Deriving Greenberg's Asymmetry in Arabic

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Abstract

Semitic verbs exhibit a well-known prohibition against forms with initial gemination, *ssam, or with an initial sequence of two identical consonants, *sasam, alongside an abundance of forms with final gemination or final identity such as samm, samam (Greenberg 1950). This asymmetry has received considerable attention in the literature. Past explanations crucially rely on restrictions imposed on the inventory of lexical inputs. In this paper, properties of the Semitic lexicon such as the asymmetry *ssam versus samm and other well-known alternations in the shape of the verb such as the 'doubled verb' alternation are considered in the context of the inflectional paradigm. This makes it possible to explain the asymmetries in the lexical inventory and other previously problematic alternations in the verb by employing three independently necessary factors: the structure of the verbal paradigm, the syllabification canons of the language, and intra-paradigmatic identity constraints requiring identity between morphologically related forms. The implications of this stem-based view for the typological distinction between concatenative and non-concatenative morphology are developed.

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1. Introduction

Linguists have posited a dichotomy in languages according to the way they form words. On the one hand, in languages like Latin or English words are formed by joining or concatenating sequences of recombinable phonological strings. So the word 'speaking' [spiki_], for instance, is formed by joining the sound sequence of the verb 'to speak' [spik], the stem, with the sound sequence of '-ing' [i_], the affix. This mode of morphology that builds words by adding affixes to stems is called **concatenative** morphology. On the other hand, there are languages with **non-concatenative** morphology, where word-formation is described not by concatenation, but rather by some generally limited possibilities of interleaving vowels with a unit called the **consonantal root**, which consists of consonants and carries the main meaning of the word. The patterns of interleaving are known as **templates** and usually express something about the grammatical function and the meaning of the resulting word. Thus, in Syrian Arabic, the words [dahhaan] 'painter', [xaddaam] 'servant', [fannaan] 'artist' have two syllables with a medial geminate and a final long vowel, and are nouns denoting the occupation of the person referred to.

This dichotomy between concatenative and non-concatenative morphology has given rise to two formally distinct models of word-formation. Non-concatenative morphology was originally argued to require a phonological representation where consonants and vowels occupy distinct planes (McCarthy 1981, 1986). In recent work, some core phonological distinctions between concatenative and non-concatenative morphology, like the segregation of vowels and consonants on different planes and (long-distance) consonantal spreading across vowels, have been argued to be unnecessary. The main claim of that work is that, as far as phonology is concerned, languages with concatenative and non-concatenative morphology rely on the same phonological representations (Gafos 1996, 1998). The patterns of consonant, vowel interleaving, characteristic of Semitic languages, may be accounted by independently necessary means such as segmental copy, as opposed to autosegmenal spreading, and by general requirements of prosody, best expressed by the formal notion of template in the theory of Prosodic Morphology (McCarthy and Prince 1995a). What emerges from this work is that the locus of the typological distinction between concatenative and non-concatenative morphology is probably not to be found in the domain of phonology.

An independent development within the area of non-concatenative morphology consists of a growing number of works which promote a stem-based view of Arabic morphology (McCarthy 1993, McOmber 1995, Ratcliffe 1998, Benmamoun 1999). The stem-based view presents the attractive possibility that yet another distinction between languages with concatenative and non-concatenative morphology may be epiphenomenal and does not need to be recognized as a primitive in linguistic theory. However, convincing evidence for this conjecture has been lacking, because certain core facts of Arabic verbal morphology that appear to rely crucially on the concept of the consonantal root have not been examined from a stem-based perspective. These facts and their proper analysis are the focus of this paper.

A pressing problem for all stem-based proposals is a prominent feature of Arabic morphology, the so-called 'doubled verbs'. A doubled verb shows two forms, a 'canonical' [samam] and a

contracted [samm]. The first form appears before consonant-initial suffixes, [samam-tu] 'I poisoned', and shows a sequence of two identical consonants (hence, 'doubled verb'), while the second form appears before vowel-initial suffixes, [samm-a] 'he poisoned'. Verbs with three consonants do not show an alternation, [katab-a] 'he wrote', [katab-tu] 'I wrote'. In the Arab grammarian and lexicographic literature, doubled verbs were not treated in a consistent manner (Haywood and Nahmad 1965, p. 95). Sometimes they were classified as triliterals and sometimes as biliterals. The generative tradition has assumed they are biliteral, but has consistently attempted to assimilate them to the triliteral norm (Brame 1970, McCarthy 1981, Farley 1987, Moore 1990). Thus, in the well-known analysis in McCarthy (1981), [samam] derives from root |sm| mapped to the template CVCVC, which is the surface form of triliteral roots. Since |sm| is biliteral and the template has three C positions the /m/ of the root is assumed to spread to the final C position. This view follows the lexicographic tradition in that it takes [samam] to be the 'canonical' form of doubled verbs, because non-alternating triliterals take this CVCVC shape. The contracted form [samm] is derived from the 'canonical' /samam/ by a morpho-lexical rule of syncope and, as we will see, in some cases metathesis. Crucial to the statement of this rule is that the two identical consonants in /samam/ derive from the same root consonant. It is in this sense that doubled verbs provide indirect evidence for the role of the root (see also Kenstowicz 1994, p. 410)

Departing from this tradition, we argue that doubled verbs present an argument for rather than an obstacle to a stem-based view of Arabic morphology. Specifically, we argue that from the morpho-phonological point of view, the contracted form /samm/ rather than the allegedly 'canonical' /samam/ is the basic stem of the doubled verb. This basic stem appears unchanged, [samm], before vowel-initial suffixes. But joining /samm/ with a consonant-initial suffix, /samm-tu/, would result in a triconsonantal cluster, an ill-formed sequence according to the general phonotactics of the language. To avoid this phonotactic problem, the verb surfaces as [samam-tu]. To capture the phonotactic motivation of the doubled verb alternation, it is crucial that the basic stem of doubled verbs is /samm/. One of the goals of this paper is to develop this stem-based analysis of the doubled verb. As a consequence, it will be argued that there is no need for the morpho-lexical rule of syncope, and no independent need that doubled verbs must conform to the shape of triliteral verbs. Doubled verbs have their own stems with lexically-specified vocalism and consonantal length (e.g., /samm/ 'poison', /rudd/ 'return', /mill/ 'be weary').[1]

The stem-based analysis of doubled verbs leads to a re-examination of the second and most well-known evidence for roots. This evidence derives from an asymmetry in the lexical stock of Arabic. Recall that doubled verbs surface in two forms, [samm] and [samam]. The first variant has

[1] Throughout this paper, surface forms are shown in brackets [ya-ktub-u], stems in slashes /ktub/, and roots in vertical bars |ktb|.

a *final* geminate, and the second has a *final* sequence of two identical consonants separated by a vowel. In Arabic, there are no surface forms with *initial* gemination or with an *initial* sequence of two identical consonants (Greenberg 1950). Past accounts of this fact, henceforth "Greenberg's Asymmetry", derive it by positing restrictions on the inventory of possible inputs, also known as morpheme structure constraints (or MSCs). For instance, the absence of *[ssam] surface forms follows by stipulating that root consonants are not specified for prosodic properties such as (consonant) length. The absence of *[sasam] forms follows by making two assumptions. First, the Obligatory Contour Principle (OCP) applies at the level of the root, thereby excluding a sequence of two adjacent, identical consonants as in root s-s-m that could give rise to *[sasam] (McCarthy 1981). Second, when biliteral roots map to the CVCVC template, mapping proceeds left-to-right. Thus from a biliteral /sm/, mapping would result in [samam], not *[sasam]. We re-examine Greenberg's Asymmetry by considering the verbal forms not in isolation, either as consonantal roots or as stems, but rather as stems in the context of their inflectional paradigm (perfect and imperfect). As in the case of doubled verbs, this allows us to explore the extent to which these asymmetries derive from independently necessary properties of the language, without constraints on the inventory of possible inputs or assumptions about the direction of spreading. The novel point here is that the observations that fall under Greenberg's Asymmetry in Arabic are the lawful consequence of three independent factors, the segmental make-up of the affixes in the verbal paradigm (perfect, imperfect), the presence of intra-paradigmatic identity constraints in the grammar, and the independently necessary phonotactics of the language.

