new evidence for ranking)
ANCHOR-R » RIGHTMOST	(new evidence for ranking)
PRWD=FTBIN » MAXσ	(no change from (23))

(27) The dominance of stressed and final syllables in (24b)

a. Disyllabic output for disyllabic penultimate input

Target (=child's input): σ́σ Child's output: σ́σ

Input: séfer		F		M		F	M
		FAITH σ́	ANCHOR-Rσ	RIGHT MOST	PRWD= FTBIN	MAXσ	PRWD = σ
a.	se.fér	*!					*
b.	fér	*!			*	*	
c.	sé		*!		*	*	
d. ☞	sé.fer			*			*

b. Disyllabic output for trisyllabic penultimate input

Target (=child's input): $\sigma_1\acute{\sigma}_2\sigma_3$ Child's output: $\acute{\sigma}_2\sigma_3$

Input: šar.šé.ret		F		M		F	M
		FAITH σ́	ANCHOR Rσ	RIGHT MOST	PRWD= FTBIN	MAX σ	PRWD = σ
a.	šar.šé.ret			*	*!		**
b.	šár	*!	*		*	**	
c.	šé		*!		*	**	
d.	rét	*!			*	**	
e.	še.rét	*!				*	*
f. ☞	šé.ret			*		*	*

c. Disyllabic output for trisyllabic antepenultimate input

Target (=child's input): σ́$_1$σ$_2$σ$_3$ Child's output: σ́$_1$σ$_3$

Input: télefon		F		M		F	M
		FAITHσ́	ANCHOR-Rσ	RIGHTMOST	PRWD=FTBIN	MAXσ	PRWD=σ
a.	té.le.fon			**!	*		**
b.	té		*!		*	**	
c.	lé	*!	*		*	**	
d.	te.lé	*!	*			*	*
e.	te.fón	*!				*	*
f.	té.le		*!	*		*	*
g. ☞	té.fon			*		*	*

The tableaux above show that at this stage words are restricted to maximal disyllabic forms, due to the dominance of PRWD=FTBIN over MAXσ. All outputs, both the monosyllabic (24a) and the disyllabic (24b) are faithful to the stressed and final syllables of the input (i.e. the target form), due to the dominance of FAITHσ́ and ANCHOR-Rσ. However, this does not explain why the data in (24a) include only monosyllabic words. The following tableau demonstrates the problematic application of the above ranking to the data in (24a):

(28) Monosyllabic outputs (24a)

Target (=child's input): σ$_1$σ$_2$σ́$_3$ Child's output: σ́$_3$

Input: avirón		F		M		F	M
		FAITH σ́	ANCHOR-Rσ	RIGHTMOST	PRWD=FTBIN	MAXσ	PRWD=σ
a.	a.vi.rón				*!		**
b.	á	*!	*		*	**	
c.	ví	*!	*		*	**	
d. √	rón				*!	**	
e.	ví.ron	*!		*		*	*
f.	á.vi	*!	*	*		*	*
g. ☞✕	vi.rón					*	*

'√'= actual form; '☞✕'= optimal but not actual form

The tableau shows that the optimal candidate is *virón* (g). However, the actual form produced by the children at this phase is *ron* (d). This implies that the monosyllabic outputs in (24a) do not result from a direct restriction on the number of syllables, but rather on the stress pattern. The form *virón* (as opposed to *sefer*) is avoided in the children's production not because it is disyllabic, but because its stress

is not initial, namely violating LEFTMOST.

In (23b), I argued for the absence of evidence for the ranking of the stress constraints. The data in (24b) provide evidence for the crucial ranking of RIGHTMOST below FAITHσ́ and ANCHOR-Rσ. The data in (24a) indicate that LEFTMOST is also ranked below FAITHσ́ and ANCHOR-Rσ, otherwise, a candidate like (e) in (28) – *vír̆on* for *avirón* – could surface. But that *virón*, which does not violate either FAITHσ́ or ANCHOR-Rσ, is ruled out, indicates that LEFTMOST is crucially ranked above PRWD=FTBIN, restricting the child's output to monosyllabic words, unless the input's stress in penultimate:

(29) Evidence for LEFTMOST » PRWD=FTBIN

Target (=child's input): $\sigma_1\sigma_2\acute{\sigma}_3$ Child's output: $\acute{\sigma}_3$

Input: avirón		F		M			F	M
		FAITHσ́	ANCHOR-Rσ	LEFT MOST	RIGHT MOST	PRWD =FTBIN	MAX σ	PRWD = σ
a.	a.vi.rón			*!*		*		**
b.	á	*!	*			*	**	
c.	vǐ	*!	*			*	**	
d.	vǐ.ron	*!			*		*	*
e.	á.vi	*!	*		*		*	*
f.	vi.rón			*!			*	*
g. ☞	rón					*	**	

Candidate (f), *virón*, which was the optimal output in tableau (28), is ruled out in (29) by LEFTMOST, leaving the monosyllabic word *rón* (g) as the optimal form, which violates the lower ranked constraint, PRWD=FTBIN. Interestingly, *virón* turns out to be the form produced by the children in the subsequent phase, namely the Minimal Word phase (§3.2.2.2).

To conclude this subsection, below is a summary of the rankings of the conflicting pairs of constraints, which represent the grammar of children acquiring Hebrew at the pre-Minimal Word phase, based on the data in (24):

(30) Constraint interaction in the pre-Minimal Word phase

a. Reranking

Demotion of PRWD=σ: PRWD=σ » MAXσ ↓ →

MAXσ » PRWD=σ

b. New evidence for ranking:

FAITHσ́ » RIGHTMOST

ANCHOR-Rσ » RIGHTMOST

FAITHσ́ » LEFTMOST

LEFTMOST » PRWD=FTBIN

c. Unchanged ranking:

PRWD=FTBIN » MAXσ

*LAPSE » MAXσ

RIGHTMOST, PRWD=FTBIN

3.2.2.2 The Minimal Word Phase: In this subsection, I discuss data which provide evidence for the Minimal Word as a phase in the course of acquisition. The data show that there is a phase in acquisition, in which for every polysyllabic input, regardless of stress pattern, a disyllabic word is the minimal and maximal prosodic word in the children's corpus.

The notion of the Minimal Word phase in acquisition is adapted here from Demuth (1995) and Demuth and Fee (1995) who show that there is a phase in acquisition in which a binary foot is the minimal and maximal prosodic word produced by children acquiring Dutch and English.[27] While in Dutch and English foot binarity is achieved either by a moraic or a syllabic analysis, the Hebrew foot is binary only under a syllabic analysis (see §3.1.3.1). Therefore, every monosyllabic word (i.e. with or without a coda) is sub-minimal. The data below serve as the basis for the discussion

[27] Unlike Demuth and Fee (1995), Ben-David (2001) shows that children acquiring Hebrew rarely expand monosyllabic inputs. Further research is required in order to find out if the different pattern seen in the Hebrew acquisition data results from the differences between the target languages' foot structure.

of the Minimal Word phase:

(31) The Minimal Word phase: disyllabic prosodic word

a. Adult's output: (σ)σ́σ; Child's output: σ́σ (cf. (24b))

Child	Adult			
sé.fer	sé.fer	2σ		'book'
já.ma	pi.já.ma	3σ	σσ́σ	'pajama'
é.tet	šar.šé.ret			'necklace'
dé.det	la.ré.det			'to get down'
ká.xat	la.ká.xat			'to take'
té.fon	té.le.fon		σ́σσ	'telephone'
tǐ.na	kle.man.tǐ́.na	4σ		'tangerine'

b. Adult's output: (σ)σσ́; Child's output: σσ́ (cf. (24a))

Child	Adult		
a.dúr	ka.dúr	2σ	'ball'
a.túl	xa.túl		'cat'
i.tót	liš.tót		'to drink'
o.xél	o.xél		'to eat'
vi.'ón	a.vi.rón	3σ	'airplane'
ti.yá	mit.ri.yá		'umbrela'
ši.ká	ne.ši.ká		'kiss'
po.tám	hi.po.po.tám	4σ	'hippopotamus'

Unlike the data in the pre-Minimal Word phase (24), where polysyllabic words surface as either monosyllabic or disyllabic (depending on stress), the data above show consistency in the number of syllables, as all productions are restricted to maximally disyllabic words regardless of the number of syllables in the input. The progress from the former phase is evident in the forms in (31b) where disyllabic words surface with stress in final position. The forms in (31a) are exactly as in the previous phase.

The essence of the progress from the previous phase to the current one has to do with the stress pattern. In the previous phase, only initial stress is allowed, whereas in this phase, final stress is allowed as well. Furthermore, recall that in the previous phase, forms like *viroń* (31b) are ruled out by LEFTMOST, which is crucially ranked above PRWD=FTBIN. This ranking prevents the surfacing of disyllabic words with

final stress. Thus, the change in the child's grammar, in the transition from the pre-Minimal Word phase to the Minimal Word phase, stems from constraint reranking, whereby LEFTMOST is demoted below PRWD=FTBIN. The demotion of LEFTMOST allows disyllabic words with ultimate stress (32) to surface, and does not affect the children's output in cases of penultimate stress (33), as illustrated below:

(32) Evidence for PRWD=FTBIN » LEFTMOST, based on (31b)[28]

a. Disyllabic input:

Target (=child's input): $\sigma_1\acute{\sigma}_2$ Child's output: $\sigma_1\acute{\sigma}_2$

Input: kadúr		F		M			F
		FAITH σ́	ANCHOR-Rσ	RIGHT MOST	PRWD =FTBIN	LEFT MOST	MAXσ
a.	ká	*!	*		*		*
b.	ká.dur	*!		*			
c.	dúr				*!		*
d.☞	ka.dúr					*	

b. Trisyllabic input:

Target (=child's input): $\sigma_1\sigma_2\acute{\sigma}_3$ Child's output: $\sigma_2\acute{\sigma}_3$

Input: avirón		F		M			F
		FAITH σ́	ANCHOR-Rσ	RIGHT MOST	PRWD =FTBIN	LEFT MOST	MAX σ
a.	a.vi.rón				*!	**	
b.	á	*!	*		*		**
c.	vǐ	*!	*		*		**
d.	vǐ.ron	*!		*			*
e.	á.vi	*!	*	*			*
f.	rón				*!		**
g. ☞	vi.rón					*	*

The tableaux above show that monosyllabic forms that do not violate ANCHOR-Rσ and FAITHσ́ are ruled out by PRWD=FTBIN (candidate (c) in (32a) and candidate (f) in (32b)). Trisyllabic forms are also ruled out by PRWD=FTBIN, which is still crucially ranked above MAXσ (candidate (a) in (32b)). Thus, words with more than two syllables cannot surface in this grammar.

Note that although the actual change regarding the data in (31b) is the transition

[28] The lowest ranked constraint, PRWD=σ, is omitted from the tableau for the sake of presentational convenience.

from monosyllabic words to disyllabic words, none of the constraints has changed its ranking with respect to MAXσ. The data at this stage provide evidence for the crucial ranking of LEFTMOST below PRWD=FTBIN. The data as a whole (i.e. (31a) and (31b)) indicate that the Minimal Word phase differs from the previous phase in that it allows foot binarity to emerge regardless of its stress pattern, and that it is similar to the previous phase in that a binary foot is the maximal prosodic word allowed:

(33) Binary foot as the maximal prosodic word (based on 31a)

a. Disyllabic outputs for trisyllabic penultimate input:

Target (=child's input): $\sigma_1\acute{\sigma}_2\sigma_3$ Child's output: $\acute{\sigma}_2\sigma_3$

Input: šaršéret		F		M			F
		FAITH σ́	ANCHOR-Rσ	RIGHT MOST	PRWD =FTBIN	LEFT MOST	MAX σ
a.	šar.šé.ret			*	*!	*	
b.	šár	*!	*		*		**
c.	šé		*!		*		**
d.	rét	*!			*		**
e.	še.rét	*!				*	*
f. ☞	šé.ret			*			*

b. Disyllabic outputs for trisyllabic antepenultimate input:

Target (=child's input): $\acute{\sigma}_1\sigma_2\sigma_3$ Child's output: $\acute{\sigma}_1\sigma_3$

Input: télefon		F		M			F
		FAITH σ́	ANCHOR-Rσ	RIGHT MOST	PRWD =FTBIN	LEFT MOST	MAX σ
a.	té.le.fon			**!	*		
b.	té		*!		*		**
c.	lé	*!	*		*		**
d.	te.lé	*!	*			*	*
e.	te.fón	*!				*	*
f.	té.le		*!	*			*
g. ☞	té.fon			*			*

The demotion of LEFTMOST does not affect the children's outputs where stress is penultimate or antepenultimate. Since the ranking of PRWD=FTBIN does not allow forms with more than two syllables, the optimal outputs for these words are the same as in the grammar in the previous phase. The constraint interaction in the Minimal Word phase is summarized below:

(34) Constraint interaction in the Minimal Word phase:

a. Reranking:

Demotion of LEFTMOST: LEFTMOST » PRWD=FTBIN →

PRWD=FTBIN » LEFTMOST

b. Unchanged ranking (with respect to the pre-Minimal Word phase):

PRWD=FTBIN » MAXσ

*LAPSE » MAXσ

RIGHTMOST, PRWD=FTBIN

MAXσ » PRWD=σ

FAITHσ́ » RIGHTMOST

ANCHOR-Rσ » RIGHTMOST

FAITHσ́ » LEFTMOST

To conclude, the data discussed in this subsection show that there is a stage in the acquisition of Hebrew nouns in which a disyllabic word is the maximal prosodic structure produced. In §3.1.3, I showed that this restriction is effective in the adult grammar of the Hebrew verbal system. This implies that the grammar suggested in this section is very similar to that of the *final* state of Hebrew verbs (cf. §3.1.3.2). The implications of this on the acquisition path of the Hebrew verbs are discussed in §3.3. However, as far as Hebrew nouns are concerned, the grammar of the Minimal Word phase is only an intermediate phase and requires further progress.

3.2.2.3 From the Minimal Word to the final state: The transition from maximally disyllabic forms (the Minimal Word) to polysyllabic forms is gradual and several intermediate phases are necessary before children can produce three and four syllables with the variety of stress patterns existing in the language. In this subsection, I explore the transition from the Minimal Word phase to the final state, where the children's forms are fully faithful to the target forms.

The data below show the children's ability to be faithful to target forms with two and three syllables, where the trisyllabic target forms have penultimate stress (35b). In forms with ultimate and antepenultimate stress, however, the children, at this point, are still incapable of producing forms longer than disyllabic (35a):

(35) Beyond the Minimal Word phase

a. Disyllabic outputs:

i. Target forms with **ultimate** stress

Child	Adult		
a.dúr	ka.dúr	2σ	'ball'
vi.rón	a.vi.rón	3σ	'airplane'
ti.yá	mit.ri.yá		'umbrela'
po.tám	hi.po.po.tám	4σ	'hippopotamus'

ii. Target forms with **antepenultimate** stress

Child	Adult		
té.fon	té.le.fon	3σ	'phone'
bé.de	bé.ga.le		'bagel'
ú.ka	mú.zi.ka		'music'

b. Disyllabic and Trisyllabic outputs; target forms with **penultimate** stress

Child	Adult		
sé.fer	sé.fer	2σ	
pi.ǰá.ma	pi.ǰá.ma	3σ	'pajama'
a.ké.vet	ra.ké.vet		'train'
vo.ká.do	a.vo.ká.do	4σ	'avocado'
a.tǐ.na	kle.man.tǐ.na		'tangerine'

The data above show a pattern similar to that in the pre-Minimal Word phase: the children increase the number of syllables they produce, but only if the target form bears penultimate stress (35b).

In the spirit of the analysis presented so far, I attribute the increase in the number of syllables to the demotion of the markedness constraint which restricts the number of syllables, i.e. PRWD=FTBIN, below MAXσ. This reranking, however, fails to affect forms with ultimate and antepenultimate stress due to a higher ranked constraint relating to the stress pattern. This constraint is ***LAPSE,** which avoids a sequence of

unstressed syllables (see (13) in §3.1.3.2), and is crucially ranked above MAXσ (see (23a), (30c) and (34b)).

*LAPSE was irrelevant to the analysis thus far. Assuming that every prosodic word must be stressed, as long as PRWD=FTBIN prevents words with more than two syllables to surface, *LAPSE cannot be violated. However, in this phase, where the children produce words with more than two syllables, the effect of *LAPSE becomes apparent: trisyllabic forms, such as *a.vi.roń* or *té.le.fon*, and quadrisyllabic forms, such as *a.vo.ká.do*, surface as *vi.roń*, *té.fon*, and *vo.ká.do* respectively (see (35)):

(36) Evidence for MAXσ » PRWD-FTBIN[29]

Trisyllabic outputs for trisyllabic penultimate input:

Target (=child's input): $\sigma_1\acute{\sigma}_2\sigma_3$ Child's output: $\sigma_1\acute{\sigma}_2\sigma_3$

Input: šaršéret		F	M		
		MAXσ	PRWD =FTBIN	RIGHT MOST	LEFT MOST
a.	šé.ret	*!		*	
b. ☞	šar.šé.ret		*	*	*

The ranking of MAXσ at the top of this hierarchy, above all markedness constraints, yields full input-output faithfulness. However, the data in (35) indicate that full faithfulness is not yet achieved for structures other than those shown in (36). The tableaux below show that in order to express the disparities that still exist between the children's forms and the target forms, the high ranking of restricting markedness constraint should still be assumed:

(37) Evidence for *LAPSE » MAXσ

a. Trisyllabic output for quadrisyllabic penultimate input

Target (=child's input): $\sigma_1\sigma_2\acute{\sigma}_3\sigma_4$ Child's output: $\sigma_2\acute{\sigma}_3\sigma_4$

Input: avokádo		M	F	M		
		*LAPSE	MAXσ	PRWD =FTBIN	RIGHT MOST	LEFT MOST
a.	a.vo.ká.do	*!		*	*	**
b.	ká.do		**!		*	
c. ☞	vo.ká.do		*	*	*	*

[29] In order to simplify the presentation, the high ranked faithfulness constraints, FAITHσ́ and ANCHOR-Rσ, have been suppressed from the tableaux, and I do not consider candidates which violate them.

b. Disyllabic output for trisyllabic ultimate input:

Input: avirón		M	F	M		
		*LAPSE	MAXσ	PRWD =FTBIN	RIGHT MOST	LEFT MOST
a.	a.vi.rón	*!		*		**
b. ☞	vi.rón		*			*

b. Disyllabic output for trisyllabic antepenultimate input:

Input: télefon		M	F	M		
		*LAPSE	MAXσ	PRWD =FTBIN	RIGHT MOST	LEFT MOST
a.	té.le.fon	*!		*	**	
b. ☞	té.fon		*			

The examples above show, once again, that the transition from one phase to another is achieved through the reranking of a markedness constraint (PRWD=FTBIN) below a faithfulness constraint (MAXσ). They also suggest that every disparity between the input and the output results from the dominance of a markedness constraint (*LAPSE » MAXσ). The ranking of the constraints at this point, where children produce trisyllabic forms, but not in all stress patterns, is summarized below. I term the phase expressed by this ranking the **pre-final phase**:

(38) Constraint interaction in the pre-final phase (only the relevant ones)

a. Reranking:

Demotion of PRWD=FTBIN: PRWD=FTBIN » MAXσ →

MAXσ » PRWD=FTBIN

b. Unchanged ranking (with respect to the Minimal Word phase):

***LAPSE » MAXσ**

RIGHTMOST, PRWD=FTBIN

PRWD=FTBIN » LEFTMOST

To get to the final state, in which the child is completely faithful to the input's prosodic structure, only one further step is required: the demotion of *LAPSE below MAXσ.

(39) The final state

a. Quadrisyllabic output for quadrisyllabic penultimate input:

Target (=child's input): $\sigma_1\sigma_2\acute{\sigma}_3\sigma_4$ Child's output: $\sigma_1\sigma_2\acute{\sigma}_3\sigma_4$

Input: avokádo		F	M			
		MAXσ	*LAPSE	PRWD =FTBIN	RIGHT MOST	LEFT MOST
a. ☞	a.vo.ká.do		*	*	*	**
b.	ká.do	*!*			*	
c.	vo.ká.do	*!		*	*	*

b. Trisyllabic output for trisyllabic ultimate input:

Input: avirón		F	M			
		MAXσ	*LAPSE	PRWD =FTBIN	RIGHT MOST	LEFT MOST
a. ☞	a.vi.rón		*	*		**
b.	vi.rón	*!				*

c. Trisyllabic output for trisyllabic antepenultimate input:

Input: télefon		F	M			
		MAXσ	*LAPSE	PRWD =FTBIN	RIGHT MOST	LEFT MOST
a. ☞	té.le.fon		*	*	**	
b.	té.fon	*!				

The grammar of the final state of Hebrew nouns is thus as follows:

(40) The optimal grammar of Hebrew nouns: the final state

MAXσ » PRWD=σ (FAITHFULNESS » MARKEDNESS)

MAXσ » PRWD=FTBIN (FAITHFULNESS » MARKEDNESS)

MAXσ »*LAPSE (FAITHFULNESS » MARKEDNESS)

FAITHσ́ » RIGHTMOST, LEFTMOST (FAITHFULNESS » MARKEDNESS)

ANCHOR-Rσ » RIGHTMOST, LEFTMOST (FAITHFULNESS » MARKEDNESS)

PRWD=FTBIN » LEFTMOST (MARKEDNESS » MARKEDNESS)

PRWD=FTBIN, RIGHTMOST (MARKEDNESS, MARKEDNESS)

The grammar of the final state is almost a mirror image of that of the initial state. In the initial state (23), the ranking of all the conflicting constraints shows the domination of a markedness constraint above a faithfulness constraint. In the final state, as represented above, markedness constraints are dominated by faithfulness constraints. In addition, the initial state lacks evidence for the ranking of many of the constraints, which in the final state have a fixed ranking.

The constraint interaction in the final state does not, however, reflect the *grammar* of Hebrew, but rather child-adult relation, where the child's outputs are finally identical to the adult's forms. For example, all the constraints relating to stress (i.e. LEFTMOST, RIGHTMOST and *LAPSE) are outranked by faithfulness constraints in the final state of acquisition (40). This ranking suggests that the child's stress pattern is identical to that of the adult's, but it cannot account for cases of stress alternation in the Hebrew grammar, as evidenced in cases of alternation resulting from affixation (e.g. *kadúr* 'ball' – *kadurím* 'balls'). These alternations provide evidence for the effect of the stress constraints and the interaction between them in the language's grammar (see Bat-El (1993), and Graf (2001) for analyses of the stress patterns in Hebrew nouns).

Furthermore, as soon as PRWD=FTBIN is demoted below MAXσ, the interaction between the alignment constraints comprising it (see (11) in §3.1.3.2), becomes relevant. The interaction between these alignment constraints defines the well-formed foot and the well-formed parsing of syllables into feet and in turn, into prosodic words. For example, in a trisyllabic word, the interaction between these constraints determines whether the well-formed parsing is [(σσσ)], [(σ)(σσ)], or [(σσ)(σ)], etc. The difference between these parsings is relevant to the regularity of secondary stress. As noted earlier, I do not consider the well-formedness of parsing, since it is irrelevant to the aspects of prosodic structure explored in this study (see Ussishkin (2000) and Graf (2001)). Moreover, the Hebrew acquisition data do not show evidence that syllables with secondary stress behave differently from unstressed

syllables (Ben-David 2001). For example, the word *à.vi.roń* is not produced as *à.roń* as can be found in similar cases in other languages (cf. Fikkkert 1994 for Dutch).

In §3.3 below, where alternating paradigms of the Hebrew verbal system are considered, I show that the final state is different in terms of the interaction between markedness and faithfulness constraints. Some of the markedness constraints which had to be demoted in the course of the acquisition of nouns, remain at the top of the hierarchy where alternation is involved.

In the following section, I review the acquisition path presented in §3.2.2, focussing on the intermediate phases and the variation involved in the transitions from one phase to another.

3.2.3 VARIABILITY IN THE COURSE OF ACQUISITION

This section focusses on **inter-phase variation** in the course of acquisition**.** I will discuss the variability involved in the transition from one phase to another throughout the acquisition path presented in the previous sections.

Variation is a wide spread phenomenon in children's pronunciation (e.g. Ferguson and Farwell 1975, Rice and Avery 1995, Demuth 1997), which poses a challenge to deterministic generative models aiming to account for learnability. Phases of acquisition as those presented in §3.2.2 are not discrete, since children's outputs at certain points of acquisition include forms with varied structures, and not only those associated with a specific phase of development (Vihman et al. 1985, Fikkert 1994, Demuth and Fee 1995, Ben-David 2001).

Demuth (1997) relates to three types of variation in the course of acquisition: (a) as a result of the absence of contrasts; (b) as a result of multiple optimal outputs generated by the same grammar; and (c) as a result of different inputs. According to Demuth, all three types can be accounted for in OT by partial constraint ranking, where some of the conflicting constraints are equally ranked. In this section I focus on type (b), where multiple outputs are generated by the same grammar in the course of change, and where these multiple outputs are contrastive, e.g. CV ~ CVC for the

target CVC (§2.4). Bernhardt and Stemberger (1998:256-7) claim that the most common pattern of variation is one which arises in times of change, where the child's pronunciation becomes (in most cases) more faithful to the target form. Bernhardt and Stemberger suggest an **unstable ranking** as the formal representation for this variability.

In the spirit of Bernhardt and Stemberger, my formal account of variation begins with its cause, namely the **change**. Change in acquisition, i.e. the transition from one phase to another, is expressed in OT through **reranking,** where markedness constraints are demoted, based on evidence from the target language. The transition from one phase to another does not occur at once. Rather, it is a continuous process in which intermediate phases are inevitable. These intermediate (transitional) phases are represented in OT by the (temporary) **crucial unranking** of conflicting constraints (see §2.4).

In what follows, I review the prosodic acquisition path from the pre-Minimal Word phase to the final state, focussing on the variable forms involved in the intermediate phases. I deal with the transition from the initial state to the pre-Minimal Word phase only briefly, for various reasons. Above all, I would like to focus on the intermediate phases relevant to the acquisition of the inflectional paradigms of the Hebrew verbs, discussed in §3.3, where it will be shown that inflected verbs do not appear before the Minimal Word phase. In addition, as noted in the discussion of the initial state in §3.2.1, the first words children produce are not prosodically contrastive and their outputs are strongly affected by segmental factors, which are beyond the scope of this study. Therefore, the forms of the initial state serve only as evidence for the initial ranking of the prosodic constraints. The data below is relevant to the discussion that follows:

(41) Inter-phase variation in the acquisition path

Phase	Child		Target	
a. **The initial state** (17) in §3.2.1	bá	1σ	bubá	2σ
	tá	1σ	sávta	2σ
	ká	1σ	kápit	2σ
	bú	1σ	ótobus	3σ
b. **Pre-Minimal** Word (24) in §3.2.2.1	dúr	1σ	kadúr	2σ
	fé.fe	2σ	séfer	
	rón	1σ	avirón	3σ
	šéret	2σ	šaršéret	
	kádo	2σ	avokádo	4σ
c. **Towards the Minimal Word Phase**	dúr ~ adúr	1σ ~ 2σ	kadúr	2σ
	féfe	2σ	séfer	
	on ~ virón	1σ ~ 2σ	avirón	3σ
	šéret	2σ	šaršéret	
	kádo	2σ	avokádo	4σ
d. **Minimal Word** Phase (31) in §3.2.2.2	**adúr**	**2σ**	kadúr	**2σ**
	féfe	**2σ**	séfer	
	virón	2σ	avirón	3σ
	šéret	2σ	šaršéret	
	kádo	2σ	avokádo	4σ
e. *Beyond the* **Minimal Word**	vi.rón	2σ	avirón	3σ
	šéret ~ šaršéret	2σ ~ 3σ	šaršéret	
	kádo ~ vokádo	2σ ~ 3σ	avokádo	4σ
f. **Pre-final state** (38) in §3.2.2.3	viron	2σ	avirón	3σ
	šaršéret	**3σ**	šaršéret	
	vokádo	3σ	avokádo	4σ
g. **Towards the** *final state*	virón ~ avirón	2σ ~ 3σ	avirón	3σ
	vokádo ~ avokádo	3σ ~ 4σ	avokádo	4σ
h. **The Final State** (39) in §3.2.2.3	**avirón**	**3σ**	avirón	**3σ**
	avokádo	**4σ**	avokádo	**4σ**

The data above differ from the data presented throughout §3.2.2 in only one respect: variable forms appear in the intermediate phases. Notice that variation of a form with *n* syllables stops as soon as the grammar can provide outputs with *n* syllables for all inputs with *n* syllables. For example, *dur* varies with *a.dúr* 'ball' before the grammar of the minimal word is established. But once it is established, only the disyllabic form *a.dúr* is produced.