This paper is organized as follows. In section 2, we present a stem-based analysis of the triliteral verb. This section defines terms and introduces the formal means that are employed in the stem-based analysis of doubled verbs in section 3, and the derivation of Greenberg's Asymmetry in section 4. Section 5 considers doubled verbs in those conjugations which do not undergo the alternation, and shows how our core proposal readily extends to these Forms as well. Section 6 places the present proposals in the context of other stem-based attempts in the literature on Arabic morphology. Section 7 argues that certain novel phonological aspects of the proposed analysis of doubled verbs receive support from independent data. Section 8 concludes with a summary of the main points of the paper.

2. Putting the verb in context

Languages organize words in *paradigms*. These are described as sets of forms built from combinations of stems with inflectional markers designating various morphosyntactic categories. Since we are interested in the interaction between stems and their inflectional context, it is useful to consider paradigms as the contexts or the environments in which stems are realized. To make this more precise, we consider paradigms as sets of (phonological) forms made out of the exponents of morphosyntactic categories.[2] As an example, consider a fragment of the Arabic verbal paradigm for

[2] My use of term 'paradigm' is a similar to that of Carstairs (1987, pp. 47-8). Carstairs is interested in matters of economy in the realization of morphosyntactic exponents. We are interested in a different problem, namely, the phonologically-motivated alternations induced when stems are put in the context of these exponents. Defining the term paradigm in this way emphasizes the distinction between stems and their immediate phonological context in order to discuss the relationship between them.

the Indicative mood of the Imperfect aspect shown in (1). The paradigm consists of the set of forms _ = {ya—u, ta—u, ta—u, ta—iina, za—u, ya—uuna, ya—na, ta—uuna, ta—na, na—u, ya—aani, ta—aani, ta—aani, ta—aani}, the markers of the morphosyntactic categories of Mood (Indicative), Person (First, Second, Third) and Number (Singular, Plural, Dual). Fully inflected words are formed by placing a verbal form, here /ktub/, in the context of the appropriate prefix—suffix pair.[3]

1. Imperfect, Indicative

		Singular	*Plural*	*Dual*
3	*m*	ya-ktub-u	ya-ktub-uuna	ya-ktub-aani
	f	ta-ktub-u	ya-ktub-na	ta-ktub-aani
2	*m*	ta-ktub-u	ta-ktub-uuna	ta-ktub-aani
	f	ta-ktub-iina	ta-ktub-na	ta-ktub-aani
1		za-ktub-u	na-ktub-u	

We will refer to the form /ktub/ as the verbal *stem* or simply ς. In the general case, ς is also a set of forms to cover instances of suppletion (e.g., in English, the verb 'be' or the noun 'man'). To avoid ambiguity, we use the term stem in the sense of Aronoff (1992), who writes: "While a lexeme consists of form, meaning, and the usually arbitrary association between them, I will reserve the term *stem* for only the form part of this trinity. A stem, in my use of this term, is a form. In particular, it is the domain of a realization rule, that form of a lexeme to which a given affix is attached or on which a given nonaffixal realization rule operates." (1992, p. 14). In the present paper, since Arabic has obligatory inflection, the stem is the sound form "to which a given affix is attached". This is the part of the definition used in this paper, though other parts of the notion of stem as defined here may turn out to be helpful in Arabic morphology. This sense of stem is essentially the same as that assumed in other modern lexeme-based theories of morphology such as that of Anderson (1992) and

[3] This listing of the prefix, suffix exponents raises issues that are of interest to the morphologist, e.g., the absence of a gender distinction in the first person, and the homophony of the third feminine and second masculine forms (see McCarthy 1979, pp. 295-303, Noyer 1992, and Fassi Fehri 2000 for relevant discussion). However, such listing suffices for our current purpose, that is, for the purpose of determining to what extent the segmental shapes of these inflectional exponents determine the shape of the verbal stem.

Matthews (1972).

Now, given a paradigm _ and a stem ς, an important point is that, in principle, each of these two sets of forms has the potential of shaping the other through phonological interaction. It is the role of this interaction that we wish emphasize in this paper because it turns out to provide a powerful source of mutual constraint. Specifically, we focus on one particular mode of this interaction between _ and ς which ensues when the paradigm _ is 'rigid', that is, consists of a fixed set of forms immune to phonological alternation. When _ is rigid, the potential interaction can take place only in one direction, from _ to ς. In other words, the context determines phonological properties of the stem. The rest of this paper provides formal content to this idea by studying a number of facts about the Arabic verb, and by showing how each of these facts derives from the interaction between rigid paradigms and verbal stems.

We begin in this section with the predominant class of verbs in the Semitic lexicon, the so-called 'triliterals'. These appear with in the 'minimal form' [CCVC] on the surface. Our immediate purpose is to show how the paradigm coupled with the phonotactics of the language 'molds' this shape of the triliteral stem.

2.1 The imperfect stem

The Arabic verb is described as having two sets of verbal forms, known as the imperfect and the perfect. Imperfect forms show an invariant shape [-CCvC-] and refer to present and future time. All basic verbal moods, the Indicative, the Subjunctive, the Jussive, and the Imperative, are based on the imperfect form [-CCvC-]. The Indicative was shown in (1). The Subjunctive differs from the Indicative in substituting the suffix vowel /a/ for /u/ and in the absence of the /na/ from the feminine singular, dual, and masculine plural suffixes, e.g., Indicative [ta-ktub-iina] 'write.2fs', Subjunctive [ta-ktub-ii] 'write.2fs'. The Jussive and the Imperative are in (2, 3) respectively.[4] As with the Indicative, a verbal form in these moods is constructed on the imperfect stem placed in the context of a paradigm of prefixes and suffixes, the markers of Person, Gender, and Number. This section is concerned with the invariance of the [-CCvC-] form.

2. Imperfect, Jussive

		Singular	*Plural*	*Dual*
3	*m*	ya-ktub	ya-ktub-uu	ya-ktub-aa
	f	ta-ktub	ta-ktub-aa	ya-ktub-na
2	*m*	ta-ktub	ta-ktub-uu	ta-ktub-aa
	f	ta-ktub-ii	ta-ktub-na	ta-ktub-aa
1		za-ktub	na-ktub	

3. Imperfect, Imperative

[4] There is also a rare variant of the Jussive, called the Energicus (see Schramm 1962, pp. 502, 516). The phonological make-up of the affixes in this mood is in all relevant respects similar to the other moods, that is, all prefixes are vowel-initial and suffixes are vowel- or consonant-initial. The forthcoming results readily extend to this mood as well.

		Singular	*Plural*	*Dual*
2	*m*	zu-ktub	zu-ktub-uu	zu-ktub-aa
2	*f*	zu-ktub-ii	zu-ktub-na	zu-ktub-aa

The vowel of the verbal stem must be lexically specified as one of /a, u, i/: [ya-ktub-u] 'he writes', [ya-lbas-u] 'he dresses', [ya-Drib-u] 'he hits'. There are also minimal pairs of stems distinguished solely on the basis of this vowel: [ya-smar-u] 'be brown' versus [ya-smur-u] 'spend the night conversing', and [ya-Hzun-u] 'sadden' versus [ya-Hzan-u] 'be sad' (Testen 1985). Given such facts, a number of researchers have proposed that the verbal morphology of triliterals builds on the imperfect stem /ktub/ (Schramm 1962, 1992, p. 1403, Kury_owicz 1972, pp. 34, 43, McOmber 1995, p. 179, Ratcliffe 1998, p. 33, Benmamoun 1999, p. 176, among others). Kury_owicz (1972) most notably writes: "The fundamental form of the Sem. conjugation, the so-called "imperfect(ive)" yaqtul(u) shows a characteristic vowel after (R2) which is unpredictable, i.e. independent of any grammatical rule, hence basic. Therefore the verbal root is not a consonantal skeleton (q-t-l), but contains an essential vocalic component (u of qtul)" (p. 43).

Put in modern terms, Kury_owicz's view consists of the claim that the morphology is stem-based. This seems to be a viable view, but it raises one important question. Observe that there is no surface contrast between [ya-ktub-u] and hypothetical [ya-kutb-u]. Whence the CCVC shape invariance of the triliteral verb? Both [ya-ktub-u] and hypothetical [ya-kutb-u] are phonologically well-formed, but only the former is attested.[5]

One account of this lack of surface contrast is to restrict the inventory of underlying stems to include only /ktub/, not /kutb/. In this view, since there is no underlying /kutb/ stem, it follows that no [ya-kutb-u] surface form can exist. This is of course an unsatisfactory account because it derives systematic properties of the surface patterns by a stipulation about the set of admissible inputs. In fact, in Optimality Theory (Prince and Smolensky 1993), the theory of grammar assumed in this paper, henceforth OT, this kind of account is expressly disallowed. In OT, the locus of explanation for language-particular surface patterns is the constraint-based grammar, rather than restrictions about the inputs to that grammar. Indeed, the set of inputs is assumed to be the same for all languages, an assumption known as *Richness of the Base*: "The source of all systematic cross-linguistic variation is constraint reranking. In particular, the set of *inputs* to the grammar of all languages is the same. The grammatical inventories of a language are the *outputs* which emerge from the grammar when it is fed the universal set of all possible inputs" (from Smolensky 1996, see also Prince and Smolensky 1993, p. 191).

Let us then turn to see how it is possible to explain the absence of /kutb/ stems through constraint ranking. We will begin by setting a slightly different goal first. That goal is to identify the grammatical statement of the fact that there are can be no surface [kutb] forms for triliteral verbs (§2.1). Once this goal is achieved, we employ an induction procedure for lexical inputs, called

[5] McCarthy and Prince (1990a, pp. 251-260; 1990b, pp. 17-23) have argued convincingly that Arabic stems are subject to a minimality requirement of two moras. Both /ktub/ and /kutb/ would satisfy this requirement. In [ya-ktub-u], /u/ and /k/ are both moraic (the /k/ is moraic due its coda status). In [ya-kutb-u], /u/ and /t/ are moraic. Thus, the minimality requirement does not exclude any of the two stems.

Lexicon Optimization, to show that the grammar responsible for the absence of surface [kutb] forms also derives the absence of /kutb/ stems from the lexicon (§2.2). The technique employed in this section generalizes to derive other well-known systematic properties of the Semitic lexicon such as the absence of stems with initial geminates.

2.1.1 Absence of [kutb] surface forms

Three crucial factors conspire to account for the absence of surface [kutb] in Arabic: the segmental make-up of the affixes in the verbal paradigm, the phonotactics of the language, and identity requirements between related forms within the paradigm. We consider each of these in turn.

Let us assume the hypothetical stem /kutb/. First, observe that there is an asymmetry in the inflectional context of all paradigms built on this stem (indicative, subjunctive, jussive, imperative). As shown in (1), (2) above, prefixes are always vowel-final, but some suffixes begin with a consonant or have no overt marking at all. This asymmetry provides the key phonotactic motivation for avoiding [-kutb-] surface forms. Before a consonant-initial or null suffix, [-kutb-C] or [-kutb-#] would induce a phonotactic violation. Arabic does not permit CCC clusters or CC margins (see Angoujard 1990, Broselow 1980, 1992, Itô 1986, Farwaneh 1995, Broselow, Chen, and Huffman 1997 for syllabification in Arabic). The sequence *[ya-kutb-na] contains a sequence of three consonants which may be syllabified as [(kut)$^{\sigma}$(bna)$^{\sigma}$] with a complex onset, or [(kutb)$^{\sigma}$(na)$^{\sigma}$] with a complex coda word-medially. Both of these syllabic sequences are disallowed. We will use *COMPLEX for the constraint that disallows such clusters in (3) below (Prince and Smolensky 1993). This is the constraint ruling out *[ya-kutb-na].[6]

4. Phonotactic constraint

*COMPLEX: Complex syllable margins are prohibited ('complex': more than one segment)

The phonotactic implies that input /ya, ktub, na/ cannot surface as *[ya-kutb-na]. The phonotactic problem created at the stem-suffix boundary could be resolved by epenthesis of a vowel, as in *[ya-kut-i-b-na], or by deletion of a consonant, as in *[ya-kut-na]. However, epenthesis or deletion never occur within the core domain of the verb, that is, within the context of [prefix-stem-suffix]. Therefore, the only alternative is metathesis from /ya-kutb-na/ to [ya-ktub-na]. Metathesis results in a violation of an identity requirement between the form of the stem /kutb/ and its surface realization [ktub]. Within OT, identity constraints between related linguistic forms are referred to as Faithfulness constraints, and they are the subject matter of McCarthy and Prince's Correspondence Theory of Faithfulness (McCarthy and Prince 1995b). The relevant constraint of this theory here is LINEARITY, defined below. The specific dimension over which input /kutb/ and output [-ktub-] differ

[6] The so-called 'super-heavy' CVCC and CVVC syllables do occur in the limited context before a pause. For example, pre-pausally [katab-tu] 'write-past-1sg' and [kitaab-in] 'book-gen-indef' appear as [katab-t] and [kitaab] (see Hoberman 1995). It is reasonable to assume that the output of the truncation morphology escapes prosodic limitations on syllable weight, as proposed in McCarthy and Prince (1990b, pp. 19, 50). Another instance where CVVC syllables occur is discussed in section 5.

is the linear ordering of segments. It is the business of LINEARITY to penalize this disparity between /kutb/ and [-kutb-]. The version of the constraint holding between input and output is denoted as IO-LINEARITY or IO-LIN.

5. LINEARITY: S_1 is consistent with the precedence structure of S_2, and vice versa.

By standard OT reasoning, hypothetical /kutb/ stems would surface as [kutb] as a result of the grammatical statement *COMPLEX >> IO-LIN. This is illustrated in the tableau below. Intuitively, this tableau expresses the fact that the phonotactics of the language (*COMPLEX) take priority over identity between the input and the output (IO-LIN), a typical case of phonological action in OT. The tableau is the same for a null suffix such as the 3ms Jussive /ya, ktub/ → [ya-ktub].

6. Fate of hypothetical stem /kutb/: /ya, kutb, na/ → [ya-ktub-na]; *COMPLEX >> IO-LIN

/ya, kutb, na/	*COMPLEX	IO-LIN
a. ya-kutb-na	*!	
b. ☞ ya-ktub-na		*

Metathesis, then, repairs the local phonotactic violation of *COMPLEX in the case of consonant-initial suffixes. However, metathesis has the global consequence of creating surface allomorphy in the verbal paradigm. The realization of /ya, kutb, u/, the 3ms, involves the simple concatenation of the stem with its inflectional affixes. But realizing /ya, kutb, na/, the 3fp, triggers metathesis. The consequence is an alternation in the realization of the stem, as the stem surfaces with two different forms [-ktub-] and [-kutb-]. A schematic of the situation is shown below.