In fact, it may be more accurate to state that each of the phases defined in §3.2.2 between the initial and the final states is merely an ideal representation of a 'phase'. The transition from one phase to another is dynamic, and does not cease until the optimal grammar, which allows all contrasts of the target language, is attained. Therefore, all phases in the course of acquisition are intermediate, and variable forms are expected to occur throughout the acquisition path.

Reranking of constraints, which is the OT's mechanism that accounts for the transition from one phase to another, provides a formal expression of the process described above, including the intermediate phases involving variation. An intermediate phase may include crucially unranked constraints, as a consequence of reranking. In what follows, I review the constraint interaction suggested in §3.2.1 and §3.2.2, from the initial to the final state, while focussing on the changes occurring in that interaction and on the consequences involved, i.e. inter-phase variation.

3.2.3.1 From the initial to the pre-minimal phase: In §3.2.2.1 I showed that the significant change occurring in the transition from the initial state to the pre-Minimal Word phase relates to the first evidence of prosodic contrasts in the children's production. The prosodic contrasts evident in the pre-Minimal Word phase are: (i) monosyllabic forms appearing alongside disyllabic words; and (ii) consistent faithfulness to the stressed and final syllables of the target forms. The data presented in (24) provide evidence for the following constraint interaction:

(42) Constraint interaction in the pre-Minimal Word phase

a. MAXσ » PRWD=σ:

Allows more than a single syllable per prosodic word, e.g. *fefe* for *sefer*.

b. FAITHσ́ » RIGHTMOST; FAITHσ́ » LEFTMOST

Requires faithfulness to the stressed syllable of the target form, e.g. *dúr* for *kadúr*, *fefe* for *sefer*.

c. ANCHOR-Rσ » RIGHTMOST

Requires faithfulness to the final syllable of the target form, whether it is stressed or not, e.g. *fefe* for *sefer*.

d. LEFTMOST » PRWD=FTBIN

Disallows non-initial stress, e.g. *dúr* for *kadúr*

e. PRWD=FTBIN » MAXσ

Disallows words with more than two syllables, e.g. *kaḍo* for *avokaḍo*.

The subsequent phases show evidence of increasing prosodic contrasts, where in each phase a single constraint is demoted below a competing one.

3.2.3.2 From the pre-Minimal to the Minimal Word phase: In §3.2.2.2 I showed that the transition from the pre-Minimal Word phase to the Minimal Word phase involves a single case of reranking, where LEFTMOST is demoted below PRWD=FTBIN:

(43) The transition to the minimal word phase

PRWD=FTBIN » MAXσ

RIGHTMOST, PRWD=FTBIN

LEFTMOST » PRWD=FTBIN ➔

PRWD=FTBIN ~ LEFTMOST ➔

PRWD=FTBIN » LEFTMOST

The demotion of LEFTMOST below PRWD=FTBIN, involves an intermediate phase in which these constraints are crucially unranked with respect to one another:

(44) Intermediate phase: between the pre-Minimal and the Minimal Word

a. Disyllabic input with ultimate stress:

Target (=child's input): $\sigma_1\acute{\sigma}_2$ Child's output: $\sigma_1 \sim \sigma_1\acute{\sigma}_2$

Input: kadúr	M			F
	RIGHTMOST	PRWD=FTBIN	LEFTMOST	MAXσ
a. ☞ dúr		*		*
b. ☞ kadúr			*	

b. Trisyllabic input with ultimate stress:

Target (=child's input): $\sigma_1\sigma_2\acute{\sigma}_3$ Child's output: $\sigma_2\acute{\sigma}_3$

Input: avirón	M			F
	RIGHTMOST	PRWD=FTBIN	LEFTMOST	MAXσ
a. ☞ ron		*		**
b. ☞ vi.rón			*	**
c. a.vi.rón		*	**!	*

This is a case of two consecutive grammars in competition: one where LEFTMOST is crucially ranked above PRWD=FTBIN, and another where PRWD=FTBIN is crucially ranked above LEFTMOST. Hence, lower ranked constraints (i.e. MAXσ) do not affect the selection of the optimal output. That multiple outputs emerge, serves as evidence of the change occurring in the grammar, in this case, the transition from one phase in the acquisition path to the next. The tableaux below demonstrate the two phases:

(45) The consecutive grammars:

a. The earlier phase: LEFTMOST » PRWD=FTBIN (pre-Minimal Word)

Input: kadúr	LEFTMOST	PRWD=FTBIN
a. ☞ dúr		*
b. kadúr	*!	

b. The subsequent phase: PRWD=FTBIN » LEFTMOST (Minimal Word)

Input: kadúr	PRWD=FTBIN	LEFTMOST
a. dúr	*!	
b. ☞ kadúr		*

The crucial unranking of the two constraints does not affect forms with penultimate stress in the target forms, as shown in tableu (46). These forms surface as disyllabic in the pre-Minimal Word phase and remain disyllabic in the Minimal Word phase. The

intermediate grammar involving the crucial unranking selects only one optimal output for an input with penultimate stress:

(46) Disyllabic penultimate form in the intermediate phase

Target (=child's input): $\sigma_1\acute{\sigma}_2\sigma_3$ Child's output: $\acute{\sigma}_2\sigma_3$

Input: šaršéret	M			F
	RIGHTMOST	PRWD=FTBIN	LEFTMOST	MAXσ
a. ☞ šé.ret	*			*
b. šar.šé.ret	*	*!	*	

In a target language with no words longer than two syllables, the grammar in (45b) is the final state and reranking halts at this point. But a child acquiring Hebrew is exposed to words with three and four syllables, and therefore reranking continues, as this grammar cannot generate words with more than two syllables. The transition from the minimal word to a larger prosodic structure, which consists of three syllables, is discussed in the following subsection.

3.2.3.3 From the Minimal Word to the pre-final state: In §3.2.2.3 I showed that the transition from the Minimal Word phase to the pre-final phase involves a single case of reranking, where PRWD=FTBIN is demoted below MAXσ ((36) and (37)). In this phase, the initial ranking between *LAPSE and MAXσ becomes relevant, and is therefore added to the analysis. The demotion of PRWD=FTBIN below MAXσ is demonstrated below:

(47) The transition from the Minimal Word to Trisyllabic forms

*LAPSE » MAXσ

PRWD=FTBIN » LEFTMOST

PRWD=FTBIN, RIGHTMOST

PRWD=FTBIN » MAXσ ➞

MAXσ ~ PRWD=FTBIN ➞

MAXσ » PRWD=FTBIN

The demotion of PRWD=FTBIN below MAXσ involves an intermediate phase in which these constraints are crucially unranked with respect to one another:

(48) Intermediate phase: between the Minimal Word to the pre-final state

a. Trisyllabic input with penultimate stress

Input: šaršéret	M	F	M		
	*LAPSE	MAXσ	PRWD =FTBIN	RIGHT MOST	LEFT MOST
a. ☞ šéret		*		*	
b. ☞ šaršéret			*	*	*

b. Quadrisyllabic input with penultimate stress

Input: avokádo	M	F	M		
	*LAPSE	MAXσ	PRWD =FTBIN	RIGHT MOST	LEFT MOST
a. a.vo.ká.do	*!		*	*	**
b. ☞ ká.do		**		*	
c. ☞ vo.ká.do		*	*	*	*

The tableaux above show that the crucial unranking of PRWD=FTBIN and MAXσ provides two optimal forms, one disyllabic and the other trisyllabic. The former represents the Minimal Word phase, and the latter represents the next phase, as demonstrated below:

(49) The consecutive grammars

a. The earlier phase: PRWD=FTBIN » MAXσ (Minimal Word)

Input: avokádo	M		F
	*LAPSE	PRWD=FTBIN	MAXσ
a. a.vo.ká.do	*!	*	
b. ☞ ká.do			**
c. vo.ká.do		*!	*

b. The subsequent phase: MAXσ » PRWD=FTBIN (Pre-final phase)

Input: avokádo	M	F	M
	*LAPSE	MAXσ	PRWD=FTBIN
a. a.vo.ká.do	*!		*
b. ká.do		**!	
c. ☞ vo.ká.do		*	*

The crucial unranking of the constraints yet does not affect forms with ultimate stress, as shown in tableau (50). These forms surface as disyllabic in the Minimal Word phase and remain disyllabic in the pre-final phase. The intermediate grammar

involving the crucial unranking, selects only one optimal output for input with ultimate stress:

(50) Disyllabic ultimate form in the intermediate phase

Input: avirón		M	F	M		
		*LAPSE	MAXσ	PRWD =FTBIN	RIGHT MOST	LEFT MOST
a.	a.vi.rón	*!		*		**
b. ☞	vi.rón		*			*

That a disyllabic form is selected for a trisyllabic target (50), and that a trisyllbic form is selected for a quadrisyllabic target (49b), indicates that further development has yet to occur. That is, reranking continues.

3.2.3.4 Towards the final state: In §3.2.2.3 I showed that in order to generate trisyllabic forms with ultimate stress, or quadrisyllabic forms with penultimate stress, *LAPSE is demoted below MAXσ.

(51) The transition to the final state

MAXσ » PRWD=FTBIN

PRWD=FTBIN » LEFTMOST

RIGHTMOST, PRWD=FTBIN

*LAPSE » MAXσ →

MAXσ ~ *LAPSE →

MAXσ » *LAPSE

The demotion of *LAPSE below MAXσ involves an intermediate phase in which these constraints are crucially unranked with respect to one another, yielding the results demonstrated below:

(52) Intermediate phase: towards the final state

a. Quadrisyllabic input with penultimate

Input: avokádo		F	M			
		MAXσ	*LAPSE	PRWD =FTBIN	RIGHT MOST	LEFT MOST
a.	ká.do	**!			*	
b. ☞	vo.ká.do	*		*	*	*
c. ☞	a.vo.ká.do		*	*	*	**

b. Trisyllabic input with ultimate stress:

Input: avirón		F	M			
		MAXσ	*LAPSE	PRWD =FTBIN	RIGHT MOST	LEFT MOST
a. ☞	a.vi.rón		*	*		**
b. ☞	vi.rón	*				*

The tableaux above show that in each case the crucial unranking of *LAPSE and MAXσ provides two optimal forms. When the target is quadrisyllabic with penultimate stress (52a), one optimal form is trisyllabic and the other is quadrisyllabic, completely faithful to the target form. When the target form is trisyllabic with ultimate stress (52b), one optimal form is disyllabic and the other is trisyllabic, completely faithful to the target form. These two consecutive phases are demonstrated below:

(53) Consecutive grammars

a. The earlier phase: *LAPSE » MAXσ (Pre-final)

Input: avokádo		M	F	M		
		*LAPSE	MAXσ	PRWD =FTBIN	RIGHT MOST	LEFT MOST
a.	ká.do		**!		*	
b. ☞	vo.ká.do		*	*	*	*
c.	a.vo.ká.do	*!		*	*	**

b. The subsequent phase: MAXσ » *LAPSE (final state)

Input: avokádo		F	M			
		MAXσ	*LAPSE	PRWD =FTBIN	RIGHT MOST	LEFT MOST
a.	ká.do	*!*			*	
b.	vo.ká.do	*!		*	*	*
c. ☞	a.vo.ká.do		*	*	*	**

It should be noted, that the intermediate phases do not generate forms which are more marked than the target forms. That is, a grammar generating, for example, *virón* ~ *avirón* (50), will not select trisyllabic forms for disyllabic target, e.g. *kadúr* ~ **kadúr**__**u**__, since the additional syllable incurs violations of markedness constraints without being more faithful to the target form.

To conclude, variation is not random, and neither are the disparities of children's outputs from the target forms. As indicated throughout this chapter, the children's forms differ from the target forms by being less marked. The acquisition path is a continuous learning of the language's marked structures, namely of the contrasts existing in the target language. This process is expressed in the OT model through (i) an initial state where all markedness constraints are ranked above faithfulness constraints, an interaction which avoids contrasts; and (ii) the transition from phase to phase, which is enabled by reranking, whereby markedness constraints are demoted in order to allow contrasts to surface. The process of reranking persists until the child attains the constraint interaction that surfaces all of the contrasts existing in the target language.

In the sections below I address the interrelation between the prosodic acquisition path and the morphological acquisition path of children acquiring Hebrew. The morphological path discussed below is that of verb inflection.

3.3 THE PHONOLOGY-MORPHOLOGY INTERFACE IN ACQUISITION

In the previous section (§3.2) I considered only the prosodic aspects of the acquisition path, taking into account the acquisition of single forms.

Faithfulness relation in the acquisition path of single forms is limited to the child-adult relation, where in the final state the child's production is identical, i.e. faithful, to the adult's production. This account is insufficient for the research of language acquisition for two major reasons. First, it does not provide evidence for lexical representation in the child's grammar, because the child's 'input' is considered to be the adult's output. This problem is crucial, considering that in the adult's grammar there are alternating paradigms where several alternating outputs are related to a single lexical input (see §2.2.2.2). Second, the constraint ranking in the final state, i.e. 'FAITHFULNESS » MARKEDNESS', does not reflect the phonology of a natural language, where some markedness constraints, accounting for alternation as well as for the absence of marked structures in the language, outrank some faithfulness constraints. This problem stems from the first, as this ranking only reflects the child-adult relation and not the phonological grammar of the target language. Such a ranking, where all markedness constraints are outranked, predicts no alternation or structural restrictions, and therefore cannot be assumed as the final state of the child's grammar.

In order to capture these aspects of linguistic knowledge in the process of acquisition, I investigate in this section the acquisition path in view of paradigms with morpho-phonological alternation. To this end, morphological structure, as evidenced from Hebrew inflected verbs, is added to the prosodic analysis suggested above.

This section is organized as follows. In §3.3.1 I discuss the initial state of the phonology-morphology interface, based on the prosodic analysis presented in the previous section. In §3.3.2 I present a constraint-based account of the manifestation of productive inflectional suffixes, and in §3.3.3 I review the acquisition path in view of alternating paradigms. I will show throughout this section that the acquisition path of

prosodic structure is interwoven with the acquisition path of morphological structure, and will suggest evidence for the child's lexical representation, as well as for the transition from child-adult relation to the child's input-output relation.

3.3.1 THE INITIAL STATE OF MORPHOLOGICAL ACQUISITION

In this section I argue that the phonological knowledge reflected in the child's production suggests access to some morphological knowledge, before this knowledge has a surface manifestation. Specifically, I will argue that the child can distinguish between stems and suffixes (by identifying the stem) before any sign of the morphological paradigm is evident.

In what follows, I discuss the phonological and morphological properties of verbs in early acquisition (§3.3.1.1), and present the constraint-based morphological model adapted in this study, in order to represent the nature of the phonology-morphology interface (§3.3.1.2).

3.3.1.1 The first verbs: Hebrew verb paradigms consist of 23 types of inflected forms, most of which (65%) are with suffixes. Based on this, one could expect to find suffixed alongside unsuffixed forms among the verbs children produce in early acquisition. Berman and Armon-Lotem (1997) explore this assumption with 120 verbs which constituted the first 20 verbs of six children.

The data presented by Berman and Armon-Lotem reveal that 75% of those 120 verbs are without suffix, or, as the authors phrase it, **stem-like** forms. Thus, the high frequency of suffixless verbs in the children's early production does not reflect their frequency in the paradigms of adult language.

The 25% occurrences of suffixed forms are rote-learned unanalyzed forms (MacWinney 1978, Berman 1986). That is, the use of suffixes is not productive, and they do not constitute morphological paradigms. For example, a child that produces *af-a* 'she flew' does not produce any other morphological form of this verb (e.g. *af* 'he flew', or *af-u* 'they flew'). Similar findings regarding Hebrew acquisition are reported

in Berman (1980, 1982, 1985), Kaplan (1983), and Dromi (1987), who show that suffixes produced in early acquisition are not productive, namely rote-learned.

The focal finding of Berman and Armon-Lotem's (1997) research is, however, the large amount of stem-like verbs. The authors note that this finding is consistent with findings from children acquiring typologically distinct languages, such as German and English (pp.37-38).[30]

In this section I aim to look at these data from a phonological point of view, based on the prosodic acquisition path provided in the previous sections, in order to find indications of the nature of the phonology-morphology interface in early acquisition. I will show that a phonological description of Hebrew inflected verbs (see §3.1.2) makes Berman and Armon-Lotem's findings even more puzzling. Following Adam and Bat-El (2000), I will propose an explanation for these findings within a constraint-based approach.

In the Hebrew inflectional system, all suffixed forms are either with ultimate or with penultimate stress (e.g. *xips-**a*́* 'she searched' – *xipáś-**ti*** 'I searched'). The acquisition path of prosodic structure presented in §3.2 shows that the final and the stressed syllables of the adult's productions are consistently produced by children from the ***pre***-Minimal Word phase (§3.2.2.1) onwards. Therefore, there is no prosodic restriction in the pre-Minimal Word phase to produce words with suffixes, such as *caťa* for *macaťa* 'you [sg. ms.] found' (cf. *jaḿa* for *pijaḿa* 'pajama') or *ka* for *zarkáˊ* 'she threw' (cf. *ka* for *nešiká* 'kiss') (cf. (24) in §3.2.2.1)).

Following is a sample of data from Berman and Armon Lotem (1997), representing the 75% suffixless forms which serve as evidence for the prosodic phase of the children in this study:

[30] Similar findings are reported by in Uziel-Karl (p.c.), based on the longitudinal data collected for her research on the development of the Hebrew verb argument Uziel-Karl (2001).

(55) First verbs production (The prefixes *le-, la-* indicate infinitive):

Child	Target		
fóx	(la).ha.fóx	'to turn over'	Smadar
fál	na.fál	'fell'	1;6-1;7
xél	o.xél	'is eating'	
tó.ax	lif.tó.ax	'to open'	
ni.gór	nis.gór	'we'll close'	
a.lá	ha.láx	'went'	
xék	(le).sa.xék	'to play'	Lior
gór	lis.gór	'to close'	1;5-1;6
šón	li.šón	'to sleep'	
pés	(le).ta.pés	'to climb'	
gó.ax	lif.tó.ax	'to open'	
dé.det	la.ré.det	'to get down'	
ni.gá	nig.már	'finished'	
se.yé	lecayér	'to paint'	
ǐd	(leh).o.rǐd	'to take down'	Keren
pés	(le).ta.pés, (le).xa.pés	'to climb, to search'	1;2-1;4
ú.ax	lif.tó.ax	'to open'	
éde	(la).re.det	'to get down'	
é.vet	(la)šé.vet	'to sit down'	
i.tó	liš.tot	'to drink'	
i.bár	niš.bár	'broke'	
a.bǐs	(leh)al.bǐš	'to dress'	

The data indicate that the children possess forms which are consistent not only with the structure of the pre-Minimal Word phase, but also with more advanced structures that characterize the Minimal Word phase. That is, disyllabic words with final stress (e.g. *nigá́* for *nigmár* 'finished') are found alongside disyllabic words with initial stress (e.g. *úax* for *liftóax* 'to open') and monosyllabic words relating to targets with ultimate stress (e.g. *xe̍k* for *lesaxe̍k* 'to play'). These forms indicate that the children are at the transition phase between the pre-Minimal and the Minimal Word phase (see §3.2.3.2). Insofar as the prosodic development is concerned, the children should be able to produce suffixed forms. The tableaux below demonstrate the expected (but nevertheless unrealized) verb outputs of a child at this intermediate phase, for the inputs *naflá* 'she fell' (56a) and *nafa̍lti* 'I fell' (56b):

(56) Evaluation of inflected verbs in the transition from the pre-Minimal Word to the Minimal Word phase

a. Disyllabic input with ultimate stress (cf. (32a) in §3.2.3.2):

Child's input (= target): $\sigma_1\acute{\sigma}_2$ Child's output: $\sigma_1\acute{\sigma}_2$

Input: naflá	F		M			F
	FAITH σ́	ANCHOR Rσ	RIGHT MOST	PRWD =FTBIN	LEFT MOST	MAXσ
a. ná	*!	*		*		*
b. ☞ lá				*		*
c. ☞ naf.lá					*	
d. fál	*!	*		*		*
e. nafál	*!	*			*	

b. Trisyllabic input with penultimate stress (cf. (32b) in §3.2.3.2):

Child's input (= target): $\sigma_1\acute{\sigma}_2\sigma_3$ Child's output: $\acute{\sigma}_2\sigma_3$

Input: nafálti	F		M			F
	FAITH σ́	ANCHOR Rσ	RIGHT MOST	PRWD =FTBIN	LEFT MOST	MAXσ
a. ná	*!	*		*		**
b. fál		*!		*		**
c. na.fál		*!			*	*
d. na.fál.ti			*	*!	*	
e. ☞ fál.ti			*			*

According to (56a), both *laˊ* (b) and *naflaˊ* (c) are expected to surface for the input *naflaˊ*. Both, however, are rarely produced by children at this phase. Rather, most of the children's verb forms at this phase are stems, in this case *fal ~ nafal*. Similarly, in (56b), the optimal candidate, *falti* (e), is a form that rarely appears in this phase. In this case, as is in the example above, all that the child produces are syllables pertaining to the stem, i.e. *fal ~ nafal*. In other words, the prosodic structure of the optimal forms in (56) (i.e. with ultimate or with penultimate stress) and their input-output relations (i.e. faithfulness to target's stressed and final syllables) are realized in this phase, but the morphological constituents other than the stem, are not.

This observation led Adam and Bat-El (2000) to infer that children have access to the distinction between stems and suffixes before suffixes are overtly evident in their

productions, and that at this phase of acquisition they distinguish between stems and affixes, or at least identify stems. This suggests that the child's input in these cases is not the adult's suffixed form (at least, not *only* the adult's form, see discussion in §3.3.3.1) but rather the child's lexical form, which is a stem.

In what follows, I show that the absence of suffixes in the child's production is not due to the interaction between phonological constraints (i.e. markedness and faithfulness), but rather to the interaction between phonology and morphology, namely, the state of the phonology-morphology interface at this stage. The model proposed below actually supports Berman and Armon-Lotem's (1997) findings and provides an explanation from the perspective of the phonology-morphology interface.

3.3.1.2 Affixes as constraints: The morphological model adopted in this study is the **Item-and-Process** model (Hockett 1954, Aronoff 1976, Kiparsky 1982a,b, Anderson 1992), as opposed to the Item-and-Arrangement model (Selkirk 1983, Lieber 1992). Within a rule-based approach, the Item-and-Process model views affixation as a process, while the Item-and-Arrangement model views affixation as a lexical item presented along with the stem. One of the significant advantages of Item-and-Process over Item-and-Arrangement for the current discussion is that only the former reflects the different status of stems and affixes in the grammar (see Anderson 1992 for further considerations).

In most studies within OT, there is no clear distinction between the two approaches. However, in several recent works, the Item-and-Process model has been considered within the framework of OT as a distinctive and preferred approach for representing morphological processes (see Russell 1995, 1999, and also Yip 1995, Bat-El 2000, 2001). This approach, as opposed to representing the affixes as lexical items along with the stem, reflects the phonology-morphology interface via the same OT mechanism that accounts for all aspects of grammar, i.e. constraint interaction.

Bat-El (2000, 2001) points out another significant advantage of this model: its ability to reflect the role of morphology in creating contrast between lexical

categories. Morphological constraints intrinsically require the output to be phonologically different from the input. According to Bat-El, the outranking of faithfulness constraints (i.e. input-output faithfulness) by morphological constraints is a case of *anti*-faithfulness (see also Alderete 2001). The notion *anti-faithfulness* differs significantly from *un*faithfulness. The former is a consequence of a direct requirement for morphological contrast. The latter is a consequence of outranking faithfulness constraints by markedness constraints, through which a phonological contrast is actually avoided.

As for the inflectional suffixes, the attachment of an inflectional suffix to a verb stem is in fact a morpho-syntactic requirement, while the structure of the output is a consequence of a morpho-phonological requirement. Following Adam and Bat-El (2000), the principles of suffixation within an OT mechanism, assuming the Item-and-Process model, are as follows:

(57) Principles of suffixation in an OT Item-and-Process model

a. The **input** indicates the stem and the required morphological category
e.g. *nafal* – [PAST SG. FM.]

b. The **suffix** is represented by an alignment constraint which 'aligns' the suffix to the appropriate edge of the stem *and* 'matches' its morphological category to that required by the input. This combination is represented by a single constraint of alignment plus matching.

The constraint accounting for the alignment and matching of the required inflectional suffix to the right edge of the stem is formulated as follows:

(58) Alignment and matching constraint

A&M [SUFF]$_{CAT}$ Align and match (Stem, R, Suffix, L)

Align the right edge of a stem with the left edge of a suffix, and match

the

category of the suffix with the one required by the stem.

This constraint is violated in two different cases: (a) when the required suffix is missing in the output; and (b) when the category of the suffix in the output does not correspond to the category specified in the input.

When suffixation occurs (i.e. when the constraint is satisfied), the right edge of the output does not correspond to the right edge of the input, because the input is the stem alone. In the previous section I used ANCHOR-Rσ (see (26) in §3.2.2.1), in order to express input-output correspondence at the right edge of the word. This constraint conflicts directly with A&M[SUFF].[31] Thus, in order to allow the suffix to be surface true, ANCHOR-Rσ should be dominated by A&M[SUFF], as demonstrated in the tableau below:

(59) Suffixation in adult grammar

a. Ranking: A&M[SUFF]$_{CAT}$ » ANCHOR-Rσ

b. Example:

Target word: *nafálti* Input: *nafál* – [PAST 1ST SG.]

Input: nafal – [PAST 1ST SG.]	MORPHOLOGICAL	FAITHFULNESS
	A&M[-ti]$_{[PAST\ 1ST.\ SG.]}$	ANCHOR-Rσ
a. nafál	*!	
b. ☞ nafálti		*

Candidate (a), which is fully faithful to the input (i.e. the stem) is ruled out by the morphological constraint, since it does not include the suffix required by this constraint. Candidate (b) is optimal although it violates ANCHOR-Rσ, since this faithfulness constraint is ranked below the morphological constraint which requires a suffix to surface. Given this model, the absence of inflectional suffixes in children's productions can be understood as the consequence of an initial ranking in which the

[31] Recall that ANCHOR-Rσ covers both MAXσ and DEPσ, since both deletion and insertion of non-lexical elements (i.e. elements that are not represented in the input) in this position yield unfaithfulness between the right edges of the input and output.

morphological constraints referring to the suffixes are ranked below the phonological constraints.