7. Consequence of hypothetical stem /kutb/: non-uniform realization

3ms: /ya, kutb, u/ → [ya-kutb-u]

↘

[-ktub-] ≠ [-kutb-]

↗

3fp: /ya, kutb, na/ → [ya-ktub-na]

Non-uniformity in stem realization is the final crucial factor involved in explaining the absence of [kutb] forms. Formally, this factor enters into the grammar via intra-paradigmatic identity constraints. Here, we rely on a body of research which converges on the hypothesis that identity constraints between related linguistic forms hold not only between an input and an output but also between pairs of related output forms (Benua 1995, Buckley 1995, Burzio 1993, 1994, 1995ab, 1996, Kenstowicz 1997, McCarthy 1995, 2000). Such constraints are called Output-Output Faithfulness constraints. In our example, the Output-Output version of the constraint LINEARITY, OO-LIN, penalizes the disparity between the two output forms [ya-kutb-u] and [ya-ktub-na].

There is thus a local phonotactic problem with /kutb/ stems: before all consonant-initial or null suffixes, such stems would result in a violation of *COMPLEX. This phonotactic problem can be resolved locally by metathesis but such a resolution has the global consequence of introducing allomorphy. The realizations of /kutb/ before all vowel-initial suffixes would take the shape [kutb], in itself a phonotactically well-formed output. But the realizations of the stem in any other context must take a different form, [ktub]. The fact that such allomorphy is not attested in Classical Arabic is a consequence of a high-ranked OO-LIN.

The grammar expressing this idea formally is shown in the 'paradigm tableau' below.[7] A paradigm tableau computes the surface realizations of a hypothetical stem in all contexts of some paradigm. Thus, given a stem /kutb/, the tableau below assesses the performance of its various realizations under the presence of the constraints *COMPLEX, OO-LIN and IO-LIN. The assessed candidate realizations are not individual surface forms, but rather sets of surface forms. Candidate (a) is [ya-kutb-u, ya-kutb-na] which incurs a fatal violation of *COMPLEX. Candidate (b) is the non-uniform set [ya-kutb-u, ya-ktub-na] with a violation of OO-LIN. Candidate (c) avoids the OO-LIN violation by leveling to [ktub] throughout. This violates IO-LIN twice, once for its of the mappings /kutb/ → [ya-ktub-u] and /kutb/ → [ya-ktub-na]. Without loss of generality and for space reasons, we only show two representative output forms for each candidate set, one with a consonant-initial and the other with a vowel-initial suffix.

8. Uniform realization: /kutb/ → [ya-ktub-u, ya-ktub-na]; *COMPLEX, OO-LIN >> IO-LIN

/kutb/	*COMPLEX	OO-LIN	IO-LIN
a. ya-kutb-u, ya-kutb-na	*!		
b. ya-kutb-u, ya-ktub-na		*!	*
c. ☞ ya-ktub-u, ya-ktub-na			**

The crucial ranking relation in the grammar is OO-LIN >> IO-LIN. The dominant OO-LIN induces leveling of the linear order to [ktub] throughout the realization set, that is, also the form before a vowel-initial suffix surfaces as [ktub]. The non-uniform set [ya-kutb-u, ya-ktub-na] is more marked than the uniform [ya-ktub-u, ya-ktub-na]. The ranking *COMPLEX, OO-LIN >> IO-LIN is the grammatical statement of the fact that allomorphy, as in the hypothetical set [ya-kutb-u, ya-ktub-na]

[7] The term 'paradigm tableau' is introduced in Tesar and Smolensky (1998, p. 41).

in (b), is not attested in Arabic.

We sum up the discussion up to now. A stem ς is realized in the context of a paradigm _, a set of prefix—suffix pairs. The context induces local phonotactic pressures on the realization of ς. These pressures can have global consequences when intra-paradigmatic identity is dominant. Specifically, it is the phonotactic pressures in the context before a consonant, [-kutb-na], which demand alternation to [-ktub-na]. With OO-LIN being dominant, the effect of the local phonotactic (here, metathesis) is transmitted to the rest of the forms in the paradigm, namely, to the contexts where the stem occurs before a vowel-initial suffix, hence [-ktub-u], not *[-kutb-u]. This is why surface *[-kutb-u] is not attested in Arabic.

The reasoning above generalizes to any phonotactic constraint which targets some phonological configuration in some local morphosyntactic context of a paradigm, and any faithfulness constraint which is forced to violation in that local context where the phonotactic pressure is met. Indeed, as we will see, this reasoning allows us to derive the absence of geminate-initial stems and the absence of stems with initial identity where different phonotactic and faithfulness constraints are involved.

It takes one more step to show that the interaction between the paradigm and the surface realizations of a stem within the paradigm has consequences for the inventory of possible stems.

2.1.2 Absence of /kutb/ stems

The grammar, that is, the ranking SYLL, OO-LIN >> IO-LIN, is responsible for the absence of [kutb] surface forms. This grammar is such that both stems /kutb/ and /ktub/ map to the same set of surface forms, [ya-ktub-u, ya-ktub-na].

Our goal is to derive the absence of /kutb/ stems from the lexical inventory of the language. In OT, inputs and in particular stems are inferred via a general technique known as Lexicon Optimization. Lexicon Optimization is the formal implementation of the following logic, originally due to Stampe (1972). Consider the fact that both /ktub/ and /kutb/ stems surface consistently as [ktub]. The realization sets of the two stems are identical. Which stem is the learner to choose as the one underlying the surface facts? Given that there are no surface [kutb] forms in the realization set, the learner will not be tempted to set up an underlying stem /kutb/. Even though both underlying stems /kutb/ and /ktub/ can derive the surface forms, the learner will choose stem /ktub/ because this stem is 'closer' to the observed surface facts. In this sense, stem /ktub/ 'hides' stem /kutb/ (Prince and Smolensky 1993, Inkelas 1995, Tesar and Smolensky 1996, 1998, Itô, Mester, and Padgett 1996, Yip 1997, McCarthy 1998).

Lexicon Optimization formalizes the logic of 'Stampean Occultation' using an Optimality theoretic grammar. Specifically, Lexicon Optimization evaluates the relative harmony of the two mappings, /kutb/ → [ya-ktub-u, ya-ktub-na] and /ktub/ → [ya-ktub-u, ya-ktub-na], as shown below. Evaluation proceeds in the standard way as defined by the Optimality theoretic function *H-Eval*. Here, stem /kutb/ surfaces as [ya-ktub-u, ya-ktub-na] with two violations of IO-LIN, but /ktub/, which underlies the same surface set, does not violate any of the constraints. Hence, stem /ktub/ provides the more harmonic mapping or, equivalently, *H-Eval* determines the harmonic ordering /ktub/ _ /kutb/ ('α _ β' stands for 'α is more harmonic than β'). The learner will choose the most harmonic stem, that is, the stem which supplies the least violations of the most important constraints.

9. Lexicon Optimization: /ktub/ _ /kutb/

Stems	Surface set	*COMPL	OO-LIN	IO-LIN
a. /kutb/	ya-kutb-u, ya-kutb-na	*!		
	ya-kutb-u, ya-ktub-na		*!	*
	☞ ya-ktub-u, ya-ktub-na			**
b. ☞ /ktub/	ya-kutb-u, ya-kutb-na	*!	*	
	ya-kutb-u, ya-ktub-na		*!	*
	☞ ya-ktub-u, ya-ktub-na			

We see, then, that Lexicon Optimization projects the effects of the grammar from the surface forms back to the inputs. This is how we can derive the absence of /kutb/ stems without stipulating a ban on such stems from the lexical inventory of the language. The latter statement would be the equivalent to a morpheme structure constraint against */kutb/ stems in Arabic. Lexicon Optimization obviates such stipulations about the set of admissible inputs (on morpheme structure constraints in OT see Myers 1997 and McCarthy 1998). Indeed, surface properties of the language, here, the segmental make-up of the affixes in the paradigm coupled with intra-paradigmatic identity constraints are responsible for the absence of /kutb/ stems from the lexical inventory.

The present stem-in-context approach directly extends to provide account for the shape invariance of triliteral nouns. Briefly, triliteral nouns appear consistently as CCVC: [nafs-un] ‘soul’, [ba_r-un] ‘sea’, [qufl-un] ‘lock’, [burd-un] ‘robe’, [_iml-un] ‘load’, [qid_-un] ‘arrow’ and so on (McCarthy 1979, p. 343). Thus, there exists a basic asymmetry between the noun and the verb: CCVC shape for the former, but CVCC shape for the latter. To understand this asymmetry, we must consider again the inflectional context. For nouns, this consists of vowel-initial suffixes, [*stem*-un] for the indefinite and [zal-*stem*-u] for the definite form. The paradigm is shown below, built on the morphosyntactic categories of Case, Gender, and Number (see McCarthy 1979, p. 352).

10.

Noun	*Masc. Sing.*	*Masc. Pl.*	*Fem. Sing.*	*Fem. Pl.*
Nominative	-un	-uuna	-atun	-aatun
Genitive	-in	-iina	-atin	-aatin
Accusative	-an	-iina	-atan	-aatin

This paradigm contrasts with the verbal one, where all prefixes are vowel-final and some

suffixes are consonant-initial or null. It is now easy to see why the CC cluster in the noun appears at the right edge of the nominal form, CVCC, not *CCVC as for the verb. The nominal paradigm coupled with the basic syllabification constraint *COMPLEX dictates [CVCC-V] as the only possible realization of a triliteral noun. The alternative form [CCVC-] is avoided because of the initial complex onset. The ranking relation *COMPLEX >> IO-LIN ensures that independent of the linear order of the segments of the input a triliteral noun surfaces as [CVCC-V]. Lexicon Optimization would then determine CVCC as the stem, since this stem would provide the most optimal mapping to the surface form.

The only previous attempt known to us for an account of the CCVC shape of verbs versus the CVCC shape of nouns is found in Ratcliffe (1998, pp. 51-2). Ratcliffe proposes that the underlying stem for both nominal and verbal stems is the same, CVCC. He derives the CCVC surface realization of the verbal stem via a requirement for "Maximal Syllabification" said to operate in a left-to-right mode. This requirement prefers [ya-ktub-u] over [ya-kutb-u] because in the former syllabification builds the maximally possible syllable [(yak)...] at the left edge. The present analysis obviates such assumptions about the input (which are impossible in a theory like OT) as well as any language-particular assumptions about directional syllabification. The paradigmatic context in conjunction with the basic syllabification constraint *COMPLEX and intra-paradigmatic identity constraints suffice to explain the asymmetry in the realization of the nominal versus verbal forms and their underlying stems.

To sum up, we have provided formal content to a particular mode of interaction between inflectional contexts and verbal stems. The inflectional context of a paradigm _ coupled with phonotactic constraints sets limits on the theoretically possible diversity of stem realizations within that context. Effectively, the paradigm 'molds' the shape of the verbal stem to 'fit' the inflectional context _. Later sections show how other well-known systematic properties of the Semitic lexicon derive from the same kind of interaction between contexts and stems.

2.2 The perfect stem

Perfect forms take the shape [CaCvC-] and generally refer to past time.[8] Fully inflected words based on the perfect appear with suffixes, marking person, gender, and number. There are no prefixes.

11.

Perfect		*Singular*	*Plural*	*Dual*
3	*m*	katab-a	katab-uu	katab-aa
	f	katab-at	katab-na	katab-ataa
2	*m*	katab-ta	katab-tum	katab-tumaa
	f	katab-ti	katab-tunna	katab-tumaa
1		katab-tu	katab-naa	

The vocalism of verbs in Form I changes between the imperfect and the perfect. Thus, the vowel

[8] But not always; see Al-Karouri (1996, chapter 4) for discussion of the long-standing issue of Tense/Aspect in the Arabic verb and for uses of the perfect to refer to future time.

of the imperfect [ktub] is a lexically specified vowel particular to the verb ‘write’. In the perfect, putting aside the first /a/ in [katab] – a marker of Active Voice – the second vowel is a counterpart of the /u/ in the imperfect [ktub]. Additional examples of this vowel alternation are shown below. The alternation is not phonologically conditioned. In [krub, xrib, drab], all vowels /u, i, a/ are found in the imperfect, even though the consonantal contexts are highly similar. The same is true with the vocalism of the perfect, [qar**u**b-, Rar**i**b-, har**a**b-] (Guerssel and Lowenstamm 1996, McCarthy 1994; frequencies are from McCarthy 1994).

12.

Vowel pairs	*Perfect*	*Imperfect*	*Gloss*	*Frequency*
$a^{Perf} \sim u^{Impf}$	kar**a**b-	-kr**u**b-	‘come near’	1029
	har**a**b-	-hr**u**b-	‘flee’	
$a^{Perf} \sim i^{Impf}$	xar**a**b-	-xr**i**b-	‘devastate’	842
	Dar**a**b-	-Dr**i**b-	‘hit’	
$i^{Perf} \sim a^{Impf}$	dar**i**b-	-dr**a**b-	‘be experienced’	518
	Rar**i**b-	-Rr**a**b-	‘drink’	
$a^{Perf} \sim a^{Impf}$	faz**a**l-	-fz**a**l-	‘do’	436
	rad**a**z-	-rd**a**z-	‘prevent’	
$u^{Perf} \sim u^{Impf}$	qar**u**b-	-qr**u**b-	‘be close to’	191
	kab**u**r-	-kb**u**r-	‘be great’	

Meillet (1964) and Grimm (1870) discuss such alternations in Indo-European languages in direct juxtaposition to their Semitic analogs. Meillet, for instance, refers to the phenomenon as ‘vowel alternations’ and illustrates it with examples from Ancient Greek and Semitic (1964, pp. 153 ff.). Grimm refers to these alternations as ‘ablaut’ when discussing the Germanic instances of the phenomenon (1870, p. 8). It is not trivial to establish which is the basic and which is the derived form in the perfect / imperfect pairs showing the alternations. Moreover, as Matthews (1974) notes, it is not clear whether such a distinction should be made beyond simply recognizing the presence of two stems for each verb.

The traditional lexicographic view takes the perfect as the citation form of the verb. If we endorse this view as linguistically significant, then the perfect would be basic, and the imperfect would derive from the perfect. In generative grammar, a formal expression of this view appears in McCarthy (1981). The imperfect is formed by addition of a CV prefix to the perfect /kVtVb/, /CV + kVtVb/, followed by a rule of medial vowel elision, /CV + kVtVb/ $\rightarrow$ /CV + kt*V*b/, where the lexical vowel in the output /kt*V*b/ is the apophonic counterpart of the lexical vowel of the perfect (McCarthy 1981, p. 403). Testen (1985, pp. 132-3) and Hudson (1986, p. 99) point out that the rule of vowel elision effecting the change from /CVCVCVC/ to [CVCCVC] cannot be phonological. In the perfect, combining CVCVC- with -VC suffixes such as the feminine singular [-at], [katab-at] ‘she wrote’, does not trigger elision of the medial vowel, and non-verbal forms with the shape CVCVCVC, such as [malikun] ‘king’, [baladun] ‘land’, [Hasanun] ‘beautiful’, do not show elision of the medial vowel.