As noted before, the first verbs produced by children (55) are suffixless and have the prosodic structure of the Minimal Word phase (or at least the pre-Minimal Word phase). The phonological and morphological structure of these verbs provides evidence of the following ranking:

(60) Phonology-morphology interface: the initial state

ANCHOR-Rσ » A&M[SUFF] (PHONOLOGY » MORPHOLOGY)

Markedness-Faithfulness interaction (see (43) in §3.2.3.2)

PRWD=FTBIN ~ LEFTMOST

PRWD=FTBIN » MAXσ

*LAPSE » MAXσ

FAITHσ́ » LEFTMOST

FAITHσ́ » RIGHTMOST

ANCHOR-Rσ » RIGHTMOST

RIGHTMOST, PRWD=FTBIN

This grammar is demonstrated in the tableau below, where the target word is the inflected verb *nafa͡lti*. The child's input is, however, not the inflected target form, but rather the stem, *nafa͡l* (cf. (34a) in §3.2.2.2 and (33b) in the current section):

(61) Target: *nafa͡lti* Child's input (= the stem): nafál – [PAST 1ST. SG.]

Input: nafál – [PAST 1ST. SG.]	PHONOLOGY						MOR
	FAITH σ́	ANCHOR Rσ	RIGHT MOST	PRWD =FTBIN	LEFT MOST	MAX σ	A&M [-ti]
a. ☞ fál				*		*	*
b. ☞ na.fál					*		*
c. na.fál.ti		*!	*	*	*		
d. fál.ti		*!	*			*	

The suffixed candidates (c) and (d) violate ANCHOR-Rσ which is ranked above the morphological constraint. The suffixless candidates (a) and (b), are both optimal,

since they do not violate the highest ranked phonological constraints. Below is another example, demonstrating why the suffix *-a* cannot be included in the child's production at this stage:

(62) Target: *naflá* Child's input (= the stem): nafál – [PAST 3RD SG. FM.]

Input: nafál - [PAST 3RD. SG. FM.]	PHONOLOGY						MOR
	FAITH σ́	ANCHOR Rσ	RIGHT MOST	PRWD =FTBIN	LEFT MOST	MAX σ	A&M [-a]
a. ☞ fál				*		*	*
b. ☞ na.fál					*		*
c. na.fa.lá	*!	*		*	**		
d. na.fá.la		*!	*	*	*		
e. naf.lá	*!	*			*	*	

The suffixed candidates in this tableau violate not only ANCHOR-Rσ, but also FAITHσ́ (c, e) and/or PRWD=FTBIN (c, d). The most interesting one is candidate (e), *naflá*, which is faithful to the target form (notice that here the target form is *not* the child's input). This form violates FAITHσ́, since the stem's stressed vowel is absent, thus violating also MAXσ. However, this form does not violate the markedness constraint PRWD=FTBIN. This case, including the status of FAITHσ́, is further elaborated in §3.3.3, where alternating paradigms are discussed.

The model presented above does not avoid rote-learned unanalyzed forms, which are present in early acquisition. Its power is in its capability to distinguish between productive suffixation, where a suffix is attached to a stem by a morphological constraint (59), and a suffix that appears unproductively as a consequence of encoding the inflected target form as the input, as in the example below:

(63) Unanalyzed suffixed form

Child's input (= target): *naflá*

Input: naflá	PHONOLOGY						MOR
	FAITH σ́	ANCHOR Rσ	RIGHT MOST	PRWD =FTBIN	LEFT MOST	MAX σ	A&M [-a]
a. fál	*!	*		*		*	*
b. na.fál	*!	*			*		*
c. nafalá				*!	**		
d. nafála	*!		*	*	*		
e. ☞ naflá					*		

This tableau shows that *nafla´* can surface as an unanalyzed form, and this example represents the 25% cases of suffixed forms reported by Berman and Armon-Lotem (1997). The 75% of unsuffixed forms, indicate that in most cases the children choose the verb stem as their form of reference for faithfulness relation, that is, they can identify the stem. Insofar as the morphological constraint is ranked below faithfulness constraints, no productive suffixation occurs, but the identification of the stem suggests that morphology already plays a role in the children's grammar.

To conclude, the constraint ranking representing the initial state of the phonology-morphology interface prevents productive suffixes from surfacing, even though prosodically, verbs with suffixes (e.g. *fa͡lti* for *nafa͡lti* or *nala´* for *naflá*) are possible. In order to allow productive suffixes to surface (as in (59)), the reranking of the faithfulness constraint ANCHOR-Rσ with respect to the morphological constraint A&M[SUFF] is required. It should be noted that ANCHOR-Rσ (i.e. faithfulness to the final syllable) is associated with perceptual considerations (see §3.2.1), which play a significant role in early acquisition where the child heavily relies on the adult's output (see Ben-David 2001). In the subsequent sections I will show that morphological acquisition involves greater reliance on lexical representation. The role of the other perceptual constraint discussed above, i.e. FAITHσ́, provides further evidence for this pattern, as it gradually loses its role in the child's grammar during the acquisition of paradigms.

A schematic summary of morphological acquisition vs. phonological acquisition is presented below:

(64) The acquisition path

a. Phonological development: demotion of **markedness** constraints

MARKEDNESS » FAITHFULNESS

b. Morphological development: demotion of **faithfulness** constraints

FAITHFULNESS **» MORPHOLOGY**

The reranking in (64a) is discussed in §3.2 above with respect to the acquisition

path of Hebrew nouns, as single forms. The reranking in (64b), where faithfulness constraints are demoted below morphological constraints, are accounted for in the subsequent sections. §3.3.2 is concerned with the consequences of demoting faithfulness constraints below morphological constraints. §3.3.3 is concerned with issues related to the interaction of markedness with faithfulness constraints in view of alternating paradigms.

3.3.2 THE PROSODIC STRUCTURE OF CHILDREN'S INFLECTED VERBS

Productive occurrences of verb inflectional suffixes appear gradually in the child's production as a consequence of morpho-syntactic factors, which are not considered in this work. In both this and the forthcoming section, I focus on the interaction between inflectional suffixes and prosodic structure.

3.3.2.1 The inflectional suffixes in the course of acquisition: As a background for the ensuing discussion, the order of acquisition of the verb inflectional suffixes, based on Armon-Lotem (1997), is presented:

(65) The order of acquisition of verb inflectional suffixes in Hebrew (there is no suffix for 3rd. sg. ms.):[32]

a. Participle:

i. Gender, fm.:	*-a*	e.g.	*malbiš-á*	'she dresses'
	-et	e.g.	*holéx-et*	'she walks'
ii. Plural, ms.:[33]	*-im*	e.g.	*holx-ím*	'they [ms.] walk'

b. Past 3rd. Person:

i. fm.:	*-a*	e.g.	*halx-á*	'she walked'
ii. pl.:	*-u*	e.g.	*halx-ú*	'they walked'

[32] Imperative forms are among the first to surface in the child's production. Nevertheless, I do not consider them here, due to the variability of imperative structures in the adult's language (Bat-El 2001). The future is productively used by children at a later stage of acquisition (Kaplan 1983, Berman 1985), and therefore is not considered here.

[33] The feminine plural suffix, *-ot*, appears regularly at a much later stage (Kaplan 1983).

c. Past 1st. Person:

i. sg. :	*-ti*	e.g.	*halaχ-ti*	'I walked'
ii. pl. :	*-nu*	e.g.	*halaχ-nu*	'we walked'

d. Past 2nd. Person:

i. sg. ms.:	*-ta*	e.g.	*halaχ-ta*	'you [sg. ms.]walked'
ii. sg. fm.:	*-t*	e.g.	*halaχ-t*	'you [sg. fm.] walked'
iii. pl.:	*-tem*	e.g.	*halaχ-tem*	'you [pl.] walked'

The order of acquisition described above shows that (i) the participle suffixes are acquired before those of the past tense; (ii) 2nd person suffixes are acquired after the 1st person suffixes, and both are acquired after the 3rd person suffixes; and (iii) in each category, the singular is acquired before the plural and the masculine before the feminine. Armon-Lotem (1997) provides a syntactic analysis for this order of acquisition, within the framework of the Minimalist Program (Chomsky 1995). In §3.3.1.1 I argued that phonological factors do not seem to affect for the *order* of acquiring inflectional categories, but they do interact with the morpho-syntactic factors along the way.[34]

The emergence of productive inflectional suffixes is represented here by the demotion of faithfulness constraints below morphological (inflectional) constraints. Theoretically, this reranking could occur at any phase along the prosodic acquisition path. Nevertheless, productive suffixes are not actually evidenced before the Minimal Word phase (§3.2.2.2), and mostly stem-like outputs appear in the preceding phase through the transitional phase towards the Minimal Word (see (55)).

The inflected verbs examined here are of the two types presented in §3.1.2. The data below show examples of children's productions of these inflected verbs. The data

[34] It should be noted that vowel initial suffixes are produced before consonant initial suffixes. This observation is not included in the analysis proposed here since the structure of the suffix does not seem to affect the order of acquisition of verb inflection. As argued in §3.3.1, the children produce structures similar to those of inflected verbs long before they produce inflectional suffixes. That is, as far as phonological development is concerned, all suffixes could surface at the same phase, however, this is obviously not the case.

in (66) show cases of vowel initial suffixes, which trigger input-output prosodic alternation within the stem, where the input is the stem and the output is the inflected form (cf. (6) in §3.1.1.2). The data in (67) show cases of consonant initial suffixes, where input-output prosodic alternation within the stem does not occur and the target forms are trisyllabic or quadrisyllabic (cf. (5) in §3.1.1.2):[35]

(66) Productive productions of inflected verbs: Vowel initial suffixes

Disyllabic target forms:

/$\sigma_1\sigma_2$/ - [σ]$_{SUFF}$ → child**:** $\sigma_1\sigma_{SUFF}$ target**:** $\sigma_1\sigma_{SUFF}$

Child	Target	Stem	Suff	Category	
pat.xá	pat.xá	pa.t**á**x	-a	past 3rd. sg. fm.	'she opened'
ax.lá	ax.lá	a.x**á**l			'she ate'
tip.sá	tip.sá	ti.pés			'she climbed'
kaf.cá	kaf.cá	ka.f**á**c			'she jumped'
tip.sú	tip.sú	ti.pés	-u	past 3rd. pl.	'they climbed'
kaf.cú	kaf.cú	ka.f**á**c			'they jumped'
ax.lú	ax.lú	a.x**á**l			'they ate'
zar.kú	zar.kú	za.r**á**k			'they threw'
o.xǐm	ox.lǐm	o.x**é**l	-im	participle pl. ms.	'are ms. eating'
zor.kǐm	zor.kǐm	zo.rék			'are ms. throwing'

The examples in (66) show cases where vowel initial suffixes are attached to disyllabic stems. This suffixation triggers the deletion of a stem vowel (in **bold** in the 'stem' column) and stress shift from the stem to the suffix. For example, the stem *patáx* 'opened' loses its final vowel in the inflected form *patxá* 'she opened'. In this case, the number of syllables in the target form equals that of the stem, i.e. two. The children's production is also disyllabic, including the suffix, and excluding the same stem vowel as the one missing in the target inflected forms. That is, the children's prosodic structure is faithful to that of the target.

The data below show that at this stage, trisyllabic outputs are avoided, and the disyllabic produced include the suffix, and excludes stem's initial syllable:

[35] The data are extracted from the Leonard and Dromi cross-linguistic research (see details in §3.1.3).

(67) Productive productions of inflected verbs: Consonant initial suffixes

Disyllabic *and* **trisyllabic** target forms:

/(σ_1)$\sigma_2\sigma_3$/ - [σ]$_{SUFF}$ → child: $\sigma_2\sigma_{SUFF}$ target: (σ_1)$\sigma_2\sigma_3\sigma_{SUFF}$

Child	Target	Stem	Suff	Category	
táx.ti	**pa**.táx.ti	pa.táx	-ti	past 1st. sg.	'I opened'
gáv.ti	**ni**.gá.vti	ni.gév	-ti		'I wiped dry'
kán.ti	**ti**.kán.ti	ti.kén	-ti		'I fixed'
báš.ti	**hil**.báš.ti	hil.bíš	-ti		'I dressed'
pás.ti	**hit.xa**.pás.ti	hit.xa.pés	-ti		'I masqueraded'
káv.nu	**hir.**káv.nu	hir.kív	-nu	past 1st. pl.	'we assembled'
dár.ta	**si**.dár.ta	si.dér	-ta	past 2nd. sg. ms.	'you arranged'
xál.tem	**a**.xál.tem	a.xál	-tem	past. 2nd. pl.	'you ate'
báš.tem	**hil**.báš.tem	hil.bíš	-tem		'you dressed'

The examples above show cases in which consonant initial suffixes are attached to disyllabic stems (e.g. *pataáx-ti* 'I opened') and to trisyllabic forms which include a derivational prefix (e.g. *hit-xapeś-ti* 'I masqueraded'). The children's productions exhibit a similar pattern to that in the previous examples (66): all of their productions are disyllabic, and suffixes are included. The stem's initial syllable is missing in all the children's forms (e.g. *taáxti* for ***pa****taxti*). In cases of prefixed stems, the prefix and the first syllable of the stem are missing in the child's outputs (e.g. *paś.ti* for *hitxapaśti*).

The data in (66) and (67) show consistency in that the children's forms are disyllabic. Stress is either initial or final. This pattern is compatible with the Minimal Word phase presented in the prosodic acquisition path (§3.2.2.2). However, in the analysis of the prosodic acquisition path in §3.2, suffixes are not considered, and the disyllabic structure includes only syllables pertaining to the stem. For example, a disyllabic target like *kadúr* 'ball' is fully produced, but in trisyllabic targets like *aviroń* 'airplane', or *šaršeŕet* 'necklace', the children delete the initial syllable (cf. (32,

33)).

In (66) and (67) bare stems as well as suffixed forms are considered. In all cases, the children produce the suffixes in question. In order to include the suffix in a maximally disyllabic word, stem syllables are deleted, resulting in violation of input-output faithfulness (where the input is the stem). Two types of violation of faithfulness to the stem are evident here: faithfulness violated only by the child (e.g. *taẋti* for *pataẋti*; stem: *pataẋ* (67)) and faithfulness violated by both the child and the adult (e.g. *patxá*; stem: *pataẋ* (66)).

The children's complete faithfulness to the target forms in (66) does not indicate a more advanced phase in the prosodic development. It is definitely not a case of an advanced phase in the *morphological* development, since the **suffixes** appear in all of the children's forms. That is, all data in (66) and (67) belong to the same phase in acquisition: morphologically, this is the phase in which the inflectional suffixes in question are productively produced, and phonologically, the prosodic structure is similar to the structures produced in the Minimal Word phase.

What do the examples in (66) and (67) teach us about the interrelation between the phonological and morphological acquisition paths? How can this interrelation be represented by the OT model presented in §3.2? These questions are addressed below.

3.3.2.2 The interrelation between phonology and morphology: In the Minimal Word phase (§3.2.2.2) the children's productions are restricted to maximally disyllabic words. The productions considered in this section (66, 67) show the same prosodic pattern, but a different morphological pattern, since the disyllabic word includes a suffix.

In (60) I presented the initial state of the phonology-morphology interface, in which the morphological constraints are outranked by phonological constraints. The phonological constraints in this initial state show the pattern of the transition from the pre-Minimal to the Minimal Word phase. Recall that the difference between these two phases results from the interaction between PRWD=FTBIN and LEFTMOST, where the

latter is demoted below the former. The data discussed in §3.2.3.2 provide clear evidence of the crucial ranking of LEFTMOST below PRWD=FTBIN, since the children's forms include disyllabic words with final stress.

The input-output relation evidenced from the current data is different from the morphology-free Minimal Word phase in §3.2.2.2. The emergence of suffixes provides evidence that ANCHOR-Rσ is outranked by the morphological suffixation constraints A&M[SUFF]. In addition, there are cases where faithfulness to the stem's stressed syllable is violated, e.g. *tipeś - tipsá* (66). Notice, however, that in these cases (i.e. the forms in (66)), stress is consistently word final (see §3.1.2). If stress is regular in the verbal system, then stress should not be specified in the lexicon (i.e. the input). In this case of regular alternation, the high ranking of FAITHσ́ is irrelevant. The crucial question is, of course, when and how the child restructures the lexicon such that stress is not specified. This issue is further elaborated in §3.3.3.1.

At this point, I would like to highlight the interrelation between the prosodic and the morphological structure, in the Minimal Word phase, where suffixes are included and prosodic alternation is involved. The emergence of suffixes results from the outranking of ANCHOR-Rσ by the A&M[SUFF]$_{CAT}$ constraints. In addition, the status of FAITHσ́ ought to be changed in the child's grammar, since the stress pattern in the Hebrew verbal system is regular (see §3.1.2) and so stress is not specified in the lexicon. In §3.3.3.1 I will discuss the status of FAITHσ́ in this phase and the process of its change in the course of acquisition. The interrelated grammar of prosodic and morphological constraints in the Minimal Word phase, excluding FAITHσ́, is illustrated below:

(68) Prosodic-morphological interaction in the Minimal Word phase (cf. (34))

a. Demotion of ANCHOR-Rσ:

ANCHOR-Rσ » A&M[SUFF]$_{CAT}$ ➞

A&M[SUFF]$_{CAT}$ » ANCHOR-Rσ

b. Prosodic constraint interaction in the Minimal Word phase:

PRWD=FTBIN » LEFTMOST

PRWD=FTBIN » MAXσ

*LAPSE » MAXσ

RIGHTMOST, PRWD=FTBIN

The tableaux below demonstrate the application of this constraint interaction to the data in (66) and (67):

(69) Disyllabic target with input-output alternation (66)

Target: patxá Child's input (= stem): patax – [PAST 3RD SG. FM.]

Input: patax – [PAST 3RD SG. FM.]	MOR	FAITH	MARKEDNESS				FAITH
	A&M [-a]	ANCHOR Rσ	*LAPSE	PRWD =FTBIN	RIGHT MOST	LEFT MOST	MAX σ
a. táx	*!			*			*
b. pa.táx	*!					*	
c. pa.ta.xá		*	*!	*		**	
d. pa.tá.xa		*		*!	*	*	
e. pát.xa		*			*!		
f. ☞ pat.xá		*				*	*

The high ranking of the suffixation constraint A&M[-a] rules out the unsuffixed forms (candidates (a, b)). The outranking of MAXσ by the markedness constraints rules out candidates (c), (d) and (e). The only markedness constraint violated by candidate (f) is LEFTMOST, which is ranked below the other markedness constraints. Therefore *naflá* is the optimal candidate. Notice that the equal ranking of RIGHTMOST with PRWD=FTBIN and above LEFTMOST, results in the correct stress pattern. Below is an example relating to the data presented in (67), where disyllabic forms are produced for trisyllabic targets:

(70) Trisyllabic target without input-output alternation

Target: patáx-ti Child's input (= stem): patax – [PAST 1ST SG.]

Input: patax – [PAST 1ST. SG]	MOR	FAITH	MARKEDNESS				F
	A&M [-ti]	ANCHOR Rσ	*LAPSE	PRWD =FTBIN	RIGHT MOST	LEFT MOST	MAX σ
a. táx	*!			*			**
b. pa.táx	*!					*	
c. pa.tax.tí		*	*!	*		*	
d. pa.táx.ti		*		*!	*	*	

e. ☞×	tax.tǐ		*			*	*
f. √	táx.ti		*		*!		*

Candidate (e) is the optimal candidate although it is not the actual form produced by the children. This form is not found in any of the children's corpuses available to me (see §3.1.3). The actual form found is *taǽx.ti* (f), which is ruled out by RIGHTMOST. This form reflects a disparity from the target form with respect to the first syllable of the stem, but not with respect to the stress pattern. An adequate account for the production of *taǽxti* for *patáxti (*70) alongside the adult-like form *patxá* (69), requires the reconsideration of the faithfulness relations, the notion of 'input', and the role of FAITHσ́ in the grammar of prosodic alternation in the course of acquisition. These issues are addressed in §3.3.3 below, where the acquisition path is considered in view of alternating paradigms.

3.3.3 THE ACQUISITION PATH IN VIEW OF ALTERNATING PARADIGMS

Alternation is represented in OT grammar through the crucial ranking of markedness constraints above faithfulness constraints (see §2.2.1). In §3.1.2.2, I presented an OT analysis of the Hebrew alternating verb paradigms discussed in this section. The analysis presented there shows the dominance of markedness constraints, such as PRWD=FTBIN and *LAPSE, over the faithfulness constraint MAXσ. These markedness constraints are dominant in the prosodic acquisition path in §3.2 up to the Minimal Word Phase (§3.2.2.2). Beyond the Minimal Word phase, they are gradually demoted in order to allow trisyllabic and quadrisyllabic nouns to surface (§3.2.2.3).

In §3.3.2, I discussed the interrelation between prosodic and morphological constraints. I showed that at the stage where children start to produce productive suffixes, their prosodic structure is restricted to maximally two syllables, and they are therefore considered to be at the Minimal Word phase. Some of the suffixed verbs at this stage are completely faithful to the inflected target forms, e.g. *patxá*, and some are not, e.g. *taǽxti* (for *pataǽxti*). This means that further reranking is required in order to allow *pataǽxti*. However, these data already exhibit alternating paradigms in the child's

production (e.g. *pataχ – patxaˊ – taχti*).

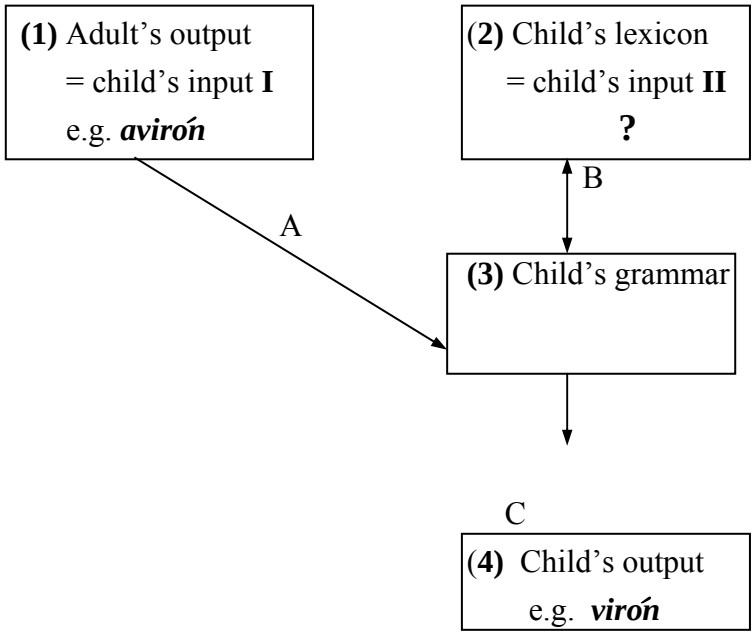
In this section, I continue the discussion of the prosodic and morphological acquisition paths, based on the analysis of Hebrew verb inflection suggested in §3.1.2. Two central topics will be addressed: faithfulness relations and the notion of 'input' (§3.3.3.1); and constraint interaction in the course of the acquisition of alternating paradigms (§3.3.3.2).

3.3.3.1 Reconsidering 'input' and faithfulness relations: In alternating paradigms, different outputs for a single input surface across the paradigm. For example, the forms *pataχ – patxaˊ – pataχti*, are the output forms of the input (i.e. lexical stem) *patax*.

In the final state (i.e. adult grammar), the assumption that *patax* is the input (i.e. the lexical representation) is based on the principles of lexicon optimization, which require minimal disparities between the input (i.e. lexical representation) and output (see §2.2.2). In the case of alternating paradigms, it is impossible for all surface forms to be identical to the input, therefore the input should be the form that best explains the paradigm as a whole, given a particular constraint interaction (see §2.2.2.2).

In the course of language acquisition, where changes continuously occur (via reranking), the child's input is not always straightforward. According to the basic assumptions of OT, the lexicon mirrors the constraint interaction of a particular grammar. In the course of acquisition, reranking is an ongoing process, so it is likely that an ongoing process of lexicon optimization is also required throughout the acquisition path. In §3.2, where the acquisition of morphologically-free forms is explored, I assumed the target form (i.e. the adult's output, including stress) to be the child's input. This faithfulness relation is illustrated below:

(71) Faithfulness relation in morphology-free acquisition path

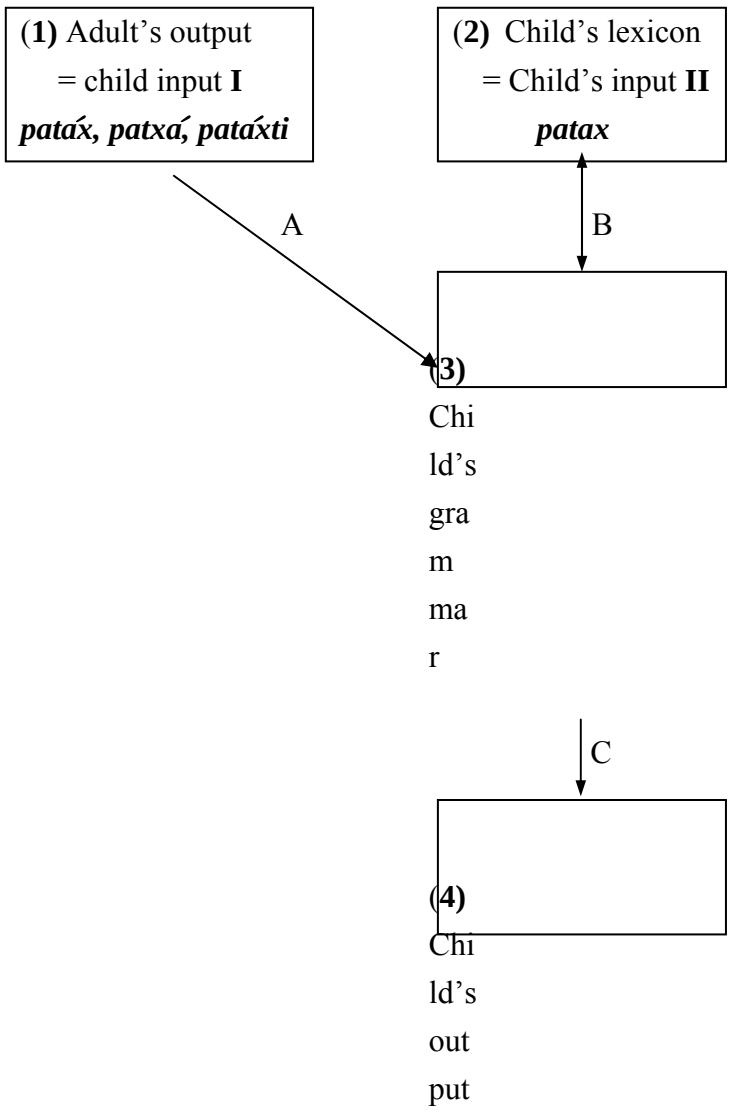


The diagram above illustrates the input-output relations assumed in §3.2. Box (1) represents the target forms, which are the adult's outputs. These outputs serve as input for the children in the construction of their grammar (represented by box (3)). The child's lexicon (box (2)) is not addressed in §3.2 because the absence of alternation disguises any overt evidence of the child's lexical representation (cf. §2.2.1). Boxes (2), (3) and (4) change continuously in the course of acquisition. The changes occurring in boxes (3) and (4) are the focus of the analysis of morphology-free forms (§3.2), which could not provide evidence for the changes occurring in box (2). The bi-directional arrow (B) represents the OT assumption that changes in the grammar affect the lexical representation (i.e. lexicon optimization) and vice-versa (i.e. lexical items serve as input and affect the evaluation of faithfulness constraints). The way this interrelation works is elaborated below.