For our purposes, we assume no directionality between the perfect and the imperfect stem. That is, we do not assume that one stem is more basic than the other. Aronoff essentially proposes the

same for Hebrew Qal verbs which have a 'prefixed' and an 'unprefixed' stem, corresponding to the Classical Arabic imperfect and perfect stems (Aronoff 1994, pp. 141-6). Thus, we assume that Arabic Form I verbs or more precisely verb lexemes have two stems, a perfect and an imperfect stem. Aronoff (1994) argues explicitly that lexemes can have more than one stem, which is one reason for making the distinction between lexeme and stem discussed in §2. Thus, the verb 'write' has imperfect stem /ktub/ and perfect stem /ktab/, 'drink' has imperfect stem /Rrab/ and perfect stem /Rr**i**b/, and so on. The fact that there is a relation between the vocalism in the perfect and the imperfect stem must be stated in some form in the lexicon of Arabic. The details of this statement, however, are orthogonal to our concerns. For discussion of this long-standing issue, see Kury_owicz (1972), McCarthy (1979, pp. 290-3, 1994), Aronoff (1994), McOmber (1995), and Guerssel and Lowenstamm (1996).

Finally, we account for the presence of the Active Voice marker /a/ in all perfect [CaCvC-] forms by affixation (as in McOmber 1995). That is, in our approach, a form like [k-a-tab-tu] 'I wrote' is the surface realization of /a, ktab, tu/. The locus of the affix can be made to fall out of the interaction of two constraints that are part of the Generalized Alignment theory of McCarthy and Prince (1993). The first constraint requires that the left edge of the affix coincides with the left edge of the prosodic word, ALIGN(/a/, L, PrWd, L). The second constraint requires that the left edge of the verbal stem coincides with the left edge of the prosodic word, ALIGN(Verb, L, PrWd, L). The locus of the affix can be seen as a consequence of ALIGN(Verb, L, PrWd, L) dominating ALIGN(/a/, L, PrWd, L)

3. Doubled verbs

The so-called 'doubled verbs' in Arabic are verbs which show an alternation between a 'canonical' form [samam] and a contracted form [samm]. The form [samam] appears before consonant-initial suffixes, [samam-tu] 'I poisoned' in the perfect, [ya-smum-na] 'they (f) poison' in the imperfect. The contracted form [samm] appears before vowel-initial suffixes, perfect [samm-a] 'he poisoned', imperfect [ya-summ-u] 'he poisons'. This alternation seems puzzling in that it does not take place in all Forms of the Arabic verb and the precise conditions for its application seem to involve a peculiar combination of phonological and morphological factors. Considerable attention has been devoted to the proper statement of this alternation. As discussed in 3.1, all past accounts consider /samam/ as the basic form underlying the alternation. Departing from this tradition, we argue that the form /samm/ is the basic stem of doubled verbs. The alternation is then shown to be driven by phonotactic, independently necessary properties of the language. A stem-based analysis of doubled verbs is developed in 3.2 and 3.3, each dealing with the alternation in the imperfect and perfect paradigm respectively. In 3.4, alternative stem-based analyses are considered and rejected.

3.1 Data and previous analyses

Doubled verbs have received considerable attention in the literature (Brame 1970, McCarthy 1981, 1986, Farley 1987, Ratcliffe 1998, Moore 1990, Rose 2000). Past accounts of the douled verb alternation treat /samam/ as the basic form from which the contracted form [samm] is derived. The purpose of this section is to show that any account that makes this assumption is bound to treat the doubled verb alternation as morphologically conditioned.

It is instructive to place the doubled verb alternation in the wider context of the rest of the alternations that take place in the verbal system of Arabic. The table below summarizes the alternations for triliteral (or strong), doubled, and hollow verbs in Form I. Hollow verbs are those verbs which are traditionally assumed to have medial /y, w/ glides in their roots. If there is an alternation, then two forms are shown separated by '~'. The first form occurs before a C-initial suffix and the second form always occurs before a V-initial suffix (shown in bold). We ultimately consider all Forms where the alternation happens or does not happen, but for current purposes the data from From I will suffice.

13.

Form I	*Perfect*	*Imperfect*
Strong	CaCvC-	ya-CCvC-
Doubled	CaC^xvC^x-**C** ~ CaC^xC^x-**V**	ya-CC^xvC^x-**C** ~ ya-CvC^xC^x-**V**
Hollow	CvC-**C** ~ CvvC-**V**	ya-CvC-**C** ~ ya-CvvC-**V**

Triliterals show no alternation, [katab-a] 'he wrote', [katab-tu] 'I wrote'. Doubled verbs show alternation. In the perfect, the alternation is between CaC^xvC^x-**C** and CaC^xC^x-**V**, hence, [madd-a] 'he extended' but [madad-tu] 'I extended'. In the imperfect, the alternation is between ya-CC^xvC^x-**C** and ya-CvC^xC^x-**V**, hence, [ya-mdud-na] 'they (f) extend' but [ya-mdud-u] 'he extends'.

The standard analysis of the alternation begins with the root /md/ which first assumes the shape of a C(V)CVC sequence (McCarthy 1979, Brame 1970). This is the shape that the non-alternating verbs assume in all contexts: perfect, [katab-a] 'he wrote', [katab-tu] 'I wrote'; imperfect, [ya-ktub-u] 'he writes', [ya-ktub-na] 'they (f) write'. In the Arabist tradition, the shapes of triliterals are assumed to be the 'canonical' shapes of the verb, and this assumption has been inherited in the standard analysis of the alternation facts. When the root /md/ assumes the shape C(V)CVC, its final consonant /d/ extends (formally, spreads) to occupy two positions. Thus, one arrives at the form /madad/. The next step, in the standard analysis, is to reduce /madad/ to /madd/ in the perfect, or /mdud/ to /mudd/ in the imperfect. More precisely, in the perfect, since CaDvD- is the basic form, a rule of v-deletion is required to effect the change from CaC^xvC^x-**V** to CaC^xC^x-**V**. In the imperfect, the change is from ya-CC^xvC^x-**V** to ya-CvC^xC^x-**V**, and this requires a rule of metathesis. Formally, both of these changes are implemented by the rule below (McCarthy 1979, pp. 265-267).

14. Syncope / Metathesis rule

1	2	3	4	5		
$<V>_a$	C	V	C	V	→	1 $<3>_b$ 2 4 5
		yt				
x						Condition a ⊃ ~b

This rule effects a reordering of the input segments so that the consonants in positions 2, 4 become adjacent in the output. The final V in position 5 ensures that the rule applies only when the CVC sequence is followed by a vowel. The "Condition" states that if there is vowel preceding the CVC sequence, then the vowel in position 3 is to delete: [malil-tu] ~ [mall-a], 'be weary.1p' ~ 'be weary.3ms'. But if there is no vowel before the CVC, then the vowel in position 3 shifts to the left,

exchanging its place in the linear order with the consonant in position 2: [ya-mdud-na] ~ [ya-mudd-a], 'stretch.3fp' ~ 'stretch.3ms'. Note also the double linking between 'x' and the two final C positions. As noted earlier, when the root /md/ assumes the shape CVCVC, its final consonant /d/ extends to occupy two positions, thus giving /madad/. This condition ensures that the rule would not apply to /katab-a/ because the final two consonants are not identical, and would also not apply to Form VIII verbs like /ktatab/, where the identity between the two /t/s is coincidental. The first /t/ is the characteristic /t/ infix of conjugation VIII and the second /t/ is part of the root. This is the core of the analysis of the doubled verb alternation under the assumption that form /m(v)dvd/ is basic.