When exploring the acquisition of alternating paradigms, the child's input in its

lexical representation is crucially relevant to understanding the child's production. The question is how to represent the changes that take place in the child's lexicon and what can serve as evidence for this change. In the spirit of the approach maintained throughout this chapter, I assume that this change takes place gradually. That is, I assume that the child 'uses' the adult's output as input all along the acquisition path while building the lexicon. This process continues until the child attains the final state grammar. In this state, if a single form is considered (as in §3.2), input-output identity is presumed even in the absence of direct evidence (see §2.2.2.1), but when alternating paradigms are considered, evidence of lexical representation becomes available. The diagram in (72) differs from that in (71) only in this respect:

(72) Multiple faithfulness relations in the acquisition of alternating paradigm



pataχ́,
patxá,
taχ́ti

The difference between the two diagrams is not in the grammatical model, but in its content, where in fact only that in (72) provides the required evidence for such a model. In (72) the target (box (1)) and the child's output (box (4)) include various alternating forms, whereas in (71) they include a single form. Based on the discussion in (§3.3.1), the emergence of alternating forms in the child's output allows to raise assumptions with respect to the child's lexicon (box (2)). The assumed input (i.e. lexical form) for the paradigm in the current example is *patax* (i.e. the stem). Arrows A and B both lead to the child's grammar, providing two types of input: the target forms (A) and the lexical form (B). Arrow A leads to output-output faithfulness and arrow B leads to input-output faithfulness. The bi-directional arrow (B) also represents the interrelation between the reranking occurring in the child's grammar and lexicon optimization. Notice that this model coincides with the notion of *multiple correspondence* (McCarthy and Prince 1995), where a grammar consists of faithfulness constraints that 'look' at two different input forms. Thus, the model in (72) is not unique to children's grammar in the course of acquisition. In what follows I argue for the validity of the model illustrated in (72), based on the analysis proposed for the data in the previous section (§3.3.2.2).

The previous section concluded with a problem posed by the child's form *taχ́ti* for *pataχ́ti*. The grammar presented above correctly accounts for other forms in that paradigm (i.e. *patxá* (69)), but rules out *taχ́ti* (70) and wrongly selectes *taxtí*. The difference between *patxá* and *taχ́ti* is the position of stress. In fact, this problem provides the necessary insight to multiple faithfulness relations in the course of acquisition.

In tableau (69), I showed that the equal ranking of RIGHTMOST and PRWD=FTBIN above LEFTMOST, results in the correct stress pattern of the form *patxá*. The problem

is that in (70), RIGHTMOST rules out the correct output, i.e. *taxti* and instead, the form to emerge as the optimal output is *taxtí*, which is not found in the children's corpus in any phase along the acquisition path. In fact, there are no incorrectly stressed verbs in the children's corpus. Therefore, a significant component is missing in the analysis presented in the previous phase, which enables incorrectly stressed forms to be optimal. Before dealing with this component, I present again the tableaux accounting for *patxá* vs. *taxti*:

(73) Correct optimal form – *patxá* (cf. (69))

Adult's output: *patxá*

Child's input (= stem; i.e. the lexical form): patax – [PAST 3RD SG. FM.]

Input: patax – [PAST 3RD SG. FM.]	MOR	FAITH	MARKEDNESS				FAITH
	A&M [-a]	ANCHOR Rσ	*LAPSE	PRWD =FTBIN	RIGHT MOST	LEFT MOST	MAX σ
a. táx	*!			*			*
b. pa.táx	*!					*	
c. pa.ta.xá		*	*!	*		**	
d. pa.tá.xa		*		*!	*	*	
e. pát.xa		*			*!		*
f. ☞ pat.xá		*				*	*

(74) Incorrect optimal form – *taxtí* (cf. (70))

Adult's output: *pataχ-ti* Child's input (= stem): patax – [PAST 1ST SG.]

Input: patax – [PAST 1ST SG]	MOR	FAITH	MARKEDNESS				FAITH
	A&M [-ti]	ANCHOR Rσ	*LAPSE	PRWD =FTBIN	RIGHT MOST	LEFT MOST	MAX σ
a. táx	*!			*			*
b. pa.táx	*!					*	
c. pa.tax.tí		*	*!	*		**	
d. pa.táx.ti		*		*!	*	*	
e. ☞× tax.tí		*				*	*
f. √ táx.ti		*			*!		*

In §3.3.2 above, I noted that insofar as the restriction on the number of syllables is concerned, the children's grammar in the Minimal Word phase (i.e. disyllabic words) is not far from the final state of Hebrew verbs. Thus, the adult-like vowel deletion and stress position in *patxá* (69) is provided by the constraint interaction of that phase.

The high ranking of PRWD=FTBIN and *LAPSE in the child's grammar, as well as in the adult's, provides similar results.

The problem in (74) has to do with the stress pattern, as this grammar cannot provide leftmost stress in disyllabic forms as in *taxti*. In order to understand the essence of the problem, I present below the subsequent phase, in which trisyllabic words are produced and the adult-like form *pataxti* is the optimal form. This form is selected not as a result of reranking RIGHTMOST, but as a result of demoting PRWD=FTBIN below MAXσ (see §3.2.2.3):

(75) Correct optimal form in the final state: *pataxti*

a. Reranking: PRWD=FTBIN » MAXσ ➔

MAXσ » PRWD=FTBIN

b. The other constraints are ranked as in the Minimal Word phase:

*LAPSE » MAXσ

PRWD=FTBIN » LEFTMOST

RIGHTMOST, PRWD=FTBIN

c. The tableau:[36]

Adult's output: patáx-ti Child's input (= stem): patax – [PAST 1ST SG.]

Input: patax – [PAST 1ST SG.]	MARKEDNESS				FAITH
	*LAPSE	MAXσ	PRWD =FTBIN	RIGHT MOST	LEFT MOST
a. tax.tǐ		*!			*
b. táx.ti		*!		*	
c. pa.tax.tǐ	*!		*		**
d. ☞ pa.táx.ti			*	*	*

The grammar represented by this tableau is the final state which the children should eventually attain. The difference between (74), where disyllabic forms with incorrect (final) stress are selected (i.e. *taxtí*), and (75), where trisyllabic forms with correct (non-final) stress are selected, has nothing to do with the constraint

[36] To simplify the discussion, I henceforth exclude the suffixation constraints (A&M[SUFF]$_{CAT}$) and ANCHOR-Rσ, and consider only suffixed candidates which inevitably violate ANCHOR-Rσ.

RIGHTMOST. Rather, the demotion of PRWD=FTBIN, allows *LAPSE to emerge and affect the output, by ruling out *pataxtí* with final stress.

In light of these observations, I propose that FAITHσ́ is effective in the children's grammar as long as the grammar is intermediate, and it requires, as shown in §3.2, faithfulness to the adult's output. That is, on the one hand, when the children **productively** produce inflected verbs that constitute a paradigm, it is likely to assume that they make reference to the lexical representation of the stem (e.g. *patax* in the current example), which is the input of their grammar (see (72)). On the other hand, as long as the child has not attained the final state, the adult's output still plays a role as the input of the child's grammar. The case discussed here provides evidence for the role the adult's output plays with respect to stress. Below, I propose the constraint interaction for the Minimal Word phase of verb inflection, which includes a distinction between faithfulness relating to the child's lexicon (i.e. Input-Output (I-O)) and faithfulness relating to the adult's output (i.e. Output-Output (O-O)):

(76) Minimal Word phase in the acquisition of alternating paradigms (cf. (72)):

A&M[SUFF]$_{CAT}$ » ANCHOR-Rσ I-O

FAITHσ́ O-O » RIGHTMOST

PRWD=FTBIN » MAXσ I-O

*LAPSE » MAXσ I-O

PRWD=FTBIN » LEFTMOST

RIGHTMOST, PRWD=FTBIN

As described above, FAITHσ́ O-O is ranked above RIGHTMOST. Note that this is the same FAITHσ́ used in §3.2, which relates to the target form. MAXσ is specified for I-O, based on evidence from the children's productions in this phase. That is, that *patáx* and *patxá* appear alongside *taxti*, indicates that the first syllable of the stem, i.e. *pa*, is encoded. It does not surface due to the high ranking of PRWD=FTBIN. Specifying

MAXσ as an I-O relation differs from its specification as an O-O relation (i.e. the adult's form), because the former relates to the stem as the input (e.g. *patax*) and the latter to the target form (e.g. *patxa*̌). This does not mean that MAXσO-O is not present in the child's grammar, but that it is presumably ranked low, as a consequence of the same path of change discussed here with respect to FAITHσ́. The tableaux below demonstrate the application of the constraint interaction in (76) to the target forms *patxa*́ and *pataxti*, which surface in this phase as *patxa*́ and *taxti*, respectively:

(77) Evidence of multiple-faithfulness relation (cf. (72))

a. Child's input **I** (= adult's output): patxá

Child's input **II** (= child's lexical representation): patax - [PAST 3RD. SG. FM.]

Input **I**: patxá	MARKEDNESS				FAITH	
Input **II**: patax – [PAST 3RD. SG. FM.]	*LAPSE	FAITHσ́ O-O	PRWD =FTBIN	RIGHT MOST	LEFT MOST	MAX I-O
a. pataxá	*!		*		**	
b. patáxa		*!	*	*	*	
c. pátxa		*!		*		*
d. ☞ patxá					*	*

Relevant inputs: FAITHσ́ O-O: *patxa* (I); MAXσ I-O: *patax* (II)

b. Child's input **I** (= adult's output): patáxti

Child's input **II** (= child's lexical representation): patax – [PAST 1ST SG]

Input **I**: patáxti	M	F	MARKEDNESS			F
Input **II**: patax – [PAST 1ST SG]	*LAPSE	FAITHσ́ O-O	PRWD =FTBIN	RIGHT MOST	LEFT MOST	MAX I-O
a. pa.tax.tǐ	*!	*	*		**	
b. pa.táx.ti			*	*!	*	
c. tax.tǐ		*!			*	*
d. ☞ táx.ti				*		*

Relevant inputs: FAITHσ́ O-O: *pataxti* (I); MAXσ I-O: *patax* (II)

Tableau (77b) shows that FAITHσ́ O-O is necessary for excluding *taxti*́ (candidate (c)). It is important to emphasize that the role of this constraint in the child's grammar goes beyond the exclusion of this form in the current example. It even goes beyond the fact that it coincides with the absence of verb forms which are incorrectly stressed

by children. FAITHσ O-O represents an essential component in the course of language acquisition, that is, the role of the adult's output. It shows that throughout the acquisition path, the children go through a gradual transition from dependence on the adult's outputs to increasing dependence on their own lexicon. The lexicon itself is gradually established together with the grammar's development from the initial to the final state, via reranking.

3.3.3.2 Constraint interaction in the acquisition of paradigms: The data discussed in §3.3.2 above show that the initial structure of productive suffixed verbs is that of the Minimal Word phase. The grammar of the Minimal Word phase is, however, not far from the final state grammar of the alternating paradigms discussed in this chapter. As discussed in §3.1.2.2, restrictions on the number of syllables and on the stress pattern are still effective in the adult's grammar of verb inflection. This final state differs from that of the morphologically-free forms presented in §3.2, where all markedness constrains relating to the number of syllables and to the stress pattern are ranked below faithfulness constraints.

The difference between the prosodic acquisition path of morphology-free forms and the acquisition path of alternating paradigms in morphological context is significant. The former path leads to a final state where all the markedness constraints are ranked below the faithfulness constraints as the children attain complete faithfulness to the target form. This, however, is misleading, since there is no (known) natural language without phonological phenomena (see Kaye 1989), i.e. there is no final state grammar where all markedness constraints are outranked by faithfulness constraints (see discussion in §5.3). Furthermore, the Hebrew verbal system is rich with phonological phenomena, only one type of which, i.e. prosodic alternation, is considered in this work.

The acquisition path of alternating paradigms leads to a more natural state, where

only some of the markedness constraints are ranked below faithfulness constraints. Such constraint interaction reflects the phonology of the language and not only the child-adult relation.

In what follows I will illustrate the transition of Hebrew inflected verbs (as described in §3.1.2.2), from the Minimal Word phase of the morphological acquisition path to the final state. Recall that disyllabic inflected target forms are correctly provided by the grammar of the Minimal Word phase of the morphological path, e.g. *patxá* (see (69)). The other forms discussed, e.g. *patáxti*, are not fully produced in the Minimal Word phase, since the high ranking of the constraint PRWD=FTBIN restricts the output to maximally disyllabic forms.

In the discussion of the prosodic acquisition path, the transition from the Minimal Word phase to a subsequent phase is explained by the demotion of PRWD=FTBIN below MAXσ (§3.2.2.3). In the grammar of alternating paradigms, forms like *patx-á* (**patax-a*) suggest that PRWD=FTBIN remains above MAXσ. According to the final state grammar presented in §3.1.2.2, PRWD=FTBIN is indeed ranked above MAXσ, where 'σ' equals a vowel, but MAXC is ranked higher. Thus, the final state grammar of Hebrew inflected verbs requires all the input consonants to surface, but at the same time restricts the number of syllables. The interaction between MAXC and the other markedness constraints result in trisyllabic words when the suffix is consonant initial (16) and in disyllabic when the suffix is vowel initial (15). Below are the lists of crucial rankings in the Minimal Word phase and in the final state:

(78) Crucial ranking in the Minimal Word phase (cf. (76))

PRWD=FTBIN » MAXC	(MARKEDNESS »FAITHULNESS)
FAITHσ O-O » RIGHTMOST	(FAITHULNESS » MARKEDNESS)

(79) Constraint interaction in the final state of alternating paradigms:[37]

[37] Recall that this grammar applies to the alternation I discuss in this chapter. In order to account for all types of prosodic and vocalic alternations existing in the system, further specifications are required. For example, the constraint PRWD=FTBIN should be decomposed, since the interaction between the constraints it includes affects the structure of prefixed forms like those of Binyan hitpaʔel (e.g. *hitlabéš-hitlabšá-hitlabášti*), which include quadrisyllabic forms. See Ussishkin (2000).

MAXC » PRWD=FTBIN (FAITHULNESS » MARKEDNESS)

(80) Similar constraint interaction in both phases:

*LAPSE » MAXσ (MARKEDNESS » FAITHFULNESS)

*$_{\sigma}$[CC » MAXσ (MARKEDNESS » FAITHFULNESS)

*LAPSE » RIGHTMOST (MARKEDNESS » MARKEDNESS)

PRWD=FTBIN, RIGHTMOST (MARKEDNESS, MARKEDNESS)

The transition from the Minimal Word phase to the final state of the alternating paradigms involves the demotion of PRWD=FTBIN below MAXC, and not below MAXσ (i.e. MAXV) as in the prosodic acquisition path. All other interactions remain the same, where markedness constraints outrank faithfulness constraints. Once PRWD=FTBIN is demoted, FAITHσO-O plays a less significant role, since higher ranked constraints provide the correct position of stress, including its alternation across the paradigm.

The tableaux below demonstrate this transition. Following the transition pattern in §3.2.3, the demotion of PRWD=FTBIN entails an intermediate phase involving variation:

(81) The transition to the final state of Hebrew verbs inflection

a. The child's inputs:
Child's input **I** (= adult's output): patáxti
Child's input **II** (= child's lexical representation): patax – [PAST 1ST SG]

b. The Minimal Word phase:

Input I: patáxti	F	M		M		F	
Input II: patax – [PAST 1ST SG]	FAITHσ O-O	*LAPSE	*[$_{\sigma}$CC	PRWD =FTBIN	RIGHT MOST	MAXC	MAXσ
a. pa.tax.tǐ	*!	*		*			
b. ptáx.ti			*!		*		*
c. tax.tǐ	*!					*	*
d. pa.táx.ti				*	*!		
e. ☞ táx.ti					*	*	*

c. The transition phase:

PRWD=FTBIN » MAXC ➞

MAXC ~ PRWD=FTBIN

Input I: patáxti	F	M		F	M		F
Input II: patax – [PAST 1ST SG]	FAITHσ́ O-O	*LAPSE	*[σCC	MAXC	PRWD =FTBIN	RIGHT MOST	MAXσ
a. pa.tax.tǐ	*!	*			*		
b. ptáx.ti			*!			*	*
c. tax.tǐ	*!			*			*
d. ☞ pa.táx.ti					*	*	
e. ☞ táx.ti				*		*	*

d. The final state

Input I: patáxti	F	M		F	M		F
Input II: patax – [PAST 1ST SG]	FAITHσ́ O-O	*LAPSE	*[σCC	MAXC	PRWD =FTBIN	RIGHT MOST	MAXσ
a. pa.tax.tǐ	*!	*			*		
b. ptáx.ti			*!			*	*
c. tax.tǐ	*!			*			*
d. ☞ pa.táx.ti					*	*	
e. táx.ti				*!		*	*

It should be noted that in the final state, FAITHσ́O-O is unnecessary and the correct output would emerge without it as well (as it does in the adult's grammar). When MAXC is crucailly ranked above PRWD=FTBIN (81c) both *taxti* (e) and *taxtǐ* (c) are ruled out by it, and *pataxti* is optimal even though it violates RIGHTMOST. The tableau below demonstrates this point:

(82) The irrelevance of FAITHσ́ in the final state

Input: patax – [PAST 1ST SG]	M		F	M		F
	*LAPSE	*[σCC	MAXC	PRWD =FTBIN	RIGHT MOST	MAXσ
a. pa.tax.tǐ	*!			*		
b. ptáx.ti		*!			*	*
c. tax.tǐ			*!			*
d. ☞ pa.táx.ti				*	*	
e. táx.ti			*!		*	*

The last point I would like to raise with respect to this transition phase, relates to the form *patxá*. The tableau below shows that the transition phase (81b) does not

select any form other than the correct one, *patxá*:

(83) Disyllabic targets in the transition phase (cf. (81c))

Input : patax – [PAST 3RD. SG. FM.]	M		F	M		F
	*LAPSE	*[σCC	MAXC	PRWD =FTBIN	RIGHT MOST	MAXσ
a. pátxa					*!	*
b. pta.xá		*!				*
c. pataxá	*!			*		
d. patáxa				*!	*	
e. ☞ patxá						*

It is interesting to note that the databases of children acquiring Hebrew (see §3.1.3) show almost no cases of forms like *pataxá* (candidate (c)) which violate *LAPSE and none at all of forms like *patáxa*, which violate RIGHTMOST (candidate (d)). This finding supports the principles of the acquisition path proposed in this study. As I showed in (§3.2.3), children do not produce structures which are prosodically more marked than the target forms. In OT terms, this means that children do not violate markedness constraints which are not violated by the adult. Moreover, violation of RIGHTMOST, which rules out *patáxa*, does not exclude *patáxti*, not because the children are particularly faithful to this form rather than the other. The form *patáxti* is optimal although it violates RIGHTMOST, as a result of the interaction of RIGHTMOST with the other constraints.

To conclude, the acquisition path in view of alternating paradigms shows that the prosodic and the morphological paths are interwoven all along the course of acquisition.

In §3.3.1 I argued that as far as prosodic development is concerned, suffixed forms could surface as early as the pre-Minimal Word phase, and yet they do not. However, even though the emergence of inflectional suffixes is not depended on prosodic development, a constraint-based approach of the phonology-morphology interface is appropriate for representing the initial state of morphological development. The model I presented explains the low frequency of rote-learned suffixed forms and represents the morphological initial state where productive suffixation is not yet

evident in the children's productions. The data indicate that children identify stems, and use them for lexical reference, before they productively attach suffixes to them.

In §3.3.2 I showed that when productive suffixes emerge, the suffixed forms produced are subject to the phonological restrictions enforced by markedness constraints. These constraints restrict the number of syllables in the word and affect the stress pattern. The data presented in this section show alternating paradigms, which indicate that children actually do refer to the stem to attach the suffixes. However, in §3.3.3.1 I raised the question of faithfulness relations, i.e. whether the adult's output plays any role in a phase where the children show evidence of their own lexical representation. I claimed that the adult's output keeps playing a role until the children attain the final state grammar, which generates the alternating forms regularly.

I concluded this section by showing that the acquisition path of alternating paradigms leads to a final state where certain markedness constraints are ranked above faithfulness constraints. These markedness constraints outrank faithfulness constraints in the initial state and remain in this position in the final state grammar of alternating paradigm. A grammar where certain markedness constraints are ranked above faithfulness constraints and certain markedness constraints are not, reflects a phonological system of a natural language.

3.4 SUMMARY

In this chapter I viewed the process of language acquisition from several points of view. The starting point of all the topics discussed here is the **change** throughout the acquisition path: change in the development of the prosodic structure of a single output form (§3.2), change in the morphological development (§3.3.1, §3.3.2) and change in an input form (§3.3).

The path of acquisition presented in §3.2 is represented in OT as a process of constraint reranking, whereby markedness constraints are demoted below faithfulness constraints, up until the point where input-output identity is achieved, that is, until the

child's output is identical to the target form. The acquisition process involves intermediate variable phases (§3.2.3). These phases are represented by the crucial non-ranking of conflicting constraints. I have claimed that the process of constraint demotion involves an intermediate phase of unstable ranking, i.e. crucial non-ranking, before the opposite crucial ranking is set:

(84) A change as a process of constraint reranking

Phase *n*:	C_1 » C_2	e.g. PRWD=FTBIN » MAXσ
Reranking:	C_1 » C_2	
Intermediate phase:	C_2 ~ C_1	
Phase *n+1*:	C_2 » C_1	MAXσ » PRWD=FTBIN

In looking at the acquisition of morphological paradigms and at the phonological alternation involved (§3.3), I obtained insight into several issues which are not accessible when considering the acquisition of single forms out of morphological context. In §3.3.1 I showed that morphological knowledge, namely the distinction between stems and suffixes, is evident before any *productive* use of these suffixes appears in the children's corpus. The OT representation I suggested for this phase is the crucial ranking of phonological constraints above morphological constraints. The morphological development is represented by reranking, where faithfulness constraints are demoted below morphological constraints:

(86) Phonological and Morphological changes as a process of reranking

Initial phase:		MARKEDNESS » FAITHFULNESS
		PHONOLOGY » MORPHOLOGY
Acquisition path:		
Phonological	MARKEDNESS »	
FAITHFULNESS →		
		FAITHFULNESS » MARKEDNESS
Morphological	FAITHFULNESS » MORPHOLOGY	→
		MORPHOLOGY » FAITHFULNESS

The phonological and morphological acquisition paths are interwoven. At some point morphological constraints dominate phonological constraints, when the phonological development has not yet been completed (see §3.3.2.2):

(87) Phonology-Morphology interaction in the acquisition path

a. MORPHOLOGY » FAITH (F_1) *as a consequence of* F_1 » MORPH

b. MARKEDNESS (M_2, M_3) » FAITH (F_2, F_3) *the same as in the initial state*

c. FAITH (F_2) » MARKEDNESS (M_2) *as a consequence of* M_2 » F_2

Constraint interaction as in (87) provides forms like *táx-ti* for *patáx-ti* where the suffix surfaces in the child's output (87a), but the initial syllable of the stem does not (87b). This form appears alongside *patx-á*, where the second vowel of the stem *patax* is missing. However, this vowel is also missing in the target form, due to the dominance of PRWD=FTBIN in Hebrew verbs (see §3.1.2.2). This is therefore an intermediate phase for forms like *patáx-ti*, but the final phase for forms like *patx-á*. The alternation *patáx – patxá* is represented in OT by the dominance of a markedness constraint above a faithfulness constraint. Assuming that in the initial ranking all faithfulness constraints are dominated by markedness constraints (§3.2.1.3), the ranking that yields the form *patxá*, does *not* result from change (87b). This is supported by the absence of variability with respect to the deleted vowel (e.g. **pat**a**xa* does not vary with *patxá*), because, as I argued in §3.2.3, in the course of change, inter-phase variation is expected. The subsequent phases are thus as follows (see §3.3.3.2):

(88) The final phases of morpho-phonological acquisition

a. MORPHOLOGY » FAITHFULNESS: *allows suffixes to surface*

b. M_3 » F_3: remains the same as in the initial state; allows the alternation

patáx – patx-á

c. Reranking: i. Constraint Demotion: M_2 » F_2 →

ii. Inter-phase variation: F_2~ M_2 (e.g. *táxti ~ patáxti*) →

iii. Final state: F_2 » M_2 (*patáxti*)

The acquisition path of the paradigms discussed here provides another important insight, into the faithfulness relations operating in the child's intermediate grammar. In §3.3.3.1 I provided evidence for the role of the adult's output (i.e. the target form) in the child's grammar. I claimed that only when the child completes the process of reranking, does the adult's output become irrelevant, and the child no longer needs to rely on it.

Several questions regarding the model I presented above need to be further developed: (a) what motivates reranking (88ci)?; (b) what blocks reranking (88b)?; and (c) what is the motivation for fixed ranking, or in other words, why don't the intermediate (variable) phases survive?

These questions are relevant also to the forthcoming chapter, where I deal with a case of language change from a synchronic point of view, and suggest the same model of change.

Chapter 4
VARIABLE AND OPTIMAL GRAMMARS IN LANGUAGE CHANGE

This chapter is concerned with intermediate grammars in the course of language change, based on a synchronic analysis of **spirantization** in Modern Hebrew (MH), where the alternation between stops and fricatives is opaque and variable.

The premises presented in this work within the framework of Optimality Theory (§2) are shown to apply to the processes and phenomena involved in language change. The common characteristics of language acquisition and language change are highlighted, showing that the basic principles characterizing intermediate phases in language acquisition (§3.2.3, §3.3.3) are evident in intermediate phases of language change, and can be accounted for within the same formal model.

The main theme of this chapter is the conditions for change, and the phenomena involved in change. Spirantization in MH serves as a highly evaluated test case for a grammar in change, as the current state of the language includes several significant contradictions which, I claim, are not random and are therefore expressible within a model of the speaker's intuitive linguistic knowledge.

I will argue that variability should be viewed within the context of a paradigm, rather than within the context of a single form. Thus, in order to understand the cause and the behaviour of variable forms, these forms are accounted for with respect to other words in the paradigm. For example, the variable verbs in the past tense ***v**ikeš* ~ ***b**ikeš* 'requested' are better understood when compared to the form in the future tense *ye**v**akeš* 'will request' which is not variable (**ye**b**akeš*). To this end, the data considered in this chapter include only verbal paradigms. Nouns are not considered since they do not display a consistent inflectional paradigm in MH.[38]

[38] See discussion of the Hebrew verbal system in §3.1 and a full representation of the verb structures (i.e. the binyanim) in the appendix.

The chapter is organized as follows: In §4.1 I present an introduction, which includes a brief language background and the data source. §4.2 to §4.4 are devoted to the formal account of the several phenomena related to the alternation between stops and fricatives in MH. This includes an Optimality Theoretic account of the grammar of regular alternation and conditions for variation and grammar optimization. In §4.5 I summarize the analysis' conclusions with respect to intermediate grammars, the inevitable variation invoked in language change, and its consequences.

4.1 INTRODUCTION

Regular alternation between stops and fricatives, evident in earlier phases of Hebrew, did not survive in MH. Rather, the alternation between stops and fricatives in MH involves a great deal of opacity and free variation. This phenomenon has been addressed by many Hebrew researchers (Ornan 1973, Fischler 1975, Schwarzwald 1976, Bolozky 1978a, Ravid 1991, Henkin 1997), and some formal accounts within a generative framework have been provided (Ben-Horin and Bolozky 1972, Barkai 1975, Doron 1980, Adam 1993).

This introductory section begins with a brief review of the historical changes affecting the status and the distribution of stops and fricatives in MH (§4.1.1) and continues with the theoretical basis of the analysis suggested in this chapter (§4.1.2).

4.1.1 LANGUAGE BACKGROUND

In Biblical Hebrew, presumably an earlier stage of MH (see §1.3), the stops *b, p, k* and *d, g, t* were in complementary distribution with the fricatives *β, ɸ, x* and *ð, ɣ, θ*, respectively. The fricatives were allophones that never surfaced in an environment other than postvocalic, either coda or onset:

(1)	p/ɸ, t/θ:	**p**aa**θ**aħ	'opened'	yi**ɸt**aħ	'will open'
	k/x, b/β:	**k**aa**β**aš	'conquered'	yi**x****b**oš	'will conquer'
	g/ɣ, d/ð:	**g**aa**ð**al	'grew'	yi**ɣd**al	'will grow'

As a result of the phonetic and structural changes listed below, MH exhibits a great deal of opacity with respect to spirantization, accompanied by a wide range of variation:

(2) Diachronic changes in Hebrew sounds and structures

a. The fricatives *θ, ð, ɣ*, which alternated in earlier stages of the language with the stops *t, d, g*, were lost. Consequently, only *p, b*, and *k* alternate with fricatives, namely *f, v, x*.

b. The non-alternating uvular stop *q* has merged with the velar stop *k* and no longer exists in the language.[39] Consequently, there is no phonetic distinction between the *k* that alternates with *x* (e.g. ***k****atav* 'wrote' – *yi****x****tov* 'will write') and the *k* derived from *q*, which never alternates (e.g. ***k****ataf* 'picked' – *yi****k****tof* **yi****x****tof* 'will pick').

c. The uvular fricative *ħ* has merged with the velar fricative *x*. Consequently, for most speakers of MH, there is no phonetic distinction between the *x* that alternates with *k* (e.g. *sa****x****ar* 'rented' – *yis****k****or* 'will rent') and the *x* that is derived from *ħ* and never alternates (e.g. *sa****x****ar* 'traded' – *yis****x****or* 'will trade').

d. The labial glide *w* has merged with the labial fricative *v* and no longer exists in the language. Consequently, there is no phonetic distinction between the *v* that alternates with *b* (e.g. ***b****itel* 'canceled' – *ye****v****atel* 'will cancel') and the *v* which was originally *w*, and never alternates (e.g. ***v****iter* 'gave up' – *ye****v****ater* 'will give up).

[39] Abstract analyses (e.g. Ornan 1973) do postulate *q* in the UR, and assume absolute neutralization at a later stage of the derivation. I do not subscribe to this view and assume that *q* does not exist in the phonology of MH.

e. The absorption of borrowed words, especially from Arabic, English and Yiddish, has strengthened the phonemic status of the fricative *f*, which was originally an allophone of *p* and surfaced only in postvocalic positions (e.g. ***p**atar* 'solved' – *yi**f**tor* 'will solve'). Thus, in addition to the alternating *f*, there is a non-alternating *f* (e.g. ***f**išel* 'screwed up' – *ye**f**ašel* 'will screw up').

f. In earlier stages of Hebrew, there were geminates, which blocked spirantization in postvocalic positions (e.g. *si**pp**er* 'told'). As a result of the loss of geminates in MH, stops appear in postvocalic positions (e.g. *si**p**er*), creating minimal pairs such as *si**p**er* 'told' – *sa**f**ar* 'counted'.

4.1.1.1 Opacity and variation: As a result of the diachronic changes described above, the distribution of stops and fricatives in MH is opaque (the distinction made between labials and dorsals is discussed later on):

(3) Opacity of stop-fricative alternation in MH

	Labial		**Dorsal**	
a. stop/fricative	p/f :	**p**izer – ye**f**azer 'to spread'	k/x:	**k**ibes – ye**x**abes 'to launder'
	b/v:	**b**itel – ye**v**atel 'to cancel'		
b. fricative/fricative	f /f :	**f**išel – ye**f**ašel 'to screw up'	x/x:	**x**ipes – ye**x**apes 'to search'
	v/v:	**v**iter – ye**v**ater 'to give in'		
c. stop/stop	p/p:	si**p**er – yesa**p**er 'to tell'	k/k:	**k**ipel – ye**k**apel 'to fold'
	b/b:	si**b**ex – yesa**b**ex 'to complicate'		

The data in (3) show that alternation does not always occur (3b,c). In addition, fricatives may appear in non-postvocalic positions (e.g. ***v**iter* (3b)) and stops may appear in postvocalic positions (e.g. *si**p**er* (3c)).

In a rule-based theory, in which segmental alternation is represented as a consequence of feature changing, the regular alternation in Biblical Hebrew (1) is represented as follows:

(4) Stop-fricative alternation in a rule-based approach:

[stop] ➞ [fricative]/ Vowel _____

Opacity of a rule is defined in terms of a counter-example to a predictable change. Kiparsky (1982c:75) defines two conditions for rule opacity:

(5) A rule A ➞ B / C _____ D is opaque if there are surface representations of the form:

i. A in environment C ____ D

or ii. B in environment other than C ____ D

In MH the rule in (4) is opaque because there are stops in postvocalic positions, e.g. *ki**b**el* (< *qi**bb**el*) – a violation of condition (5i), and fricatives in initial, non-postvocalic positions, e.g. ***v**alad* (< ***w**aalad*) – a violation of condition (5ii). As Kiparsky (1982c) indicates, rule opacity is a consequence of language change, where the original rule loses its naturalness. This may lead either to a complete loss of the rule or to new restrictions on its application. During this gradual change, it is not uncommon to find free variation. The data in (6) indicate that variation is found in various phonological environments:

(6) Variation in MH

a. Variation in word-initial position

Past		FUTURE		
pizer	~ **f**izer	ye**f**azer	* ye**p**azer	'to spread'
bitel	~ **v**itel	ye**v**atel	* ye**b**atel	'to cancel'

b. Variation in postconsonantal position

Past		FUTURE		
ka**f**ac	*ka**p**ac	yik**p**oc	~ yik**f**oc	'to jump'
ka**v**ar	*ka**b**ar	yik**b**or	~ yik**v**or	'to bury'
sa**x**ar	*sa**k**ar	yis**k**or	~ yis**x**or	'to rent'

c. Variation in word-initial **and** postvocalic position

Past		FUTURE		
kibes	~ **x**ibes	ye**x**abes	~ ye**k**abes	'to launder'
kisa	~ **x**isa	ye**x**ase	~ ye**k**ase	'to cover'

There is a significant difference between the paradigms in (6a&b) and the one in (6c). The paradigms involving the labials (6a&b) exhibit variation only in non-postvocalic position, while the one involving dorsals (6c) exhibits variation in both postvocalic and non-postvocalic position. It is the purpose of this chapter to account for the alternation and the absence of alternation in (3), as well as for the variation and the absence of variation in (6).

4.1.1.2 Labials vs. dorsals: Table (7) below summarizes the facts of stop-fricative alternation in MH. Alternation and the absence of alternation refer only to cases in which there is alternation in the phonological environment of the relevant segment (e.g. postvocalic *f* in *sa**f**ar* 'counted' and postconsonantal *p* in *yis**p**or* 'will count'). Cases in which the relevant segment does not change its phonological environment (e.g. postvocalic *p* in *si**p**er – yesa**p**er* 'told – will tell') are ignored here. Their effect on the stop-fricative alternation in MH is discussed in §4.2.

(7) Stops and fricatives in MH (in alternating environment)

	Labial		**Dorsal**			**coronal**
Predicted alternation	**p ~ f**	**b ~ v**	**k ~ x**			
Never alternate	**f** (< borrowed)	**v** (< w)	**k** (< q)	**x** (<ħ)	**g**	**t, d** **s, z, š**

As illustrated in (7), alternation between stops and fricatives in MH is manifested only by the pairs *p ~ f*, *b ~ v*, and *k ~ x*. All other consonants are irrelevant. More crucially, each of the labial and dorsal fricatives in the alternating pairs has a non-alternating counterpart. Furthermore, a distinction should be drawn between the dorsal and the labial pairs. First, the labials have a voiced as well as voiceless pair, while the dorsals have only a voiceless pair. More importantly, while labials only have non-alternating fricatives, the dorsals have a non-alternating fricative as well as a non-

alternating stop. I believe that this latter distinction allows the dorsal alternation to develop separately from the labial alternation. It should also be noted that the non-alternating dorsal fricative is much more common than the non-alternating labial fricatives since the latter ones are derived mostly from loan words while the former is derived from native words, which are more common. The table below summarizes the differences between labials and dorsals:

(8) Summary of differences between labials and dorsals

	LABIAL	DORSAL
ALTERNATION	All consonants are potentially subject to alternation	Only the voiceless consonants (*k*-*x*) are potentially subject to alternation.
VARIATION	Variation exists only in non-postvocalic position.	Variation exists both in postvocalic and non-postvocalic position.

Since the differences between labials and dorsals described above affect the way each group of sounds behaves, I will address labials and dorsals separately.

In what follows, I address the puzzle presented above within the constraint-based approach of Optimality Theory. All the phenomena related to the behaviour of stops and fricatives in MH, including the conditions for opacity and variation, are expressed by the types of constraint interaction proposed by Optimality Theory (see §2).

4.1.2 SEGMENTS IN OPTIMALITY THEORY

In OT, the constraints referring to segmental features are derived from **universal** rankings, based on markedness hierarchies (Prince and Smolensky 1993, Kager 1999). For example, the typological observation that stops are universally more common than fricatives (Greenberg 1978, Maddieson 1984), and its implication that stops are less marked than fricatives (see §1.1.2), is expressed by a universal hierarchy of constraints relating to the features CONT[INUANT] and STOP:

(9) Universal constraint hierarchy with respect to stops and fricatives

*[CONT] » *[STOP]

According to the above hierarchy, it is better to avoid fricatives than stops. Both constraints in this hierarchy are, of course, violable, but the hierarchy itself is constant, and thus universal. This means that a language which violates the higher ranked constraints, violates the lower ranked constraints as well, but not vice versa. This generalization reflects the fact that a language which has fricatives also has stops, but not necessarily vice versa: not every language that has stops has fricatives as well.

The alternation between stops and fricatives discussed in this chapter is motivated not by the general markedness of these groups of sounds, but by their prosodic position, i.e. postvocalic, vs. non-postvocalic (see §4.1.1). The interaction between segmental features and prosodic position is associated in phonological theories with the concept of **Sonority Sequencing Principle** (Steriade 1982), which provides an explanation for the interaction between segmental features and syllable structure. Before presenting the OT account of this issue (§4.1.2.2), I will briefly outline the basic notions involved in the sonority hierarchy and syllable structure.

4.1.2.1 Sonority values and syllabification: Although the phonetic property of sonority has not entirely been established (Kenstowicz 1994), sonority plays a crucial role in many phonological phenomena, especially in those referring to syllable structure. The relation between sonority of segments and their position in the syllable was already observed by Jeperson (1904), and Saussure (1922). The core of this observation is that the most sonorous segments occupy the peak of the syllable and the less sonorous segments occupy the margins (see Hooper 1976, Lowenstamm 1981, Steriade 1982, Clements 1990, Kenstowicz 1994, and many others).

The sonority of segments is presented along a scale, where vowels are the most sonorous sounds and voiceless stops are the least sonorous (Hooper 1976, Steriade 1982, Kenstowicz 1994). Along this scale, the sounds are arranged hierarchically, as below:

(10) The sonority scale

a. Vowels are more sonorous than consonants.

b. The sonority scale of vowels (from highest to lowest sonority):

Low > Mid > High

c. The sonority scale of consonants (from highest to lowest sonority):

Glides > Liquids > Nasals > Fricatives (voiced > voiceless) >

Stops (voiced > voiceless)

The syllabification of speech sounds is restricted by the sonority sequencing principle (SSP), which requires a sonority slope or plateau between the segments of the syllable, from the head to the margins (Steriade 1982). Thus, the syllabification of clusters and the sequences of segments in complex onsets and codas are governed by universal principles. For example, in a sequence such as $C_1VC_2C_3V$, the consonants C_1 and C_3 are syllabified in all languages as the onsets of the following vowel, while the syllabification of C_2 is language specific, and is therefore a case of cross-linguistic variation. However, this variability is restricted by the SSP, which rules out a complex onset if C_2 is more sonorous than C_3 (Steriade 1982, Clements 1990). That is, the sequence of segments in output forms is not only restricted by prosodic factors which account for the language's syllable structures, but also by segmental factors. The theoretical generalizations that account for sonority values and syllabification coincide with the interaction between segmental features and their position in the syllable:

(11) Typology of syllable position with respect to sonority values:

a. Onset: Stop > Fricative > Nasal > Liquid > Glide

b. Coda: Glide > Liquid > Nasal > Fricative > Stop

The hierarchies in (11) and the SSP are applicable to another phonological generalization regarding the sequence of syllables, namely syllable contact (Vennemann 1988). The principle of syllable contact requires that the onset of a syllable be less sonorous than the final segment of the preceding adjacent syllable, and that the sonority slope between these two segments should be the greatest, in

order to achieve maximal contrast between syllables. This principle coincides with the generalizations made by Clements (1990), according to which the sequence V.CV, rather than VC.V, is the best syllabification. This is consistent with syllable typology: while there are CV syllables in all languages, VC is found only in some languages.

On the basis of this typology and of the fact that all languages have CV syllables (with onsets and without codas), the 'best' syllable is an open syllable with a **stop** in the onset. Variation among languages results from the fact that most languages allow consonants other than stops to appear in onset position (otherwise no contrastive distinctions are available; see §2.2), but no language prohibits stops in onset position. The OT account of these issues is presented below.

4.1.2.2 Segments and syllables in Optimality Theory: The relation between sonority values and syllable structure (11) is expressed in OT through two universal hierarchies of markedness constraints, referring to syllable position. Both hierarchies consist of the same type of constraints, and the ranking reflects the sonority scale in two opposite relations:

(12) Sonority values and syllable position

a. Onset position:

$*_{\sigma}$[GLIDE » $*_{\sigma}$[LIQUID » $*_{\sigma}$[NASAL » $*_{\sigma}$[FRICATIVE » $*_{\sigma}$[STOP

b. Coda position:

*STOP]$_{\sigma}$ » *FRICATIVE]$_{\sigma}$ » *NASAL]$_{\sigma}$ » *LIQUID]$_{\sigma}$ » *GLIDE]$_{\sigma}$

These constraints are obviously violable, but the ranking is constant. The violability of the constraints is often motivated by the linguistic need for contrast, which is represented in OT by the dominance of faithfulness constraints (see §2.2). When referring to features, the faithfulness constraints are presented under the general constraint IDENT-F(EATURE) (McCarthy and Prince 1995):

(13) The general faithfulness constraint regarding features

IDENT-F

Correspondent segments S_1 and S_2 have identical values for some feature [F] (i.e. features do not change).

IDENT-F may be specified for specific features, e.g. IDENT-NASAL. Cross-linguistic variation with respect to the range of segments allowed in onset and coda results from the position of the general IDENT-F in the hierarchies in (12), the positions of the specific IDENT constraints (e.g. the relation between *NASAL]$_\sigma$ and IDENT-NASAL), and of their interaction with other constraints. It is not, however, a consequence of different rankings between the markedness constraints in the hierarchy itself.

The generalizations discussed in this section serve as the basis for the analysis of the issues related to the alternation between stops and fricatives in MH, suggested in the remainder of the chapter.

4.1.3 DATA SOURCE

The data presented in this chapter are based on a long-term study I have been conducting on the distribution and behavior of stops and fricatives in MH (Adam 1993).

All the data presented here are frequently used by the average native speakers of Hebrew in common speech. The sources are diverse: speech in various natural environments (e.g. coffee shops as well as campus gatherings, at home and on the street), and electronic media (i.e. radio and television). Therefore, the data source is not limited to a particular definable population, either in terms of education or socioeconomic distinctions (see Ravid 1988, 1995 for these considerations). Rather, it represents the average native Israeli Hebrew speaking population.

4.2 SPIRANTIZATION IN MODERN HEBREW

In this section I discuss the regular alternation between stops and fricatives in MH verbs. Two types of paradigms are presented in the subsections below: (a) alternating paradigms which provide evidence for the phonological generalization known as spirantization (§4.2.1); and (b) non-alternating paradigms which exist in MH alongside alternating paradigms (§4.2.2).

4.2.1 REGULAR ALTERNATION

One significant observation pursues in the analysis of the alternation between stops and fricatives in MH: there is an obligatory dependency of segmental alternation on prosodic alternation such that **segmental alternation occurs only when prosodic alternation occurs**. Three types of alternating paradigms exist in the MH verbal system:

(14) Alternating paradigms in MH verbs:

a. **Alternation in prosodic position** between *onset* and *coda*, where the onset is occupied by a stop and the coda by a fricative:

p*a.gaš* 'met' – *yi****f.****goš* 'will meet'

b*a.xar* 'chose' – *yi****v****.xar* 'will choose'

b. Alternation in **prosodic context:**

i. Alternation between ***word-initial*** and ***postvocalic*** *onset*, where the word initial position is occupied by a stop and the postvocalic position by a fricative:

b*i.keš* 'requested' – *ye.****v****a.keš* 'will request'

p*i.zer* 'spread' – *ye.****f****a.zer* 'will spread'

ii. Alternation between ***postvocalic*** and ***postconsonantal*** *onset*, where the postvocalic position is occupied by a fricative and the postconsonantal position by a stop:

*ka.**v**ar* 'buried' – *yik.**b**or* 'will bury'

*sa.**f**ar* 'counted' – *yis.**p**or* 'will count'

c. Summary

	STOP	**FRICATIVE**
(a)	onset	coda
(bi)	word-initial onset	postvocalic onset
(bii)	postconsonantal onset	

The analysis I propose for these alternations is based on universal generalizations concerning syllable structure and the sonority scale. Universally, a coda position prefers the most sonorous segment, while an onset position prefers the least sonorous segment. Therefore, in the competition between stops and fricatives, stops are preferred in onset position and fricatives in coda position (see §4.1.2).

In Optimality Theoretic terms, alternation is expressed by the crucial ranking of a markedness constraint above its competing faithfulness constraint (see §2.2.1). This ranking reflects the basic assumption that alternation is motivated by restrictions on output forms, allowing only the unmarked structure to surface. The paradigm in (15) reflects surface markedness regarding the prosodic positions of stops and fricatives, as stops are universally the most unmarked segments in onset positions and the most marked in coda positions:

(15) Prosodic alternation: onset – coda

	PAST	PARTICIPLE	FUTURE	
a.	**p**a.gaš	**p**o.geš	yi**f.**goš	'to meet'
b.	**b**a.dak	**b**o.dek	yi**v.**dok	'to escape'
	STOP IN ONSET		FRICATIVE IN CODA	

The markedness constraints that account for the paradigm in (15) are extracted from the respective universal rankings presented above, where it is better to avoid a fricative than a stop in onset position (12a), and it is better to avoid a stop than a

fricative in a coda position (12b). The faithfulness constraints which compete with these constraints are the specific INDENT-F (see (13)) for stop and fricative, requiring an input stop to surface as a stop, and an input fricative to surface as a fricative:

(16) The constraint accounting for stop-fricative alternation in MH

a. Markedness constraints

i. ***$_{\sigma}$[CONT**

A **fricative** does not appear in an **onset** position.

ii. ***STOP]$_{\sigma}$**

A **stop** does not appear in a **coda** position.

b. Faithfulness constraints

i. **IDENT$_{[STOP]}$**

Corresponding segments S_1 and S_2 have identical values for the feature [STOP] (i.e. a stop in the input is realized as a stop in the output).

ii. **IDENT$_{[CONT]}$**

Corresponding segments S_1 and S_2 have identical values for the feature [CONT] (i.e. a fricative in the input is realized as a fricative in the output).

When the markedness constraints are crucially ranked above the faithfulness constraints, *STOP]$_{\sigma}$ avoids a stop in coda position and *$_{\sigma}$[CONT avoids a fricative in onset position:

(17) A grammar yielding stops in onset position and fricatives in coda position

a. Crucial ranking:

*STOP]$_{\sigma}$ » IDENT$_{[STOP]}$

*$_{\sigma}$[CONT » IDENT$_{[CONT]}$

b. Alternating paradigm:

Input: **p**agaš		*STOP]$_\sigma$	*$_\sigma$[CONT	IDENT$_{[STOP]}$	IDENT$_{[CONT]}$
a.	**f**a.gaš		*!	*	
b. ☞	**p**a.gaš				
Input: yi**p**goš					
a. ☞	yi**f.**goš			*	
b.	yi**p.**goš	*!			

In the tableau above, the form ***f****agaš* violates *$_\sigma$[CONT due to the presence of a fricative in onset position, and the form *yi**p**goš* violates *STOP]$_\sigma$ due to the presence of a stop in coda position. The violation of IDENT$_{[STOP]}$ by the optimal form *yi**f**goš* is not crucial due to the low ranking of the faithfulness constraints. The constraint IDENT$_{[CONT]}$ is inactive, since the segment specified in the input is a stop.[40]

The grammar in (17a) applies not only to alternating paradigms, but also to the paradigms presented below, where there is no alternation in the environment, and either a stop appears in an onset position or a fricative appears in coda position:

(18) Consistent prosodic position: stop in onset or fricative in coda

a. The paradigms

	PAST	PARTICIPLE	FUTURE	
ONSET	hit.**b**a.yeš	mit.**b**a.yeš	yit.**b**a.yeš	'to be ashamed'
CODA	hi**f**.lig	ma**f**.lig	ya**f**.lig	'to sail'

b. The application of the grammar in (17a)

i. Onset position

Input: hit**b**ayeš		*STOP]$_\sigma$	*$_\sigma$[CONT	IDENT$_{[STOP]}$	IDENT$_{[CONT]}$
a. ☞	hit.**b**a.yeš				
b.	hit.**v**a.yeš		*!	*	
Input: mit**b**ayeš					
a. ☞	hit.**b**a.yeš				
b.	hit.**v**a.yeš		*!	*	

[40]As long as markedness constraints are crucially ranked above their competing faithfulness constraints, there is no direct evidence for the representation of the relevant segment in the input. The results would be the same regardless of whether a stop or a fricative is specified in the input. This issue is further discussed in §4.2.2.

ii. Coda position

Input: hi**f**lig		*STOP]$_\sigma$	*$_\sigma$[CONT	IDENT$_{[STOP]}$	IDENT$_{[CONT]}$
a. ☞	hi**f**.lig				
b.	hi**p**.lig	*!			*
Input: ya**f**lig					
a. ☞	ya**f**.lig				
b.	ya**p**.lig	*!			*

So far, the analysis has been focussed on stop-fricative alternation where the prosodic alternation is between onset and coda. This alternation reflects a universal generalization with respect to the unmarked segments in these syllable positions. The facts of Hebrew exhibit, however, more diverse cases of alternation between stops and fricatives, which require further modifications to the grammar (i.e. the ranking) presented so far.

In the following paradigms, fricatives are found in onset position, violating the constraint *$_\sigma$[CONT. Although the prosodic position (onset) is consistent in these paradigms, the prosodic *context* alternates between postvocalic onset and non-postvocalic onset:

(19) Alternation in prosodic context: postvocalic onset – non-postvocalic onset

a. **postvocalic** – **postconsonantal** onset

	PAST	PARTICIPLE	FUTURE	
i.	ka.**f**ac	ko.**f**ec	yik.**p**oc	'to jump'
ii.	sa.**v**al	so.**v**el	yis.**b**ol	'to suffer'
	FRICATIVE POSTVOCALIC		STOP POSTCONSONANTAL	

b. **word-initial** – **postvocalic** onset

	PAST	PARTICIPLE	FUTURE	
i.	**p**i.zer	me.**f**a.zer	ye.**f**a.zer	'to spread'
ii.	**b**i.tel	me.**v**a.tel	ye.**v**a.tel	'to cancel'
	STOP WORD INITIAL	FRICATIVE POSTVOCALIC		

The high ranking of the constraints given so far, *STOP]$_\sigma$ and *$_\sigma$[CONT, allows only stops in onset position, and fricatives in coda position. Given the data in (19), where also fricatives appear in onset position, there must be some other constraint which

overrides the effect of *$_{\sigma}$[CONT in some contexts. This constraint, I suggest, does not allow a stop in postvocalic position:[41]

(20) ***V-STOP**

The sequence [vowel]-[stop] is prohibited.

The constraints *V-STOP and *$_{\sigma}$[CONT are in conflict when the relevant segment is in a postvocalic onset position. The fact that postvocalic onsets are occupied by fricatives in MH verbs (e.g. *me.**v**a.tel* 'cancels') provides evidence of the crucial ranking of *V-STOP above *$_{\sigma}$[CONT. Since the coda position (in the absence of a complex coda) is a subset of postvocalic positions, the effect of *STOP]$_{\sigma}$ is absorbed by that of *V-STOP; therefore *STOP]$_{\sigma}$ will be ignored from here on:

(21) A modified grammar (cf. (17a))

***V-STOP » *$_{\sigma}$[CONT**

***V-STOP » IDENT$_{[STOP]}$**

*$_{\sigma}$[CONT » IDENT$_{[CONT]}$

The tableaux in (22)-(24) below demonstrate the grammar of the stop-fricative alternation presented in (19), based on the ranking in (21). Note that the faithfulness constraints IDENT$_{[STOP]}$ and IDENT$_{[CONT]}$ are crucially ranked at the bottom of the hierarchy, and do not affect the output. This ranking also indicates that there is no direct evidence for the representation of the relevant segments in the input. As long as markedness constraints are crucially ranked above their competing faithfulness constraints, the same output is selected for any given input (see §2.2.2). This generalization is demonstrated below, where both possibilities are considered for each type of paradigm:

[41] It should be noted that this constraint reflects the postvocalic context of spirantization in Tiberian Hebrew (see Benua 1997), where this is the only context of the fricatives (see §4.1.1).