Hollow verbs show an alternation in vowel length both in the perfect and the imperfect. This alternation too is triggered by a following suffix. Observe, however, that in the hollow verbs the nature of the alternation is just the opposite from that seen in doubled verbs. The doubled verbs reduce (i.e., may lose a vowel) before a V-initial suffix, whereas the hollow verbs reduce (i.e., shorten a stem vowel) before a C-initial suffix. For hollow verbs, the reduction is phonotactically driven. Shortening of the stem-medial long vowel before C-initial suffixes avoids CVVC-C syllabification: [ya-quul-u] 'he says', [ya-qul-na], *[ya-quul-na] 'they (f) say' (McCarthy and Prince 1990b, p. 9). That the doubled verbs reduce when suffixed by a vowel, $CVC^{x}VC^{x}$-V, does not lend itself to a similar phonotactic motivation. There does not seem to be any reason why /madad-/ should reduce to /madd-/ before a vowel or why /ya-mdud-/ should reduce to /ya-mudd-/ before a vowel. One also wonders why these alternations, if assumed to be phonological, do not apply to triliterals, so that, for example, /katab-/ gives /katb-/ and /ya-ktub/ gives /ya-kutb-/ before a vowel. As McCarthy (1986, pp. 247-8) notes, the doubled verb alternation as formulated in the Syncope / Metathesis rule is not a 'phonological' rule but rather a 'morpholexical' rule.

If however the basic stem of doubled verbs is /$CvC^{x}C^{x}$/, with a final geminate, the alternation is phonotactically motivated as with the hollow verbs. Doubled verbs would not reduce before V-initial suffixes because their basic stem is /$CvC^{x}C^{x}$/ to which V-initial suffixes can attach with no need for further modification. The doubled verbs would expand before C-initial suffixes to avoid an unsyllabifiable [$VC^{x}C^{x}$-C] sequence. The conditions of alternation in doubled and hollow verbs are fully transparent phonotactically: augment doubled verbs before C-initial suffixes to avoid the unsyllabifiable [$VC^{x}C^{x}$-C] sequence, and shorten long vowels in hollow verbs before C-initial suffixes again to avoid the marked [CVVC-C] syllabification. It is the goal of the next section to develop this phonotactics-based proposal about doubled verbs.

Up to now, the doubled verb alternation facts concern verbs in Form I. Doubled verbs do not show the alternation in all Forms. For example, doubled verbs in Form II have the invariant form [$CaC^{x}C^{x}aC^{x}$-] in the perfect, and [yu-$CaC^{x}C^{x}iC^{x}$-] in the imperfect, hence no alternation. But in Form IV, doubled verbs do show the alternation, [$zaCC^{x}aC^{x}$-**C** ~ $zaCaC^{x}C^{x}$-**V**] in the perfect, and [yu-$CC^{x}iC^{x}$-**C** ~ yu-$CiC^{x}C^{x}$-**V**] in the imperfect. In the standard Syncope / Metathesis analysis, the absence of the alternation in some conjugations is factored into the statement of that rule (see McCarthy 1979, p. 418). It will be seen that the phonotactics-based analysis correctly predicts when the alternation happens or does not happen using independently necessary properties of the language.

To sum up, past analyses arrive at [madd] via the allegedly 'canonical' /madad/. This latter form is the result of mapping a biliteral root /md/ to the template CVCVC, which is the shape of triliterals. This intermediate output is then 'repaired' by the application of a morphologically conditioned

Syncope / Metathesis rule. It is clear that any such analysis is bound to morphological stipulation. Clearly an account without any intermediate, unmotivated steps or arbitrary morphological stipulations would be preferable.

3.2 The imperfect stem

In the imperfect, doubled verbs exhibit allomorphy between [ya-mudd-u], 3ms, and [ya-mdud-na], 3fp. Following standard reasoning in generative grammar, we assume that the surface forms [mudd, mdud] derive from a common underlying stem. The surface realization of that stem is a function of the grammatical context, usually what follows or precedes the stem in the intended utterance. The goal is to discover the degree to which the various realizations of the hypothesized stem are conditioned by generally accepted laws in a theory of language. In our case, two hypotheses present themselves. The form underlying the alternation may be /mdud/ or it may be /mudd/.

15. Imperfect, Indicative

		Singular	*Plural*	*Dual*
3	*m*	ya-mudd-u	ya-mudd-uuna	ya-mudd-aani
	f	ta-mudd-u	ya-mdud-na	ta-mudd-aani
2	*m*	ta-mudd-u	ta-mudd-uuna	ta-mudd-aani
	f	ta-mudd-iina	ta-mdud-na	ta-mudd-aani
1		za-mudd-u	na-mudd-u	

16. Imperfect, Jussive

		Singular	*Plural*	*Dual*
3	*m*	ya-mdud	ya-mudd-uu	ya-mudd-aa
	f	ta-mdud	ta-mudd-aa	ya-mdud-na
2	*m*	ta-mdud	ta-mudd-uu	ta-mudd-aa
	f	ta-mudd-ii	ta-mdud-na	ta-mudd-aa
1		za-mdud	na-mdud	

17. Imperfect, Imperative

		Singular	*Plural*	*Dual*
2	*m*	zu-mdud	zu-mudd-uu	zu-mudd-aa
2	*f*	zu-mdud-ii	zu-mdud-na	zu-mudd-aa

Taking /mdud/ to be the underlying stem requires a phonologically unmotivated syncope rule. If we assume that /mudd/ is the stem, with a final geminate, then we can show that alternation is accounted for without any stipulation. When a V-initial suffix attaches to the stem /mudd/ the result is straightforward, [ya-mudd-u]. However, when a C-initial suffix attaches to /mudd/, a phonotactic problem arises. Classical Arabic does not allow sequences of a geminate followed by another consonant as in *[ya-mudd-na]. Such sequences, we assume, are excluded via a markedness constraint $VC_xC_x]^{\sigma}$ disallowing geminates as syllable codas. The same constraint is in effect for the case of null suffixes such as the 3ms, Jussive /ya, mudd/. This constraint could ultimately be seen a reflex of a general upper bound on syllabic weight (e.g., see Broselow, Chen, Huffman 1997, p.

65, for a proposal on a bound of two moras).

18. $VC_xC_x]^{\sigma}$: Geminates are not allowed as syllable codas

The actual outputs from /ya, mudd, na/ or /ya, mudd/ are [ya-mdud-na], [ya-mdud] respectively. The phonotactic problem met by simple concatenation as in *[ya-mudd-na], *[ya-mudd] is resolved by splitting the geminate. Specifically, the constraint violated here is one of the basic constraints of Correspondence Theory called INTEGRITY, defined below (McCarthy and Prince 1995b). INTEGRITY penalizes relations between a form S_1 (here, the input) and another related form S_2 (here, the output), where a single segment in S_1 has two correspondents in S_2. When the correspondence relation holds between an Input and an Output, then we refer to the constraint as IO-INTEGRITY.