(22) Alternation in prosodic position: stop in onset; fricative in coda

a. [STOP] in the input

Input: **p**agaš		*V-STOP	*$_{\sigma}$[CONT	IDENT$_{[STOP]}$	IDENT$_{[CONT]}$
a.	**f**a.gaš		*!	*	
b. ☞	**p**a.gaš				
Input: yi**p**goš					
a. ☞	yi**f.**goš			*	
b.	yi**p.**goš	*!			

b. [CONT] in the input:

Input: **f**agaš		*V-STOP	*$_{\sigma}$[CONT	IDENT$_{[STOP]}$	IDENT$_{[CONT]}$
a.	**f**a.gaš		*!		
b. ☞	**p**a.gaš				*
Input: yi**f**goš					
a. ☞	yi**f.**goš				
b.	yi**p.**goš	*!			*

(23) Alternation in prosodic context: postvocalic onset – postconsonantal onset

a. [STOP] in the input

Input: ka**b**ar		*V-STOP	*$_{\sigma}$[CONT	IDENT$_{[STOP]}$	IDENT$_{[CONT]}$
a. ☞	ka.**v**ar		*	*	
b.	ka.**b**ar	*!			
Input: yik**b**or					
a.	yik.**v**or		*!	*	
b. ☞	yik.**b**or				

b. [CONT] in the input

Input: ka**v**ar		*V-STOP	*$_{\sigma}$[CONT	IDENT$_{[STOP]}$	IDENT$_{[CONT]}$
a. ☞	ka.**v**ar		*		
b.	ka.**b**ar	*!			*
Input: yik**v**or					
a.	yik.**v**or		*!		
b. ☞	yik.**b**or				*

(24) Alternation in prosodic context: word-initial onset – postvocalic onset

a. [STOP] in the input

Input: **p**izer		*V-STOP	*$_{\sigma}$[CONT	IDENT$_{[STOP]}$	IDENT$_{[CONT]}$
a. ☞	**p**i.zer				
b.	**f**i.zer		*!	*	
Input: ye**p**azer					
a.	ye.**p**a.zer	*!			
b. ☞	ye.**f**a.zer		*	*	

b. [CONT] in the input

Input: **f**izer		*V-STOP	*$_{\sigma}$[CONT	IDENT$_{[STOP]}$	IDENT$_{[CONT]}$
a. ☞	**p**i.zer				*
b.	**f**i.zer		*!		
Input: ye**f**azer					
a.	ye.**p**a.zer	*!			*
b. ☞	ye.**f**a.zer		*		

The tableaux in (22)-(24) show that regardless of the segments represented in the input, a stop is selected only in word-initial and postconsonantal positions, and a fricative is selected in all postvocalic positions, as a result of the crucial ranking of the markedness constraints above the faithfulness constraints. This grammar, however, still does not cover all the occurrences of the alternating stops and fricatives, and further modifications are still necessary in light of the data discussed in the following section.

4.2.2 COUNTER-EVIDENCE FOR REGULAR ALTERNATION

In this section I present data that conflict with the alternations discussed in §4.2.1, and suggest a modified analysis that reconciles the conflict.

4.2.2.1 Postvocalic stops: Alongside the alternating paradigms discussed in §4.2.1, MH has non-alternating paradigms as well. Indeed, non-alternating paradigms have already been presented in (18). These paradigms exhibit fricatives in postvocalic positions (e.g. *hi**f**.lig – ya**f**.lig* 'sailed – will sail'), and stops in non-postvocalic positions (e.g. *hit.**b**a.yeš – yit.**b**a.yeš* 'was ashamed – 'will be ashamed'), as the grammar predicts. This is, however, not true for the data below: MH has paradigms where stops *do* appear in postvocalic position, incurring a violation of the dominating markedness constraint *V-STOP:

(25) Non-alternating paradigms

	PAST		FUTURE		
a.	ti**p**es	* ti**f**es	yeta**p**es	* yeta**f**es	'to climb'
b.	hitla**b**et	* hitla**v**et	yitla**b**et	* yitla**v**et	'to have doubts'

The violation of *V-STOP proves that the grammar in (21) is wrong. The question is whether this counterevidence indicates the complete loss of the spirantization process in the language. There is a phonological distinction between the paradigm in (25) and the alternating paradigm in (19), which indicates that a phonological generalization does exist, and so the process is not lost. The phonological distinction is this: paradigms with a stop-fricative alternation alternate prosodically, while paradigms without a stop-fricative alternation do not. That is, the following generalization can be made: a stop-fricative alternation occurs only in paradigms with prosodic alternation. When the prosodic context of a segment is preserved throughout the paradigm, the segment's features are preserved as well. The distinction between prosodically alternating and prosodically non-alternating paradigms is parallel to the prosodic structure and alternation of the MH verbal system (i.e. the binyanim):[42]

(26) Prosodic structure and alternation in the verbal system:

a. **C_1**

	PAST	FUTURE	PROSODIC ALTERNATION	SEGMENTAL ALTERNATION
B1	**C**a.CaC word-initial	yi**C**.Co/aC coda	yes	yes: **p**a.tax – yi**f.**tax
B2	ni**C**.CaC coda	yi.**C**a.CeC postvocalic onset	yes	yes: ni**f.**tax – yi.**p**a.tax
B3	hi**C**.CiC coda	ya**C**.CiC coda	no	no: hi**f.**lig – ya**f.**lig
B4	**C**i.CeC word-initial	ye.**C**a.CeC postvocalic onset	yes	yes: **p**i.zer – ye.**f**a.zer
B5	hit.**C**a.CeC postconsonantal	yit.**C**a.CeC postconsonantal	no	no: hit.**b**a.yeš – yit.**b**a.yeš

b. **C_2**

	PAST	FUTURE	PROSODIC ALTERNATION	SEGMENTAL ALTERNATION
B1	Ca.**C**aC postvocalic onset	yiC.**C**oC postconsonantal	yes	yes: ka.**f**ac – yik.**p**oc
B2	niC.**C**aC postconsonantal	yi.Ca.**C**eC postvocalic onset	yes	yes: niš.**b**ar – yi.ša.**v**er
B3	hiC.**C**iC postconsonantal	yaC.**C**iC postconsonantal	no	no: hil.**b**iš – yal.**b**iš
B4	Ci.**C**eC postvocalic onset	ye.Ca.**C**eC postvocalic onset	no	no: ti.**p**es – ye.ta.**p**es
B5	hit.Ca.**C**eC postvocalic onset	yit.Ca.**C**eC postvocalic onset	no	no: hit.la.**b**et – yit.la.**b**et

[42] See §3.1.1 and the appendix for the definition and presentation of the MH binyanim.

Based on the above distinction, a grammar that accounts for both types of paradigms (i.e. that in (19) and that in (25)) is presented below.

4.2.2.2 A revised analysis for stop-fricative alternation: Before presenting the modifications required in order to reconcile the conflict between alternating and non-alternating paradigms, it is necessary to address the issue of the inputs of these paradigms, i.e. the lexical representation.

Alternating paradigms do not bear evidence of a specific input, since the markedness constraints (*V-STOP, *$_{\sigma}$[CONT]) dominate the faithfulness constraints. Therefore, the faithfulness constraints do not get to affect the output form (see (22-24)). But when considering the non-alternating paradigm in (25), where only stops surface, the domination of a faithfulness constraint is crucial and the representation of the specific segments in the input is deduced.

Following the principles of *lexicon optimization* (§2.2.2), the input of the non-alternating paradigms in (25) should be specified for a *stop*, since fricatives never surface in these paradigms. In alternating paradigms, on the other hand, two competing segments appear on the surface – stops and fricatives (in this case). What would the optimal input for these paradigms be?

The paradigms in (25), providing counter-examples to (19), suggest that stops and fricatives are contrastive. There is no way to assume that forms like *ka**f**ac* and *ti**p**es* can be selected by the same grammar as the most harmonic forms if they are not specified differently in the input. Non-alternating paradigms like those in (25), where the stop remains as such in all contexts, suggest the ranking of IDENT$_{[STOP]}$ above the markedness constraints:

(27) Revised grammar I:

IDENT$_{[STOP]}$ » *V-STOP

*V-STOP » *$_{\sigma}$[CONT

*$_{\sigma}$[CONT » IDENT$_{[CONT]}$

The ranking of IDENT$_{[STOP]}$ above *V-STOP expresses the facts whereby the specification of [STOP] in the input is preserved in all contexts (e.g. *ti**p**es – yeta**p**es*). In other words, when [STOP] is specified in the input, alternation is blocked, since the faithfulness constraint that refers to it (IDENT$_{[STOP]}$) outranks the markedness constraint that avoids stops in certain positions (*V-STOP). Tableau (28) below demonstrates this case:

(28) Non-alternating paradigm: stop in postvocalic position

Input: ti**p**es		IDENT$_{[STOP]}$	*V-STOP	*$_{\sigma}$[CONT	IDENT$_{[CONT]}$
a. ☞	ti.**p**es		*		
b.	ti.**f**es	*!		*	
Input: yeta**p**es					
a.☞	ye.ta.**p**es		*		
b.	ye.te.**f**es	*!		*	

The case of postvocalic stops in non-alternating paradigms, where the lexical representation of the segment is obvious, has implications on the lexical representation of alternating paradigms, where a faithfulness constraint – IDENT$_{[STOP]}$ – is ranked high. As noted above, the crucial high ranking of a faithfulness constraint with respect to its competing markedness constraint, preserves lexical contrast and prevents alternation. Therefore, the high ranking of IDENT$_{[STOP]}$, which is crucial for non-alternating paradigms with postvocalic stops, indicates that in the alternating paradigm, the only lexical representation possible is a fricative. This inference is demonstrated in tableaux (29)-(31) below, where the grammar presented in (27) is applied to alternating paradigms. Two alternative lexical representations, with a stop and with a fricative, are examined, showing that a fricative is indeed the only possible input:

(29) Alternation in prosodic position: onset – coda

a. [STOP] in the input

Input: **p**agaš		IDENT$_{[STOP]}$	*V-STOP	*$_{\sigma}$[CONT	IDENT$_{[CONT]}$
a.	**f**a.gaš	*!		*	
b. ☞	**p**a.gaš				
Input: yi**p**goš					
a. √	yi**f.**goš	*!			
b. ☞✕	yi**p.**goš		*		

'√'= actual form; '☞✕'= optimal but not actual form

b. [CONT] in the input

Input: **f**agaš		IDENT$_{[STOP]}$	*V-STOP	*$_{\sigma}$[CONT	IDENT$_{[CONT]}$
a.	**f**a.gaš			*!	
b. ☞	**p**a.gaš				*
Input: yi**f**goš					
a. ☞	yi**f.**goš				
b.	yi**p.**goš		*!		*

Tableau (29a) shows that when the input is specified for [STOP], the selected outputs are ***p**agaš* and **yi**p**gošˇ*. While ***p**agaš* is the actual correct form, **yi**p**gošˇ* is a form that never surfaces, and so the wrong candidate is selected. Only when the input is specified for [CONT], as in (29b), are the correct outputs selected. Tableau (29b) shows that alternation takes place since the markedness constraint that refers to the fricatives, i.e. *$_{\sigma}$[CONT, is crucially ranked above the faithfulness constraint, IDENT$_{[CONT]}$. However, when considering both (29a) and (29b), it is clear that such an alternation can only occur when the input is *not* specified for [STOP]. The same results are obtained when considering the other types of alternating paradigms discussed in this chapter:

(30) Alternation in prosodic context: postvocalic onset – postconsonantal onset

a. [STOP] in the input

Input: ka**b**ar		IDENT$_{[STOP]}$	*V-STOP	*$_{\sigma}$[CONT	IDENT$_{[CONT]}$
a. √	ka.**v**ar	*!		*	
b. ☞✕	ka.**b**ar		*		
Input: yik**b**or					
a.	yik.**v**or	*!		*	
b. ☞	yik.**b**or				

b. [CONT] in the input

Input: ka**v**ar		IDENT$_{[STOP]}$	*V-STOP	*$_{\sigma}$[CONT	IDENT$_{[CONT]}$
a. ☞	ka.**v**ar			*	
b.	ka.**b**ar		*!		*
Input: yik**v**or					
a.	yik.**v**or			*!	
b. ☞	yik.**b**or				*

In (30), only when the input is specified for [CONT], are the correct outputs selected, i.e. *ka**v**ar* and *yik**b**or*. The tableaux below demonstrate the paradigm in which prosodic alternation occurs between word-initial onset and postvocalic onset:

(31) Alternation in prosodic context: word-initial onset – postvocalic onset

a. [STOP] in the input

Input: **p**izer		IDENT$_{[STOP]}$	*V-STOP	*$_{\sigma}$[CONT	IDENT$_{[CONT]}$
a.	**f**i.zer	*!		*	
b. ☞	**p**i.zer				
Input: ye**p**azer					
a. √	ye.**f**a.zer	*!		*	
b. ☞✕	ye.**p**a.zer		*		

b. [CONT] in the input

Input: **f**izer		IDENT$_{[STOP]}$	*V-STOP	*$_{\sigma}$[CONT	IDENT$_{[CONT]}$
a.	**f**i.zer			*!	
b. ☞	**p**i.zer				*
Input: ye**f**azer					
a. ☞	ye.**f**a.zer			*	
b.	ye.**p**a.zer		*!		*

In (31), as in (30), only when the input is specified for [CONT] are the correct outputs selected, i.e. ***p**izer* and *ye**f**azer*.

4.2.2.3 Summary: So far, I have presented an analysis which distinguishes between alternating and non-alternating paradigms. The contrast manifested between stops and fricatives in postvocalic onset position (e.g. *ti**p**es* vs. *ka**f**ac*) is expressed by the constraint ranking. IDENT$_{[STOP]}$, which is the dominant constraint in the hierarchy, restricts the effect of *V-STOP to stops that do not have a correspondent in the input (e.g. **ka**p**ac*, where the input is *ka**f**ac*). That is, only when the input is specified for [CONT] does the grammar disallow the occurrence of postvocalic stops on the surface.

Conversely, if [STOP] is specified in the input, then *V-STOP is not effective since IDENT$_{[STOP]}$ is ranked higher. In such a case, alternation is avoided.

MH has yet another type of paradigm, which conflicts with some of the alternating paradigms presented above. This conflict, which has a crucial effect on MH grammar, is discussed in the following section.

4.3 CONDITIONS FOR VARIATION

In the previous sections, I have shown that segmental alternation between stops and fricatives occurs when alternation in prosodic position or prosodic context occurs. The prosodic distinction between the paradigms, and the fact that only stops are involved in the non-alternating paradigms, suggest a grammar in which stops and fricatives are distinctive, but only in certain prosodic contexts (i.e. postvocalic). This generalization is summarized in the following table:

(32) Prosodic and segmental interaction in stop-fricative alternation (cf. (26)):

input	alternation	
	segmental	prosodic
stop (28)	**no** alternation	**no** alternation
fricative (29-31)	**yes**	**yes**: postvocalic (fricative) – initial/post consonantal (stop)

However, MH has a paradigm that conflicts with the above generalization. In this paradigm alternation in prosodic context *does* occur, but, against the predictions made by the grammar established so far, the prosodic alternation is not accompanied by segmental alternation. Furthermore, the segments involved in this paradigm are fricatives.

(33) Alternation in prosodic context *without* segmental alternation

word-initial onset ~ **postvocalic** onset			
PAST	PARTICIPLE	FUTURE	
vi.ter	me.**v**a.ter	ye.**v**a.ter	*'to give up'*
fi.šel	me.**f**a.šel	ye.**f**a.šel	*'to screw up'*

Tableau (34) below demonstrates the failure of the grammar established so far to account for the data presented in (33):

(34) Alternation in prosodic context without segmental alternation

Input: **v**iter		IDENT$_{[STOP]}$	*V-STOP	*$_{\sigma}$[CONT	IDENT$_{[CONT]}$
a. √	**v**i.ter			*!	
b. ☞✕	**b**i.ter				*
Input: ye**v**ater					
a. ☞	ye.**v**a.ter			*	
b.	ye.**b**a.ter		*!		*

The examples in (33) represent a relatively small group of verbs, consisting of forms with *v* derived from historical *w*, and loan words with *f*. However, the fact that only few such words exist reflects only their historical source and not any synchronic restriction in the language. In any case, the distinction between the ***v*** in the alternating paradigm ***b****itel* – *ye****v****atel* 'cancelled – will cancel' (19b), and the ***v*** in the non-alternating paradigm ***v****iter* – *ye****v****ater* 'gave up – will give up' (33), is opaque. The same applies to *f* in *ye****f****azer* 'will spread' which alternates with *p* in ***p****izer* 'spread', but does not alternate in the paradigm ***f****išel* – *ye****f****ašel* 'screwed up – will screw up'. A discussion of the nature of this conflict and its implications on MH grammar follows.

The phenomenon described above reveals an unresolved competition between two types of paradigms that exhibit prosodic alternation: (a) paradigms that involve segmental alternation; and (b) paradigms that do not involve segmental alternation. This conflict is illustrated in tableau (34) above, where the ranking of *$_{\sigma}$[CONT above IDENT$_{[CONT]}$ is crucial for alternations like ***p****izer* – *ye****f****azer* (19b), but selects the wrong output in the non-alternating paradigm (i.e. ****b****iter* instead of ***v****iter*). This conflict between the paradigms is expressed in the OT model presented here, by an unresolved competition between the markedness constraint *$_{\sigma}$[CONT and the faithfulness constraint IDENT$_{[CONT]}$. In order to select the correct output in a non-alternating paradigm with fricatives, *$_{\sigma}$[CONT must be ranked below IDENT$_{[CONT]}$ (35), but the opposite order is required in (36) :

(35) Alternation in prosodic context involving stop-fricative alternation

Paradigm: ***b**itel – ye**v**atel* 'to cancel'

Ranking: $*_{\sigma}$[CONT » IDENT$_{[CONT]}$

Input: **v**itel		IDENT$_{[STOP]}$	*V-STOP	***$_{\sigma}$[CONT**	**IDENT$_{[CONT]}$**
a.	**v**i.tel			*!	
b. ☞	**b**i.tel				*
Input: ye**v**atel					
a. ☞	ye.**v**a.tel			*	
b.	ye.**b**a.tel		*!		*

The tableau above demonstrates an alternating paradigm similar to that in (19b). The crucial ranking of the markedness constraint $*_{\sigma}$[CONT above the faithfulness constraint IDENT$_{[CONT]}$ enables alternation to occur, by blocking a word-initial fricative. The following tableau shows exactly the opposite result:

(36) Alternation in prosodic context ***without*** stop-fricative alternation

Paradigm: ***v**iter – ye**v**ater* 'to give in'

Ranking: IDENT$_{[CONT]}$ »$*_{\sigma}$[CONT

Input: **v**iter		IDENT$_{[STOP]}$	*V-STOP	**IDENT$_{[CONT]}$**	***$_{\sigma}$[CONT**
a. ☞	**v**i.ter				*
b.	**b**i.ter			*!	
Input: ye**v**ater					
a. ☞	ye.**v**a.ter				*
b.	ye.**b**a.ter		*!	*	

Thus, if $*_{\sigma}$[CONT is ranked below IDENT$_{[CONT]}$, the input (a fricative) is preserved and alternation is blocked, i.e. a fricative appears throughout the paradigm. In the forthcoming section I discuss the effect these conflicting paradigms have on the language, and present a theoretical model to account for them.

4.3.1 THE EFFECT OF CONFLICTING EVIDENCE

The conflict between the paradigms presented above extensively affects the occurrences of stops and fricatives in MH in general, and colloquial Hebrew in particular. The essence of this effect is the great extent of ***variability*** in the context of alternation:

(37) Variation in the occurrences of stops and fricatives

Prosodic Alternation	PAST		FUTURE		
	normative	***Colloquial***	***normative***	***Colloquial***	
V.$\mathbf{C_2}$/C.$\mathbf{C_2}$	da.**f**ak	*da.**p**ak	yid.**p**ok	~ yid.**f**ok	'to knock'
	ka.**v**ar	*ka.**b**ar	yik.**b**or	~ yik.**v**or	'to bury'
#C_1**V/V.**C_1	**p**i.zer	~ **f**i.zer	ye.**f**a.zer	*ye.**p**a.zer	'to spread'
	bi.keš	~ **v**i.keš	ye.**v**a.keš	*ye.**b**a.keš	'to request'
#C_1**V/V**C_1.	**p**a.gaš	~ **f**a.gaš	yi**f.**goš	*yi**p.**goš	'to meet'
	ba.xar	~ **v**a.xar	yi**v.**xar	*yi**b.**xar	'to choose'

The data in (37) show that variation occurs only in non-postvocalic position, i.e. after a consonant (e.g. *yid**p**ok* ~ *yid**f**ok* 'will knock') and in word initial position (e.g. ***p**izer* ~ ***f**izer* 'spread'). In addition, all the non-normative variants are fricatives in onset position, and they actually create non-alternating paradigms. For example, *ka.**v**ar* (**ka.**b**ar*) 'buried' and the normative form *yik.**b**or* 'will bury' exhibit alternation. However, the non-normative form in these paradigms, i.e. *yik.**v**or*, creates a non-alternating paradigm with the form *ka.**v**ar* (which is invariable).

The variation presented in (37) manifests the consequences of the conflict between the alternating and the non-alternating paradigms in the same prosodic context, discussed earlier. The variation suggests that this conflict entails a competition between two grammars: one which allows alternation and one which blocks it. In the OT model presented here, this conflict is expressed as the unresolved competition between the markedness constraint $*_{\sigma}$[Cont and the faithfulness constraint $\text{Ident}_{[\text{cont}]}$. As argued in the context of acquisition, unresolved competition between constraints is actually an unfixed ranking, termed ***crucial unranking*** (see §2.4 and §3.2.3). Thus, the grammar of the MH stop-fricative alternation seems to be as follows:

(38) Constraint hierarchy of the variable grammar (cf. (27)):

IDENT$_{[STOP]}$ » *V-STOP

*V-STOP » *$_{\sigma}$[CONT

***$_{\sigma}$[CONT ~ IDENT$_{[CONT]}$**

The above ranking expresses a variable grammar, where the crucial unranking between *$_{\sigma}$[CONT and IDENT$_{[CONT]}$ yields the following two competing rankings:

(39) a. A grammar with alternation (e.g. *ka**v**ar – yik**b**or*):

IDENT$_{[STOP]}$ » *V-STOP

*V-STOP » *$_{\sigma}$[CONT

***$_{\sigma}$[CONT » IDENT$_{[CONT]}$**

b. A grammar without alternation (e.g. *kavar – yikvor*):

IDENT$_{[STOP]}$ » *V-STOP

*V-STOP » *$_{\sigma}$[CONT

IDENT$_{[CONT]}$ » *$_{\sigma}$[CONT

This state of the grammar, with the crucial unranking of two conflicting constraints, necessarily involves one of the inevitable consequences of an intermediate grammar, namely **variation.** As discussed in §3 with respect to language acquisition, crucial unranking is a consequence of reranking (i.e. change), and the variation involved is therefore, an **inter-phase variation**. The MH stop-fricative alternation suggests a process of **reranking** of the markedness constraint *$_{\sigma}$[CONT with respect to the faithfulness constraint IDENT$_{[CONT]}$.

Following the arguments presented in §3 and the theoretical basis in §2.3.3, I assume that this reranking is a case of **Constraint Demotion**, whereby the markedness constraint *$_{\sigma}$[CONT is demoted below the faithfulness constraint IDENT$_{[CONT]}$, due to evidence of its violability. That is, the data exhibiting violation of *$_{\sigma}$[CONT (e.g. ***v**iter*) trigger the constraint demotion. Since reranking is a continuous process, it creates an intermediate phase, an indeterminate grammar, involving inter-

phase variation. This intermediate grammar is represented in OT by indeterminate ranking which provides two optimal outputs for a single input, i.e. variation. This process and its consequences are demonstrated below:

(40) The process of change in MH grammar (cf. §3.2.3)

a. Initial state (regular alternation): $*_{\sigma}$[CONT » IDENT$_{[CONT]}$

b. Reranking: $*_{\sigma}$[CONT » IDENT$_{[CONT]}$

c. Intermediate phase (a variable grammar): IDENT$_{[CONT]}$ ~ $*_{\sigma}$[CONT

d. Predicted state: IDENT$_{[CONT]}$ » $*_{\sigma}$[CONT

This process is demonstrated on two types of paradigms in tableaux (41) and (42) below:

(41) Alternation in prosodic context: word-initial – postvocalic onset

a. Paradigm *without* variation (normative): ***b**itel – ye**v**atel* 'to cancel'

Ranking: $*_{\sigma}$[CONT » IDENT$_{[CONT]}$

Input: **v**itel		IDENT$_{[STOP]}$	*V-STOP	$*_{\sigma}$[CONT	IDENT$_{[CONT]}$
a.	**v**i.tel			*!	
b. ☞	**b**i.tel				*
Input: ye**v**atel					
a. ☞	ye.**v**a.tel			*	
b.	ye.**b**a.tel		*!		*

b. Paradigm *with* variation (colloquial) : ***b**itel ~ **v**itel – ye**v**atel*

Ranking: $*_{\sigma}$[CONT ~ IDENT$_{[CONT]}$

Input: **v**itel		IDENT$_{[STOP]}$	*V-STOP	$*_{\sigma}$[CONT	IDENT$_{[CONT]}$
a. ☞	**v**i.tel			*	
b. ☞	**b**i.tel				*
Input: ye**v**atel					
a. ☞	ye.**v**a.tel			*	
b.	ye.**b**a.tel		*!		*

It should be noted that when the form ***v**itel* is picked (41b), a non-alternating paradigm is created (cf. ***v**iter – ye**v**ater* (36)). Another type of paradigm that exhibits the same behavior is demonstrated by the tableaux below:

(42) Alternation in prosodic context: postvocalic – postconsonantal onset

a. Paradigm *without* variation (normative): *ta**f**as – yit**p**os* 'to catch'

Ranking: $*_{\sigma}$[CONT **»** IDENT$_{[CONT]}$

Input: ta**f**as		IDENT$_{[STOP]}$	*V-STOP	$*_{\sigma}$[CONT	IDENT$_{[CONT]}$
a. ☞	ta.**f**as			*	
b.	ta.**p**as		*!		*
Input: yit**f**os					
a.	yit.**f**os			*!	
b. ☞	yit.**p**os				*

b. Paradigm *with* variation (colloquial): *ta**f**as – yit**p**os ~ yit**f**os*

Ranking: $*_{\sigma}$[CONT **~** IDENT$_{[CONT]}$

Input: ta**f**as		IDENT$_{[STOP]}$	*V-STOP	$*_{\sigma}$[CONT	IDENT$_{[CONT]}$
a. ☞	ta.**f**as			*	
b.	ta.**p**as		*!		*
Input: yit**f**os					
a. ☞	yit.**f**os			*	
b. ☞	yit.**p**os				*

In both (41) and (42) the same facts are manifested: alternation is obligatory only when $*_{\sigma}$[Cont is crucially ranked above Ident$_{[cont]}$ ((41a), (42a)). Both normative and non-normative forms are available only when these competing constraints are crucially unranked ((41b), (42b)). In this case, the competition is not only between two forms, but between two types of paradigm, since the selection of the non-normative forms (***v**itel* or *yit**f**os*), due to the available interpretation of ranking $*_{\sigma}$[Cont below Ident$_{[cont]}$, creates non-alternating paradigms. Variation is a consequence of this conflict, and it indicates a change in the language. The OT mechanism represents this conflict and its consequences through constraint interaction: the contradicting data are accounted for through the crucial unranking of the conflicting constraints. This crucial unranking provides two types of paradigms, with and without alternation.

Non-alternating paradigms seem to be the inevitable result of the contradicting data existing in the language. There is extensive counterevidence to the regular alternation between stops and fricatives. THIS RESULT SEEMS TO EXHIBIT A TENDENCY TOWARDS CHANGE IN MH GRAMMAR, given that variation exists ***only*** in the (originally) alternating paradigms and not in originally non-alternating paradigms, e.g. ***v****iter (*****b****iter)* – *ye****v****ater* (**ye****b****ater*). This tendency towards change and its theoretical accounts are further elaborated in §4.4 below.

4.3.2 THE CASE OF DORSALS

So far, the analysis provided for alternation between stops and fricatives focussed on labial consonants (*b* ~ *v*, *p* ~ *f*). In this section it will be shown that the dorsal consonants exhibit the same phonological behaviour as labials, but provide stronger evidence for what was described in §4.3.1 as the tendency of change in the language towards non-alternating paradigms.

4.3.2.1 Dorsals vs. Labials: The behaviour of dorsal consonants differs from that of labial consonants in two respects: (a) only the voiceless dorsals are subject to alternation; and (b) both the stop and the fricative dorsals have a non-alternating twin (see §4.1.1.2). These differences yield the following distinct paradigms:

(43) Paradigms with labials vs. paradigms with dorsals

a. Paradigms with **labials**

PAST		FUTURE		
normative	***colloquial***	***normative***	***colloquial***	
pizer	~ **f**izer	ye**f**azer	*ye**p**azer	'to spread'
bitel	~ **v**itel	ye**v**atel	*ye**b**atel	'to cancel'

b. Paradigms with **dorsals**

PAST		FUTURE		
normative	***colloquial***	***normative***	***colloquial***	
kibes	~ **x**ibes	ye**x**abes	~ ye**k**abes	'to launder'
kisa	~ **x**isa	ye**x**ase	~ ye**k**ase	'to cover'

The paradigms with labials exhibit variation only in positions that are occupied by a stop in the normative form, i.e. in non-postvocalic position. According to the discussion in §4.3.1, this variation results from the coexistence of two competing paradigms: a paradigm with an alternation in prosodic context involving segmental alternation (e.g. ***b**itel – ye**v**atel* 'to cancel'), and a paradigm with an alternation in prosodic context without segmental alternation (e.g. ***v**iter – ye**v**ater* 'to give in'). The data in (43) show basically the same consequences, but with one significant difference: not only does variation exist in non-postvocalic onset position which is normatively occupied by a stop (e.g. ***k**ibes* ~ ***x**ibes* 'laundered'), but also in postvocalic onset position normatively occupied by a fricative (e.g. *ye**x**abes* ~ *ye**k**abes* 'will launder'). This variability in forms is due to the fact that when considering dorsals, ***three*** (as opposed to two with labials) types of contradicting paradigms exist in the (normative as well as in the colloquial) language:

(44) Three types of conflicting paradigms involving dorsals:

a. Alternating paradigms
e.g. ***k**ibes – ye**x**abes* 'to launder' (cf. ***b**itel – ye**v**ael*)

b. Non-alternating paradigms with a **fricative**
e.g. ***x**ipes – ye**x**apes* 'to search' (cf. ***v**iter – ye**v**ater*)

c. Non-alternating paradigms with a **stop**
e.g. compare with ***k**ipel – ye**k**apel* 'to fold'

That is, unlike the paradigms with labials, the paradigms with dorsals exhibit non-alternating paradigms with stops (44c), and not only with fricatives (44b). Thus, variation between dorsals exists not only in non-postvocalic position as is in the case of labials, but also in postvocalic position (e.g. *ye**x**abes* ~ *ye**k**abes* 'will launder'), because the language exhibits evidence of postvocalic dorsal stops in the same

prosodic context (e.g. ***k**ipel – ye**k**apel* 'to fold'). In other words, when more types of conflicting evidence exist, greater variability should be expected.

In the following subsection, I present a revised analysis of the MH stop-fricative alternation, which takes into account the data exhibited by the dorsals. I will provide a comprehensive theoretical model for all types of occurrences of stops and fricatives in the language, dorsal as well as labial. This model expresses the variability of MH grammar and the prediction for a particular change.

4.3.2.2A revised analysis for stop-fricative alternation: Two out of the three types of paradigms involving dorsals are adequately accounted for by the grammar presented for labials in §4.2.2.2 and §4.3.1 above. The tableaux in (45) demonstrate these two types and the additional one specific to dorsals:

(45) Alternation in prosodic context

a. Paradigm *without* variation (normative): ***k**ibes – ye**x**abes* 'to launder'

Ranking: $*_{\sigma}$[CONT » IDENT$_{[CONT]}$

Input: **x**ibes		IDENT$_{[STOP]}$	*V-STOP	***$_{\sigma}$[CONT**	**IDENT$_{[CONT]}$**
a.	**x**i.bes			*!	
b. ☞	**k**i.bes				*
Input: ye**x**abes					
a. ☞	ye.**x**a.bes			*	
b.	ye.**k**a.bes		*!		*

b. Paradigm *with* variation (colloquial): ***k**ibes ~ **x**ibes – ye**x**abes*

Ranking: $*_{\sigma}$[CONT ~ IDENT$_{[CONT]}$

Input: **x**ibes		IDENT$_{[STOP]}$	*V-STOP	***$_{\sigma}$[CONT**	**IDENT$_{[CONT]}$**
a. ☞	**x**i.bes			*	
b. ☞	**k**i.bes				*
Input: ye**x**abes					
a. ☞	ye.**x**a.bes			*	
b.	ye.**k**a.bes		*!		*

c. Paradigm *without* alternation *or* variation (anticipated): ***x**ibes – ye**x**abes*

Reranking: IDENT$_{[CONT]}$ » $*_{\sigma}$[CONT

Input: **x**ibes		IDENT$_{[STOP]}$	*V-STOP	**IDENT$_{[CONT]}$**	***$_{\sigma}$[CONT**
a. ☞	**x**i.bes				*
b.	**k**i.bes			*!	
Input: ye**x**abes					
a. ☞	ye.**x**a.bes				*
b.	ye.**k**a.bes		*!	*	

The above analysis cannot capture the occurrence of a postvocalic stop, e.g. *ye**k**abes* 'will launder'. In the above constraint hierarchy, this form is blocked by the highly ranked markedness constraint *V-STOP. This blocking is crucial for labials, since postvocalic labial stops do not exist in prosodically alternating paradigms (see (19)). However, since the current data suggest a significant distinction between dorsals and labials with respect to stops and fricatives in postvocalic position, this fact must be expressed in the grammar as well. Therefore, I suggest specifying *V-STOP for labials and dorsals, i.e. *V-STOP$_{[LAB]}$ and *V-STOP$_{[DOR]}$, respectively. In order for this specification not to change the grammar for labials, *V-STOP$_{[LAB]}$ remains crucially ranked above *$_{\sigma}$[CONT. *V-STOP$_{[DOR]}$, on the other hand, is crucially ranked above *$_{\sigma}$[CONT in the regular normative alternations, but seems to be reranked, yielding crucial *un*ranking with respect to *$_{\sigma}$[CONT. This reranking represents the variation in postvocalic position. The postvocalic variation, as the non-postvocalic variation, indicates a change in the grammar towards a different stop-fricative relation. The process of change in postvocalic position is presented in (46), and demonstrated by the tableaux in (47):

(46) The process of change in MH grammar II (cf. (40))

a. The current constraint ranking (cf. (27)):

IDENT$_{[STOP]}$ » *V-STOP$_{[LAB]}$

IDENT$_{[STOP]}$ » *V-STOP$_{[DOR]}$

*V-STOP$_{[LAB]}$ » *$_{\sigma}$[CONT

*$_{\sigma}$[CONT ~ IDENT$_{[CONT]}$

***V-STOP$_{[DOR]}$ ~ *$_{\sigma}$[CONT**

b. The process of change:

i. Initial state (regular alternation): *V-STOP$_{[DOR]}$ » *$_{\sigma}$[CONT

ii. Reranking: *V-STOP$_{[DOR]}$ » *$_{\sigma}$[CONT

iii. Intermediate phase (a variable grammar): *$_{\sigma}$[CONT ~ *V-STOP$_{[DOR]}$

iv. Predicted state: *$_{\sigma}$[CONT » *V-STOP$_{[DOR]}$

(47) Alternation in prosodic context[43]

a. Paradigm *without* variation (normative): ***k**ibes – ye**x**abes* 'to launder'

Ranking: **V-STOP$_{[DOR]}$ » *$_{\sigma}$[CONT » IDENT$_{[CONT]}$**

Input: **x**ibes		***V-STOP$_{[DOR]}$**	*$_{\sigma}$[CONT	IDENT$_{[CONT]}$
a.	**x**i.bes		*!	
b. ☞	**k**i.bes			*
Input: ye**x**abes				
a. ☞	ye.**x**a.bes		*	
b.	ye.**k**a.bes	*!		*

b. Paradigm *with* variation in word-initial position: ***k**ibes ~ **x**ibes – ye**x**abes*

Ranking: **V-STOP$_{[DOR]}$ » *$_{\sigma}$[CONT ~ IDENT$_{[CONT]}$**

Input: **x**ibes		*V-STOP$_{[DOR]}$	*$_{\sigma}$[CONT	IDENT$_{[CONT]}$
a. ☞	**x**i.bes		*	
b. ☞	**k**i.bes			*
Input: ye**x**abes				
a. ☞	ye.**x**a.bes		*	
b.	ye.**k**a.bes	*!		*

c. Paradigm *with* variation in both positions: ***k**ibes ~ **x**ibes – ye**x**abes ~ yeka**b**es*

Ranking: ***V-STOP$_{[DOR]}$ ~ *$_{\sigma}$[CONT ~ IDENT$_{[CONT]}$**

[43] For reasons of convenience, the highest ranked constraint IDENT$_{[STOP]}$ is suppressed, since all the inputs in these paradigms are presumably specified for [CONT], and therefore IDENT$_{[STOP]}$ is irrelevant. Similarly, I ignore *V-STOP$_{[LAB]}$ since only dorsals are considered in this context.

Input: **x**ibes		*V-STOP$_{[DOR]}$	*$_{\sigma}$[CONT	IDENT$_{[CONT]}$
a. ☞	**x**i.bes		*	
b. ☞	**k**i.bes			*
Input: ye**x**abes				
a. ☞	ye.**x**a.bes		*	
b. ☞	ye.**k**a.bes	*		*

Tableau (47c) should be read as follows: each pair of conflicting constraints, i.e. *V-STOP ~ *$_{\sigma}$[CONT and *$_{\sigma}$[CONT ~ IDENT$_{[CONT]}$, is a case of crucial unranking (see (46)). That is, *V-STOP$_{[DOR]}$ is crucially unranked with respect to *$_{\sigma}$[CONT and *$_{\sigma}$[CONT is crucially unranked with respect to IDENT$_{[CONT]}$, providing two types of variation:

(48) Two types of variation

a. Variation in word-initial position: ***k**ibes ~ **x**ibes – ye**x**abes*

Ranking: *V-STOP$_{[DOR]}$ **» *$_{\sigma}$[CONT ~ IDENT$_{[CONT]}$**

Inpit: **x**ibes		*V-STOP$_{[DOR]}$	***$_{\sigma}$[CONT**	**IDENT$_{[CONT]}$**
a. ☞	**x**i.bes		*	
b. ☞	**k**i.bes			*
Input: ye**x**abes				
a. ☞	ye.**x**a.bes		*	
b.	ye.**k**a.bes	*!		*

b. Variation in postvocalic position: ***k**ibes – ye**x**a`bes ~ ye**k**abes*

Ranking: ***V-STOP$_{[DOR]}$** ~ ***$_{\sigma}$[CONT »** IDENT$_{[CONT]}$

Input: **x**ibes		***V-STOP$_{[DOR]}$**	***$_{\sigma}$[CONT**	IDENT$_{[CONT]}$
a.	**x**i.bes		*!	
b. ☞	**k**i.bes			*
Input: ye**x**abes				
a. ☞	ye.**x**a.bes		*	
b. ☞	ye.**k**a.bes	*		*

The variation in (48a) is, in fact, similar to the one found among the labials. The difference between labials and dorsals is manifested in (48b), where a postvocalic stop (*ye**k**abes*) varies with a postvocalic fricative (*ye**x**abes*).

The tableaux in (47) and (48) show that the reranking between *V-STOP and *$_{\sigma}$[CONT with respect to dorsals expresses further weakening of the realization of

alternating paradigms (in addition to the crucial unranking between $*_{\sigma}$[CONT and IDENT$_{[CONT]}$]. This weakening suggests that MH speakers tend to avoid alternation between stops and fricatives. The fact that not all types of variations exist in the language, in spite of the extensive occurrences of variation, points to a specific direction towards which the paradigms are moving. This issue is discussed in §4.4 below.

4.4 GRAMMAR OPTIMIZATION

The notion of 'grammar optimization' refers to a grammar's inherent tendency to be as transparent as possible (Kiparsky 1973c, 1982c). This transparency is achieved in two ways: (a) paradigms with alternation, in which the input-output disparities involved are transparent due to the regularity of the alternation; (b) paradigms without alternation, i.e. a uniformed paradigm. In Optimality Theoretic terms, regular alternation is represented by the dominance of markedness constraints, and paradigm uniformity is achieved through the dominance of faithfulness constraints (Benua 1995, 1997).

These principles are not new in phonological theory in general, nor are they unprecedented in the phonological discussion of language change, where the notions of 'paradigm uniformity' and 'paradigm leveling' are used (Kiparsky 1968, Chomsky and Halle 1968). OT's contribution to this issue is its account of the processes and consequences of language change using the same mechanism which accounts for all other types of linguistic knowledge and behavior, including the representation of different types of paradigms (Burzio 1996, Kenstowicz 1996, Steriade 1996, McCarthy 2001). It will be shown in this section that the model of change presented so far, based on the data of spirantization in MH (and language acquisition in §3), predicts that loss of regularity in alternation results in paradigm uniformity.

The application of the mechanisms of OT to the data of stop-fricative alternation and variation has so far been presented in two contexts. The first context is the case of regular alternation, where unmarked forms surface, input-output faithfulness is irrelevant, and output-output faithfulness is not achieved (§4.2.1). The second context is the case of conflicting evidence for the regular alternation, which yields variation within the alternating paradigms (§4.3). Following, is a discussion of the grammatical consequence of the uncertainty displayed by the extensive occurrence of variation. The main argument is that paradigm uniformity is a *consequence* of a variable grammar. That is, grammar optimization is a consequence of reranking.

4.4.1 THE EFFECT OF A VARIABLE GRAMMAR

The current grammar of MH stop-fricative alternation was presented in §4.3 as a variable grammar, expressed by the following constraint hierarchy:

(49) The current variable grammar of MH spirantization

IDENT$_{[STOP]}$ » *V-STOP$_{[LAB]}$

IDENT$_{[STOP]}$ » *V-STOP$_{[DOR]}$

*V-STOP$_{[LAB]}$ » *$_{\sigma}$[CONT

*V-STOP$_{[DOR]}$ ~ *$_{\sigma}$[CONT

*$_{\sigma}$[CONT ~ IDENT$_{[CONT]}$

The tableaux below demonstrate the application of this grammar in paradigms with labials in (50) and with dorsals in (51) and (52):

(50) The application of the variable grammar in paradigms with labials:

a. The variable grammar of MH

Ranking of relevant constraints: *V-STOP$_{[LAB]}$ » *$_{\sigma}$[CONT ~ IDENT$_{[CONT]}$

Input: **v**itel		IDENT$_{[STOP]}$	*V-STOP$_{[LAB]}$	*$_{\sigma}$[CONT	IDENT$_{[CONT]}$
a. ☞	**v**i.tel			*	
b. ☞	**b**i.tel				*
Input: ye**v**atel					
a. ☞	ye.**v**a.tel			*	
b.	ye.**b**a.tel		*!		*

b. A grammar with alternation and without variation (normative):

Reranking of relevant constraints: *V-STOP$_{[LAB]}$ » *$_{\sigma}$[CONT » IDENT$_{[CONT]}$

Input: **v**itel		IDENT$_{[STOP]}$	*V-STOP$_{[LAB]}$	*$_{\sigma}$[CONT	IDENT$_{[CONT]}$
a.	**v**i.tel			*!	
b. ☞	**b**i.tel				*
Input: ye**v**atel					
a. ☞	ye.**v**a.tel			*	
b.	ye.**b**a.tel		*!		*

c. A grammar without alternation or variation (colloquial):

Reranking of relevant constraints: *V-STOP$_{[LAB]}$ » IDENT$_{[CONT]}$ » *$_{\sigma}$[CONT

Input: **v**itel		IDENT$_{[STOP]}$	*V-STOP$_{[LAB]}$	IDENT$_{[CONT]}$	*$_{\sigma}$[CONT
a. ☞	**v**i.tel				*
b.	**b**i.tel			*!	
Input: ye**v**atel					
a. ☞	ye.**v**a.tel				*
b.	ye.**b**a.tel		*!	*	

Given that the input is specified for a fricative, the variable grammar in (50) has two invariable interpretations: one with alternation, where *$_{\sigma}$[CONT is crucially ranked above IDENT$_{[CONT]}$, yielding ***b****itel – ye**v**atel* (50b), and one without alternation, where the ranking is the opposite, yielding ***v****itel –ye**v**atel* (50c). There is no third possibility. That is, neither an alternation like ***v****itel – ye**b**atel,* nor one like ***b****itel – ye**b**atel* can be generated by the current grammar. Indeed, such cases do not exist in MH.

Dorsal paradigms differ from labial ones in that variation exists in postvocalic positions in addition to non-postvocalic positions (43), yielding (in addition to alternating paradigm) ***two*** types of paradigms that do not exhibit either alternation or

variation. A non-alternating paradigm with a fricative is achieved in the same way as with labial paradigms:

(51) The application of the variable grammar (49) in paradigms with dorsals

a. Regular alternation: ***k**ibes – ye**x**abes* 'to launder' (cf. (50b))

Input: **x**ibes		IDENT$_{[STOP]}$	*V-STOP$_{[DOR]}$	*$_{\sigma}$[CONT	IDENT$_{[CONT]}$
a.	**x**i.bes			*!	
b. ☞	**k**i.bes				*
Input: ye**x**abes					
a. ☞	ye.**x**a.bes			*	
b.	ye.**k**a.bes		*!		*

b. Non-alternating paradigm with fricatives only: ***x**ibes – ye**x**abes* (cf. (50c))

Input: **x**ibes		IDENT$_{[STOP]}$	*V-STOP$_{[DOR]}$	IDENT$_{[CONT]}$	*$_{\sigma}$[CONT
a. ☞	**x**i.bes				*
b.	**k**i.bes			*!	
Input: ye**x**abes					
a. ☞	ye.**x**a.bes				*
b.	ye.**k**a.bes		*!	*	

The question is how a non-alternating paradigm with a dorsal *stop* is achieved. The answer coincides with the mechanism of change presented so far. The constraint which blocks stops in postvocalic positions is distinctly specified for the different places of articulation, namely *V-STOP$_{[DOR]}$ and *V-STOP$_{[LAB]}$. While *V-STOP$_{[LAB]}$ remains above IDENT$_{[CONT]}$ due to the absence of evidence to trigger its demotion (49), *V-STOP$_{[DOR]}$ undergoes reranking. As illustrated in (43), paradigms with postvocalic dorsal stops do appear in the same phonological conditions as the alternating paradigms (e.g. ***k**ipel – ye**k**apel* 'to fold' alongside ***k**ibes – ye**x**abes* 'to launder'). These paradigms trigger the demotion of *V-STOP$_{[DOR]}$ below IDENT$_{[STOP]}$ in much the

same way as paradigms such as ***x**ipes – ye**x**apes* (alongside ***k**ibes – ye**x**abes*) trigger the demotion of *$_{\sigma}$[CONT below IDENT$_{[CONT]}$.

It is clear, then, that a paradigm such as ***k**ibes – ye**k**abes* (normatively ***k**ibes – ye**x**abes*), indicates that dorsal stops are not blocked when in a postvocalic position. It is also clear that speakers who produce non-alternating paradigms with fricatives (51b) do not produce non-alternating paradigms with stops. That is, the non-alternating paradigms indicate **two paths of change,** one with a stop and another with a fricative.

The current grammar of Hebrew (49) includes two pairs of crucially unranked constraints: *$_{\sigma}$[CONT vs. IDENT$_{[CONT]}$ and *V-STOP$_{[DOR]}$ vs. *$_{\sigma}$[CONT. The demotion of *$_{\sigma}$[CONT below IDENT$_{[CONT]}$ provides the paradigms in (50c) and (51b). The demotion of *V-STOP$_{[DOR]}$ below *$_{\sigma}$[CONT (46c) provides the paradigm below:

(52) Non-alternating paradigms with dorsal **stops**

Input: **x**ibes		IDENT$_{[STOP]}$	*$_{\sigma}$[CONT	*V-STOP$_{[DOR]}$	IDENT$_{[CONT]}$
a.	**x**i.bes		*!		
b. ☞	**k**i.bes				*
Input: ye**x**abes					
a.	ye.**x**a.bes		*!		
b. ☞	ye.**k**a.bes			*	*

(51b) and (52) are two distinct grammars, rather than a single variable grammar, because there is no speaker that displays both of them (i.e. a unified paradigm with a fricative (51b) alongside a unified paradigm with a stop (52)). This, however, is not the final state. I claim that (51) and (52) are two types of intermediate grammars undergoing change and they indicate two consequences of a variable grammar, which develop simultaneously and which coexist. That is, this is a case of variation between speakers, where different consonants are represented in the input. Notice that in (52), where only a stop surfaces (***k**ibes – ye**k**abes*), there is no justification to assume a fricative in the input. This is the key to understanding the path of change exhibited by

the paradigms of MH stops and fricatives, and the predictability of the model of change suggested here.

4.4.2 THE FATE OF SPIRANTIZATION IN MODERN HEBREW

At this point in the discussion, it is important to clarify once again that the several types of variability presented throughout the chapter represent all the occurrences of stops and fricatives in MH verbs, and not the specific grammar of a specific speaker. As mentioned in the discussion relating to (48), there is no actual or hypothetical speaker who produces both (48a) and (48b). Fortunately, there is also no way of representing these two paradigms within the same grammar by applying any possible manipulation of constraint interaction. Therefore, it can be concluded that the contradicting data which cause variation within a single grammar of a single speaker, may also cause variation among different speakers. The reason I do not consider variation among speakers to be a type of variable grammar, is based on my assumption that the variation among speakers is a *consequence* of a variable grammar, rather than a *type* of a variable grammar.

The MH data provide evidence of three groups of speakers: (a) pure normative speakers who produce regular alternation (rather rare); (b) colloquial as well as normative speakers who exhibit variation, that is, sometimes they alternate and sometimes they do not (most speakers); and (c) pure colloquial speakers who do not alternate (a small but increasing group). Groups (a) and (b) are accounted for by the variable grammar presented in §4.3. Group (c), as discussed in §4.4.1, represents the predicted final state of the change, i.e. a grammar without alternation nor variation. In what follows, I claim that the final state indicates the restructuring of the lexical representation.

4.4.2.1 Lexical restructuring through lexicon optimization: Lexical restructuring is one of the consequences of grammatical change (Kiparsky 1968). In OT, this consequence is addressed by the principles of **lexicon optimization** (§2.2.2), which

minimizes input-output disparities. The application of these principles to paradigms results in faithfulness of the paradigm's input to at least one of the output forms. If the paradigm alternates, the different outputs are evaluated by a constraint hierarchy as candidates for inputs, providing that the one that minimally violates the highest ranked constraint is chosen as the optimal input. If the paradigm does not alternate, the input is faithful to all the outputs.

These principles entail that, in addition to change in the output forms (i.e. different outputs are chosen as optimal), reranking involves a re-evaluation of the input in order to meet the requirements of lexicon optimization. Therefore, lexicon restructuring is in fact one of the consequences of reranking.

Non-alternating paradigms with dorsal fricatives, e.g. ***x****ibes – ye****x****abes* 'to launder' (51b), exist in the language alongside non-alternating paradigms with dorsal stops, e.g. ***k****ibes – ye****k****abes* (52). In (51b), a fricative is assumed in the input and the constraint interaction does not allow stops to surface in any position. In fact, the grammar of a speaker who produces only fricatives in the paradigm, is one in which faithfulness constraints outrank markedness constraints. This grammar is demonstrated below:

(53) Non-alternating paradigms with dorsal **fricatives**[44]

Ranking:

IDENT$_{[CONT]}$ » *V-STOP

IDENT$_{[CONT]}$ » *$_{\sigma}$[CONT

Input: **x**ibes		IDENT$_{[CONT]}$	*V-STOP	*$_{\sigma}$[CONT
a. ☞	**x**i.bes			
b.	**k**i.bes	*!		*
Input: ye**x**abes				
a. ☞	ye.**x**a.bes			*
b.	ye.**k**a.bes	*!	*	

This tableau demonstrates the grammar after the demotion of *$_{\sigma}$[CONT below IDENT$_{[CONT]}$ (40d). It generates a paradigm with output-output and input-output

[44] In this case the dorsals are not different from the labials.

faithfulness. Since a fricative was assumed in the input from the beginning (§4.2.2), the reranking does not require the restructuring of the lexical representation.

Non-alternating paradigms with dorsal stops, however, exhibit a different path of change. In (52), a grammar which allows only stops to surface, was demonstrated with fricatives in the input. However, when considering a speaker who exclusively produces non-alternating paradigms with dorsal *stop*s, it is most reasonable to assume a process of change involving lexical restructuring:

(54) Non-alternating paradigms with a dorsal **stop**:

a. Reranking (cf. (46)):

*V-STOP » *$_{\sigma}$[CONT↓ ➔ *$_{\sigma}$[CONT » *V-STOP$_{[DOR}$

Input: **x**ibes		IDENT$_{[STOP]}$	*$_{\sigma}$[CONT	*V-STOP$_{[DOR]}$
a.	**x**i.bes		*!	
b. ☞	**k**i.bes			
Input: ye**x**abes				
a.	ye.**x**a.bes		*!	
b. ☞	ye.**k**a.bes			*

b. Lexicon optimization: Input is specified for ***k***

Input: **k**ibes		IDENT$_{[STOP]}$	*$_{\sigma}$[CONT	*V-STOP$_{[DOR]}$
a.	**x**i.bes	*!	*	
b. ☞	**k**i.bes			
Input: ye**k**abes				
a.	ye.**x**a.bes	*!	*	
b. ☞	ye.**k**a.bes			*

According to the principles of lexicon optimization, (54a) is undesirable because none of the output forms is faithful to the input. The restructuring in (54b) 'fixes' this shortcoming.

A similar phenomenon exists in MH not only with dorsals but also with labials, although dorsal cases are much more frequent for reasons discussed above. Consider the following examples:

(55) Parallel non-alternating paradigms with labials

FRICATIVE		STOP		
Past	Future	Past	Future	
sa**f**ar	yis**f**or	sa**p**ar	yis**p**or	'to count'
ša**f**ax	yiš**f**ox	ša**p**ax	yiš**p**ox	'to spill'
ša**v**ar	yiš**v**or	ša**b**ar	yiš**b**or	'to break'

The data with fricatives were already introduced and discussed above (e.g. (50c)). The examples in (55) are the only ones existing for non-alternating labials with stops. I present them here because they are very common among speakers and I claim that they represent the same consequence as the paradigms with non-alternating dorsal stops. That is, the examples in (55) exhibit similar behavior as those in (53) and (54), where different speakers induce different lexical representations.

It is very noticeable that these examples share a certain sequence of segments, i.e. a strident followed by a labial stop/fricative. Henkin (1997) suggests that this sequence explains the paradigms with stops, since a strident-stop sequence exhibits a case of dissimilation. I do not discard this observation, but I claim that these forms are compatible with the language's tendency regarding stops and fricatives presented here. First, these examples coexist alongside the non-alternating forms with fricatives, e.g. *sa**f**ar – yis**f**or* alongside *sa**p**ar – yis**p**or* 'to count', which indicate variation between speakers (cf. (53) vs. (54)). In addition, if dissimilation is so crucial for Hebrew speakers, why does it *not* appear elsewhere and affect other paradigms (e.g. **sa**p**ag (sa**f**ag) – yis**p**og ~ yis**f**og* 'to absorb'*; *sa**b**al (sa**v**al) – yis**b**ol ~ yis**v**ol* 'to suffer')?

4.4.2.2 The predicted final state of change: The groups of speakers represented by (53) and (54) provide indication of the predicted state of paradigms involving stops and fricatives in MH. These data display an inverse version of the alternating paradigms presented as an initial state in §4.2.1. The 'initial' state, where regular alternation is considered, is expressed by the crucial dominance of markedness constraints above faithfulness constraints. The markedness constraints force unmarked outputs regardless of the input.

The course of change presented throughout the chapter is characterized by restrictions on types of alternation (§4.2.2), contradicting paradigms which trigger variation (§4.3) and, finally, evidence of the complete loss of alternation by some of the speakers. Note that all these descriptions are synchronic, despite their diachronic nature. That is, all these cases currently coexist in Hebrew. Nevertheless, this description reflects a diachronic path: from the ideal regular alternation to an anticipated future state; from a grammar which generates unmarked forms to a variable grammar which leads to an optimal grammar with further lexical contrasts. The grammar of alternating paradigm and the grammar which is the result of change, are presented below:

(56) From alternating to non-alternating paradigm:

a. Alternating paradigm: *V-STOP, *$_{\sigma}$[CONT » IDENT[F]
MARKEDNESS » FAITHFULNESS

b. Non-alternating paradigm: IDENT[F] » *V-STOP, *$_{\sigma}$[CONT
FAITHFULNESS » MARKEDNESS

All other cases presented throughout this chapter are intermediate grammars that account for the variability existing in the language, intra-speaker variation (§4.3) as well as inter-speaker variation (§4.4). The tableaux below demonstrate the predicted state as a consequence of the change:

(57) The predicted state:

a. Labials (initial state: ***b****ikeš – ye****v****akeš*)

Input: **v**ikeš		IDENT[F]	*V-STOP	*$_{\sigma}$[CONT
a. ☞	**v**i.keš			*
b.	**b**i.keš	*!		
Input: ye**v**akeš				
a. ☞	ye.**v**a.keš			*
b.	ye.**b**a.keš	*!	*	

b. Dorsals (initial state: ***k****ibes* – *ye**x**abes*)

i. Lexical representation: **stop**

Input: **k**ibes		IDENT[F]	*V-STOP	*$_{\sigma}$[CONT
a.	**x**i.bes	*!		*
b. ☞	**k**i.bes			
Input: ye**k**abes				
a.	ye.**x**a.bes	*!		*
b. ☞	ye.**k**a.bes		*	

ii. Lexical representation: **fricative**

Input: **x**ibes		IDENT[F]	*V-STOP	*$_{\sigma}$[CONT
a. ☞	**x**i.bes			*
b.	**k**i.bes	*!		
Input: ye**x**abes				
a. ☞	ye.**x**a.bes			*
b.	ye.**k**a.bes	*!	*	

This predicted state of stop-fricative alternation in Hebrew displays the loss of a phonological generalization and the gain of an optimal grammar, where input-output, as well as output-output faithfulness is achieved (see Benua 1995, 1997, McCarthy and Prince 1999, McCarthy 2001). This prediction implies that in a synchronic analysis, the variation existing in Modern Hebrew provides evidence for grammatical change. In this sense, this is a case of inter-phase variation, much like the inter-phase variation seen in §3 in the course of language acquisition, in the transition from one phase to another.

Chapter 5
SUMMARY AND CONCLUSION

In this work I have made an attempt to extract phenomena from language acquisition and language change that exhibit phonological properties in the course of change. I approached these phenomena from a constraint-based viewpoint, suggesting an Optimality Theoretic account for the representation of change and the inter-phase variation. In this section I summarize the main issues discussed in the dissertation, and draw some conclusions regarding the mechanism of change as evidenced by the data analyzed here.

5.1 THE PATH OF CHANGE

The path of change in the course of language acquisition is examined with respect to an ideal end-state language, namely the target language spoken in the child's environment. The path of change in the course of (historical) language change is examined with respect to an ideal *former* state of a language. Beyond this difference, the paths of change I have examined in this dissertation have much in common, including the characteristics of the presumed initial state and the conception of the final state. These similarities are summarized below.[45]

5.1.1 LANGUAGE ACQUISITION

The phonological aspects of language acquisition I chose to consider are of two types: the acquisition path of prosodic structure of single forms, out of morphological context (§3.2), and the acquisition path of prosodic structure within alternating paradigms (§3.3), where alternation in the adult's language is highly regular (§3.1).

The acquisition path of **single forms** shows a pattern of gradual increase of prosodic structure (e.g. number and type of syllables), involving a gradual increase of prosodic contrasts (e.g. diverse stress patterns), up until the child's production is phonologically identical to the target forms. This pattern shows gradual loss of phonological generalizations (e.g. PRWD=FTBIN) in favor of input-output faithfulness, up to the point where there is no actual evidence of the phonological generalizations.

This type of phonological analysis shows a gradual transition from unmarked structures with input-output disparities (indicating phonological generalizations) to marked structures, lacking input-output disparities (indicating the absence of phonological generalizations). This process is represented in OT by gradual reranking, where markedness constraints are demoted below faithfulness constraints:

(1) From child-adult disparities to child-adult identity (see §3.2)

PHASE	CONSTRAINT-RANKING	CHILD-ADULT RELATION

[45] Recall that I focus on linguistic properties only, regardless of developmental and cognitive aspects involved in language acquisition, and sociolinguistic aspects involved in language change.

Initial §3.2.1	All markedness constraints outrank faithfulness constraints	Maximal disparities
Reranking §3.2.2.1-2	Markedness constraint are gradually demoted below faithfulness constraints	Less and less disparities
Final §3.2.2.3	All markedness constraints are outranked by faithfulness constraints	Maximal identity

The constraint ranking of the final phase, where all markedness constraints are outranked by faithfulness constraints, does not reflect, however, the actual grammar of the target language, simply because this is in fact a grammar without phonology. For this reason I considered in §3.3 the acquisition path of **alternating paradigms**, where not only the child-adult relations are examined, but also the relation between words where the target language itself exhibits input-output disparities, namely alternation (e.g. *gadaɬ - gadl-á – gadaɬ-ta* (see (6) in §3.1.1.2). The acquisition path in view of alternating paradigm differs from that in (1) in the final state, where some markedness constraints still outrank faithfulness constraints, thus reranking is only partial:

(2) From child-adult disparities to alternating paradigms (see §3.3; cf. (1))

PHASE	CONSTRAINT-RANKING	CHILD'S PARADIGM
Initial §3.3.1	Markedness constraints outrank faithfulness constraints	No evidence for a paradigm in child's production
Partial reranking §3.3.2	**Some** markedness constraint are gradually demoted below faithfulness constraints	Evidence for inflectional paradigm in child's production
Final §3.3.3	**Some** markedness constraints are outranked by faithfulness constraints, and others remain dominant	Child's paradigm = adult's paradigm

The constraint ranking of the final-phase of alternating paradigms reflects a situation where even though only some of the markedness constraints are demoted below faithfulness constraints, maximal child-adult identity is achieved. Thus, the path of acquisition in view of alternation provides end-state results which coincide

with the grammar of a natural language, namely a grammar with phonological generalizations realized as alternation and restrictions on surface structure.

5.1.2 LANGUAGE CHANGE

The phonological aspects of language change I chose to consider are related to spirantization in Modern Hebrew, where the alternation between stops and fricatives is highly irregular due to independent changes (see §4.1.1).

The path of change presented with respect to MH spirantization is quite puzzling, because it relates to the grammar of a *language* rather than to the grammar of a single speaker. The co-existence of several types of grammars in current Hebrew is interpreted in this dissertation as phases in the course of change, based on the patterns of the paradigms in each grammar and its status among Hebrew speakers. For example, an alternating paradigm without variation (e.g. *ta**f**as – yit**p**os* 'to catch') is associated with normative Hebrew only, while the non-alternating/non-variable version of this paradigm (*ta**f**as – yit**f**os* 'to catch') is associated with colloquial Hebrew only. In between, the majority of Hebrew speakers exhibit, or at least acknowledge, the variation *yit**p**os ~ yit**f**os*. This variation indicates a competition between the normative grammar (*ta**f**as – yit**p**os*) and the colloquial one (*ta**f**as – yit**f**os*).

The difference between these two grammars is represented within OT by two types of constraint ranking: an alternating paradigm is expressed through the dominance of a markedness constraint over a conflicting faithfulness constraint (e.g. $*_{\sigma}$[CONT » IDENT$_{[CONT]}$]; a paradigm without alternation is expressed through the opposite ranking (see Benua 1995). Thus, the direction of change shows the gradual loss of a phonological generalization. The pattern of this change is parallel to the path of acquisition of *single* forms (see (1)), where markedness constraints are demoted below faithfulness constraints, and the final state is characterized by input-output and output-output identity:

(3) From alternating to non-alternating paradigms (see §4.4.2; cf. (1))

PHASE	CONSTRAINT-RANKING	TYPES OF PARADIGMS
Initial §4.2.1	Markedness constraints outrank faithfulness constraints	Alternating paradigms
Reranking §4.2.2, §4.3	Some markedness constraints are demoted below faithfulness constraints	Alternating alongside non-alternating paradigms
Final §4.4	Markedness constraints are outranked by faithfulness constraints	Non-alternating paradigms

This path of change shows how a phonological generalization, as realized by regular alternation, is lost. It parallels the acquisition path of single forms, in that both paths begin with unmarked structures (e.g. avoidance of polysyllabic words in acquisition; avoidance of fricatives in non-postvocalic positions in spirantization) and end with marked structures (e.g. polysyllabic words; fricatives in non-postvocalic positions). The transition from the unmarked to the marked structures is in fact a transition from a universal phonological generalization to a language specific contrast. This transition, in both paths, involves inter-phase variation.

5.2 INTER-PHASE VARIATION

The notion **inter-phase variation** relates to variation in the course of change, where variability is restricted to the intermediate phases. In this dissertation I looked at cases of variation as evidence for change and as indication of the directionality of change.

5.2.1 LANGUAGE ACQUISITION

In this work I found that inter-phase variation is evidenced in the course of language acquisition only in the acquisition path of single lexical forms (§3.2.3). Variation is not evidenced in the acquisition path of alternating paradigm. This finding is significant, since it provides further evidence for the relation between change and variation (§3.3.3.2).

Variation is represented in OT by the crucial unranking of conflicting constraints. This type of constraint interaction is a consequence of reranking: in the course of constraint demotion there is an intermediate phase where the ranking between the demoted constraint and its conflicting one is not fixed, yielding multiple optimal outputs. Such intermediate phases are found in the course of acquisition whenever reranking occurs:

(4) Inter-phase variation in the course of acquisition (see §3.2.3)

PHASE	CONSTRAINT-RANKING	INTER-PHASE VARIATION
Initial §3.2.1	**Fixed** ranking M » F	_
Reranking §3.2.2	Crucial **unranking:** F ~ M	phase *n* ~ phase *n+1* e.g. *viron ~ aviron*
Final §3.2.2.3	**Fixed** ranking: F » M	_

In the acquisition of alternation, the markedness constraints ranked at the top of the hierarchy in the final state, are at the top from the beginning, therefore reranking of these constraints does not occur and variation is not expected:

(5) The acquisition of alternation (see §3.3)

PHASE	CONSTRAINT-RANKING	INTER-PHASE VARIATION
Initial §3.2.1	**Fixed** ranking M » F	_
Partial reranking §3.3.2	Crucial **unranking:** F_1 ~ M_1	phase *n* ~ phase *n+1* e.g. *pas-ti ~ xipas-ti* 'I searched'
	Fixed ranking: M_2 » F_2	*(*xips-a ~ xip**e**s-a* 'she searched')
Final 3.3.3	**Fixed** ranking: F_1 » M_1	_
	Fixed ranking: M_2 » F_2	_

The partial ranking involved in the acquisition of alternation, is evidenced not only in the final state (see §5.1.1) but also in the restrictions on the types of variation. In pure phonological terms *pasti ~ xipasti* and *xipsa ~ *xipesa* are the same type of

variation, where a disyllabic form varies with a trisyllabic form. However, only the former type is found in the children's corpus, because only in the former the missing syllable in the disyllabic form is not a consequence of alternation existing in the target language. The variation suggests that the child performs reranking. In the latter disyllabic form, *xipsa*, the missing syllable is a consequence of alternation existing in the target language. The absence of variation with respect to this form (e.g. **xipesa*) suggests that the child does not perform reranking.

To conclude, inter-phase variation in the course of language acquisition – where it exits and where it does not – indicates where reranking occurs, namely where change occurs. It suggests that reranking occurs only in order to achieve the lexical contrasts existing in the target language. Reranking does not occur in cases of *regular* alternation in the target language.

5.2.2 LANGUAGE CHANGE

In the study of language change in this work, variation is the starting point: I interpret the existence of variable forms an indication of language change, and I base my claims for the directionality of the change on the distinction between occurrences and non-occurrences of variable forms (§4.3).

The most significant finding with respect to the variation involved in MH spirantization is that variation exists only in the originally alternating paradigms. That is, a normative alternating paradigm (e.g. ***b**ikeš – ye**v**akeš* 'to request') is variable (e.g. ***b**ikeš* ~ ***v**ikeš*), while normative non-alternating paradigm is not (e.g. ***v**iter* (***b**iter*) – *ye**v**ater* 'to give up'). Continuing the terminology used for language acquisition, I claim that where there is no variation there is no change, namely no reranking:

(6) Inter-phase variation in the course of language change (see §4.3):

PHASE	CONSTRAINT-RANKING	PARADIGMS	VARIATION

Initial §4.2.1	**Fixed** ranking: M_1 » F_1	Alternating paradigms alongside	_
§4.2.2	**Fixed** ranking: F_2 » M_2	non-alternating paradigms	_
Reranking §4.3	Crucial unranking: $M_1 \sim F_1$	Alternating paradigms alongside	***b****ikeš* ~ ***v****ikeš* – *ye****v****akeš*
	Fixed ranking: F_2 » M_2	non-alternating paradigms	No variation: ***v****iter* (****b****iter*) – *ye****v****ater*
Final §4.4	**Fixed** ranking: F » M	Non-alternating paradigms	No variation: ***v****ikeš* – *ye****v****akeš* ***v****iter* – *ye****v****ater*

The cases of variable forms are found in dynamic states, and are not found in fixed ones. Fixed states are of two types: (a) where alternation is *regular*; and (b) where there is no alternation at all. The absence of variable forms in the normative non-alternating paradigms provides the required evidence for the direction of change in MH spirantization, towards the complete loss of the alternation and a fixed state where the phonological generalization responsible for the alternation is doomed.

5.3 THE FINAL STATE OR: WHAT STOPS THE CHANGE?

Throughout this work I addressed the question of what motivates change, or what triggers reranking. The model of change presented here arises, however, questions which have not yet been addressed, that is, what avoids change where it does not occur? and what stops reranking?

The model of change presented above, where markedness constraints are demoted below faithfulness constraints, predicts in fact the loss of phonological generalizations. Such a process is shown in the acquisition path of single lexical forms and in the change path of MH stop-fricative alternation. The final state of both paths is a grammar without phonology, which is reminiscent of Kaye's (1989) statement that "the most remarkable fact about phonological phenomena is that they exist at all" (p. 16). The model I presented, as is, does predict the loss of phonological

phenomena. The question is how come there are no languages without phonology after all? The answer to this question lies, I believe, in the reasons for change.

5.3.1 LANGUAGE ACQUISITION

Change in the course of language acquisition is explained in this work by the demotion of the markedness constraints that are violated in the target language. The demotion of markedness constraints results in surface contrasts which exist in the target language and which are presumably represented in the child's lexicon.

The final state of the acquisition path of *alternation* (§3.3) shows that the child does not demote, not even temporarily, the markedness constraints which account for regular alternation in the target language. Thus, reranking has to be triggered, otherwise it does not occur at all. Since the initial state is characterized by the general dominance of markedness constraints, and reranking (i.e. demotion of markedness constraints) is a result of some triggering (i.e. preserving lexical contrasts), reranking stops at the point where the child achieves all *and only* the contrasts existing in the target language:

(7) The final state in the paths of acquisition (see §3.4)

PATH	INITIAL RANKING	RERANKING	FINAL RANKING
Single forms	M » F	occurs	F » M
Alternation	M » F	occurs	F_1 » M_1
		does not occur	M_2 » F_2

I have shown in this work, through the analysis of the acquisition of both single lexical forms and of *regular* alternation (i.e. the prosodic alternation in the MH verbal system, §3.1.1), that reranking is restricted to the acquisition of contrasts and is blocked where phonological generalizations exist in the target language. These phonological generalizations are not a consequence of change, they are rather a consequence of universally motivated constraints which are respected in the target language.

5.3.2 LANGUAGE CHANGE

The model suggested for language change in this work raises the question of whether the fate of the alternation between stops and fricatives in MH represents the fate of all cases of alternation in natural languages.

The motivation for change in the case of MH spirantization is the opacity involved in the alternation between stops and fricatives, as a consequence of some historical changes (see §4.1.1). As a result of these historical changes, contradicting data, where non-alternating paradigms exhibit counter evidence of alternation, are evidenced. This counter evidence triggers reranking, which eventually results in the loss of alternation between stops and fricatives in the language. As in the case of language acquisition, this indicates that change, or reranking, occurs only when it is triggered. Otherwise, as long as alternation is regular (e.g. the prosodic alternation in the MH verbal system, §3.1.1), it is long lasting:

(8) The final state in the paths of language change

PATH	INITIAL RANKING	RERANKING	FINAL RANKING
Alternation with counter evidence §4.4	M » F	occurs	F » M
Alternation without counter evidence §3.1.3, §3.4	M » F	does not occur	M » F

The study of irregular alternation in the course of change shows that reranking takes place in order to 'fix' contradictions, but it does not occur where alternation is regular. The path of acquisition of such regular alternation may serve as an explanation for why regular alternations are long lasting: children demote markedness constraints only if these are violated in the target language. If they are not violated, i.e. regular alternations or other phonological phenomena exist in the target language,

there is no trigger for demotion of markedness constraints, and therefore no condition nor motivation for change.

To conclude, it should be emphasized that the OT mechanism of change does allow linguistic change up to the point of loss all phonological generalizations. However, the premises of the theory, whereby (i) markedness constraints are dominant in the initial state, and (ii) reranking is conditioned by positive evidence, actually restrict the change process to the minimal scope required for allowing the phonological contrasts in the target language (as in language acquisition), or in order to cope with opacity (as in language change). The studies presented in this work offer some support for the validity of these conditions and restrictions.

Appendix:

THE BINYANIM IN MODERN HEBREW

As described in §3.1.1, the verbal system of MH includes five derivational morphological classes, traditionally termed *binyanim*. These five binyanim are named *paʔal* (B1), *nifʔal* (B2), *hifʔil* (B3), *puʔal* (B4) and *hitpaʔel* (B5). This appendix includes a presentation of the basic forms of the binyanim (excluding defective verbs), in past, participle, future and infinitive (1), and of their inflectional forms (2), as presented in Bat-El (1989, to appear).

In the following tables the prefixes of the binyanim in past, participle and infinitive are overt, and the prefixes of the future forms in (1) are represented by 'F', which stands for the inflectional prefixes listed in (2). Each form is accompanied by examples specified for syllable boundary (with a dot) and stress:

(1) The basic forms of the binyanim

	PAST	PARTICIPLE	FUTURE	INFINITIVE
B1: paʔal	CaCaC	CoCeC	FiCCo/aC	liCCoC
'to finish'	ga.már	go.mér	yig.mór	lig.mór
'to learn'	la.mád	lo.méd	yil.mád	lil.mód
B2: nifʔal	niCCaC	niCCaC	FiCaCeC	lehiCaCeC
'to be finished'	nig.már	nig.már	yi.ga.mér	le.hi.ga.mér
'to be learned'	nil.mád	nil.mád	yi.la.méd	le.hi.la.méd
B3: hifʔil	hiCCiC	maCCiC	FaCCiC	lehaCCiC
'to enlarge'	hig.dĭl	mag.dĭl	yag.dĭl	le.hag.dĭl
'to dress s.o.'	hil.bĭš	mal.bĭš	yal.bĭš	le.hal.bĭš
B4: piʔel	CiCeC	meCaCeC	FeCaCeC	leCaCeC
'to raise'	gi.dél	me.ga.dél	ye.ga.dél	le.ga.dél
'to teach'	li.méd	me.la.méd	ye.la.méd	le.la.méd
B5: hitpaʔel	hitCaCeC	mitCaCeC	FitCaCeC	lehitCaCeC
'to get excited'	hit.ra.géš	mit.ra.géš	yit.ta.géš	le.hit.ra.géš
to get dressed'	hit.la.béš	mit.la.béš	yit.la.béš	le.hit.la.béš

(2) Verb inflection

PAST

B1: *gamar* 'to finish'

	singular		plural	
1st.	CaCaC-ti	ga.már.ti	CaCaC-nu	ga.már.nu
2nd. ms.	CaCaC-ta	ga.már.ta	CaCaC-tem	ga.már.tem
2nd fm.	CaCaC-t	ga.márt		
3rd. ms.	CaCaC	ga.már	CaCC-ú	gam.rú
3rd. fm.	CaCC-á	gam.rá		

B2: *nigmar* 'to be finished'

	singular		plural	
1st.	niCCaC-ti	nig.már.ti	niCCaC-nu	nig.már.nu
2nd. ms.	niCCaC-ta	nig.már.ta	niCCaC-tem	nig.már.tem
2nd fm.	niCCaC-t	nig.márt		
3rd. ms.	niCCaC	nig.már	niCCeC-u	nig.me.ŕu
3rd. fm.	niCCeC-a	nig.me.rá		

B3: *higdil* 'to enlarge'

	singular		plural	
1st.	hiCCaC-ti	hig.dál.ti	hiCCaC-nu	hig.dál.nu
2nd. ms.	hiCCaC-ta	hig.dál.ta	hiCCaC-tem	hig.dál.tem
2nd fm.	hiCCaC-t	hig.dált		
3rd. ms.	hiCCiC	hig.dil	hiCCiC-u	hig.dǐ.lu
3rd. fm.	hiCCiC-a	hig.dǐ.la		

B4: *gidel* ‘to raise’

	singular		plural	
1st.	CiCaC-ti	gi.dál.ti	CiCaC-nu	gi.dál.nu
2nd. ms.	CiCaC-ta	gi.dál.ta	CiCaC-tem	gi.dál.tem
2nd fm.	CiCaC-t	gi.dált		
3rd. ms.	CiCeC	gi.dél	CiCC-u	gid.lú
3rd. fm.	CiCC-a	gid.lá		

B5: *hitrageš* ‘to get excited’

	singular		plural	
1st.	hitCaCaC-ti	hit.ra.gáš.ti	hitCaCaC-nu	hit.ra.gáš.nu
2nd. ms.	hitCaCaC-ta	hit.ra.gáš.ta	hitCaCaC-tem	hit.ra.gáš.tem
2nd fm.	hitCaCaC-t	hit.ra.gášt		
3rd. ms.	hitCaCeC	hit.ra.géš	hitCaCC-u	hit.rag.šú
3rd. fm.	hitCaCC-a	hit.rag.šá		

PARTICIPLE

B1: *gomer* ‘to finish’

	singular		plural	
ms.	CoCeC	go.mér	CoCC-im	gom.rǐm
fm.	CoCeC-et	go.mé.ret	CoCC-ot	gom.rót

B2: *nigmar* ‘to be finished’

	singular		plural	
ms.	niCCaC	nig.már	niCCaC-im	nig.ma.rǐm
fm.	niCCeC-et	nig.mé.ret	niCCaC-ot	nig.mar.rót

B3: *magdil* ‘to enlarge’

	pingular		plural	
ms.	maCCiC	mag.díl	maCCiC-im	mag.di.lím
fm.	maCCiC-a	mag.di.lá	maCCiC-ot	mag.di.lót

B4: *megadel* ‘to raise’

	singular		plural	
ms.	meCaCeC	me.ga.dél	meCaCC-im	me.gad.lím
fm.	meCaCeC-et	me.ga.dé.let	meCaCC-ot	me.gad.lót

B5: *mitrageš* ‘to get excited’

	singular		lural	
ms.	mitCaCeC	mit.ra.géš	mitCaCC-im	mit.rag.ším
fm.	mitCaCeC-et	mit.ra.gé.šet	mitCaCC-ot	mit.rag.šót

Future[46]

B1: *yigmor* ‘to finish’

	singular		plural	
1st.	ʔ̈eCCoC	ʔeg.mór	ni-CcoC	nig.mór
2nd. ms.	t-iCCoC	tig.mór	ti-CCeC-u	tig.me.rú
2nd fm.	t-iCCeC-i	tig.me.rí		
3rd. Ms.	y-iCCoC	yig.mór	yi-CCeC-u	yig.me.rú
3rd. Fm.	t-iCcoC	tig.mór		

B2: *yigamer* ‘to be finished’

	singular		plural	
1st.	ʔe-CaCeC	ʔe.ga.mér	ni-CaCeC	ni.ga.mér
2nd. ms.	ti-CaCeC	ti.ga.mér	ti-CaCC-u	ti.gam rú
2nd fm.	ti-CaCC-i	ti.gam.rí		
3rd. ms.	yi-CaCeC	yi.ga.mér	yi-CaCC-u	yi.gam rú
3rd. Fm.	ti-CaCeC	ti.ga.mér		

B3: *yagdil* ‘to enlarge’

	singular		plural	
1st.	ʔ-aCCiC	ʔag.díl	n-aCCiC	nag.díl
2nd. ms.	t-aCCiC	tag.díl	t-aCCiC-u	tag.dí.lu
2nd fm.	t-aCCiC-i	tag.dí.li		
3rd. ms.	y-aCCiC	yag.díl	y-aCCiC-u	yag.dí.lu
3rd. fm.	t-aCCiC	tag.díl		

B4: *yegadel* ‘to raise’

	singular	plural

[46] In colloquial Hebrew the the prefix of ‘1st person singular’ is often produced as ‘3rd. ms. sg.’ (e.g. ***y**igmor* for both ‘**I** will finish’ and ‘**he** wil finish’.

1st.	ʔe-CaCeC	ʔe.ga.dél	ne-CaCeC	ne.ga.dél
2nd. ms.	te-CaCeC	te.ga.dél	te-CaCC-u	te.gad.lú
2nd fm.	te-CaCC-i	te.gad.lí		
3rd. ms.	ye-CaCeC	ye.ga.dél	ye-CaCC-u	ye.gad.lú
3rd. Fm.	te-CaCeC	te.ga.dél		

B5: *yitrageš* 'to get excited'

	singular		plural	
1st.	ʔet-CaCeC	ʔet.ra.géš	nit-CaCeC	nit.ra.géš
2nd. ms.	tit-CaCeC	tit.ra.géš	tit-CaCC-u	tit.rag.šú
2nd fm.	tit-CaCC-i	tit.rag.ši		
3rd. ms.	yit-CaCeC	yit.ra.géš	yit-CaCC-u	yit.rag.šú
3rd. fm.	tit-CaCeC	tit.ra.géš		

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