19. INTEGRITY: No segment of S_1 has multiple correspondents in S_2

IO-INTEGRITY violation:

m u dd	Input (S_1)
f h	
m d u d	0utput (S)

Thus, given input /ya, mudd, na/ the output is [ya-mdud-na]. This output violates IO-INTEGRITY to avoid syllabification as in [(ya)-(mudd)-(na)]. Therefore it must be that $VC_xC_x]^{\sigma}$ dominates IO-INTEGRITY. Moreover, *COMPLEX dominates IO-INTEGRITY because [(ya)(mud)(dna)] is also not an option.[9] The following tableau uses the cover name SYLL for the two syllable structure constraints

[9] The markedness of a geminate consonant in coda position cannot be subsumed under the general markedness constraint against complex margins, *COMPLEX, introduced in §2.1. This can be illustrated by the dialect of Palestinian Arabic described in Abu-Salim (1980). In this dialect, geminates are permitted at the ends of syllables so that, for example, [zimm-na] 'our mother' contrasts with [zim-na] 'we removed'. But triconsonantal clusters must be broken by

$VC_xC_x]^{\sigma}$ and *COMPLEX which are active in enforcing the output [ya-mdud-na]. The tableau is the same for a null suffix as in the 3ms, Jussive /ya, mudd/ → [ya-mdud].

20. Integrity violation before C-initial suffixes: /ya, mudd, na/ → [ya-mdud-na]

/ya, mudd, na/	SYLL	IO-INT
a. ya-mudd-na	*!	
b. ☞ ya-mdud-na		*

The analysis up to now provides phonotactic motivation for the surface variant of /mudd/, [ya-mdud-na]. However, this variant introduces allomorphy in the verbal paradigm. There are two distinct surface realizations of the stem /mudd/, [ya-mudd-u] and [ya-mdud-na]. The geminate in [ya-mudd-u] corresponds to two separate consonants in [ya-mdud-na]. This is a violation of the Output-Output version of INTEGRITY, OO-INTEGRITY.

This situation is depicted in the paradigm tableau below. The attested set of surface forms is shown as candidate (a), [ya-mudd-u, ya-mdud-na]. In this set, [ya-mdud-na] incurs a violation of IO-INTEGRITY, but also a violation of OO-INTEGRITY. It is informative to compare (a) to (b) in which the stem appears with the invariant surface form [mdud]. The advantage of this set is that it avoids the violation of OO-INTEGRITY at the cost of violating IO-INTEGRITY twice, once for its of the mappings /mudd/ → [ya-mdud-u] and /mudd/ → [ya-mdud-na]. Since the actual output is (a), not (b), it must be that IO-INTEGRITY >> OO-INTEGRITY. The final candidate incurs a violation of the dominant constraint SYLL and is excluded for this reason.

21. /mudd/ → [ya-mudd-u, ya-mdud-na], SYLL >> IO-INT >> OO-INT

/mudd/	SYLL	IO-INT	OO-INT

epenthesis, hence /zakl/ ‘food’, [zakl-i] ‘my food’, [zakil-na] ‘our food’, [zakil-kum] ‘your food’, with an epenthetic /i/ in the last two forms. Hence, the constraint $VC_xC_x]^{\sigma}$, specifically targetting geminates in coda, is necessary and independent from *COMPLEX.

a. ☞ ya-mudd-u, ya-mdud-na		*	*
b. ya-mdud-u, ya-mdud-na		*!*	
c. ya-mudd-u, ya-mudd-na	*!		

If, instead, OO-INTEGRITY dominated IO-INTEGRITY, then uniformity would be required. A concrete example of this case was met in the explanation for the absence of [ktub ~ kutb] alternation in the triliterals.

One notable characteristic of this analysis is the violation of geminate integrity seen in /mudd/ → [ya-mdud-na]. This violation seems unusual given the often-made assumption that geminates do not split (Kenstowicz and Pyle 1973, Guerssel 1977, 1978, Steriade 1982, Hayes 1986, Schein and Steriade 1986). In section 7, however, we argue that geminate integrity violations must be admitted independently.

We now consider alternative repairs to the illicit [ddn] sequence in *[ya-mudd-na]. Candidate (b), [ya-mud□d-na], breaks the geminate with epenthesis of a default vowel, [□]. This form violates IO-INTEGRITY, but also the constraint against epenthesis, IO-DEP, "Output segments must have input correspondents" (McCarthy and Prince 1995b). Hence, (b) incurs a superset of the violations of (a), and is therefore sub-optimal. Candidate (c) shows epenthesis of a default vowel at the boundary between the stem and the suffix, *[mudd-□-na]. This candidate too incurs a violation of IO-DEP. In addition, it violates a requirement of proper suffixation: in a stem-suffix combination the suffix must be directly attached to the stem, or equivalently, there should be no intervening segments which do not belong to either of the two concatenated morphemes. The constraint expressing this requirement is ALIGN(Stem, R, Affix, L), a constraint of the Generalized Alignment theory of McCarthy and Prince (1993). Formally, this constraint states that the right edge of (every) stem is aligned with the left edge of some suffix or in short STEM][AFFIX. The epenthetic vowel misaligns the two edges since that vowel is inserted in the seams between stem and affix. By comparing (a) to (c), we infer that either the anti-epenthesis constraint or the alignment constraint is higher ranked than IO-INTEGRITY (or both).

22. Comparison of [ya-mdud-na], (a), with alternative repairs (b-d) of *[ddn]

/ya, mudd, na/	IO-IDENT^{L}	STEM][AFFIX	IO-DEP	IO-INT
a. ☞ ya-mdud-na				*
b. ya-mud-□-d-na			*	*
c. ya-mudd-□-na		*	*	
d. ya-mud-na	*!			

Candidate (d) illustrates an alternative repair by shortening the geminate, as in [ya-mud-na].

This alternation between a verbal form with /dd/ and a related form with /d/ is not met anywhere. Throughout the verbal morphology, doubled verbs never appear with an ungeminated consonant. Hence, a constraint disallowing the change from /dd/ to /d/, that is a faithfulness constraint preserving distinctive consonantal length is dominant here. This is the constraint IO-IDENT^{L}, "A segment in S_1 and its correspondent in S_2 must have identical length," which must be ranked higher than IO-INTEGRITY.

To sum up, in the proposed analysis the stem /mudd/ underlies the surface set [ya-mudd-u, ya-mdud-na]. In this analysis, the alternation between [mudd] and [mdud] is phonotactically motivated. The independently necessary syllabification canons of Arabic disallow the combination of a geminate-final stem with a consonant-initial or null suffix, *[mudd-na], *[mudd]. To avoid this violation, the geminate splits, resulting in the surface variant [mdud].

Let us compare the behavior of doubled verbs to that of triliteral verbs. For triliterals, there is no surface allomorphy in the realization of the verbal stem. The stem is realized in all contexts with the invariant shape [ktub]. There can be no *[kutb] form. OO-LIN, the relevant OO-FAITH constraint, is dominant and enforces uniformity in stem realization. For doubled verbs, however, we do find alternation in stem realization, [ya-mudd-u, ya-mdud-na], and thus OO-FAITH must be low-ranked. There is no contradiction here, because the relevant OO-FAITH for doubled verbs is OO-INT, a different constraint from OO-LIN. Specifically, the surface allomorphy of doubled verbs implies that OO-INT is ranked lower than the corresponding IO-INT constraint. The two ranking schemas and their effects are summarized below.

23.	*Rankings*		*Surface set*	*Impossible set*
a.	SYLL, OO-LIN >> IO-LIN	⇒	[ktub]	[kutb, ktub]
b.	SYLL >> IO-INT >> OO-INT	⇒	[mudd, mdud]	[mdud]

Finally, note that the ranking responsible for the doubled verb alternation, SYLL >> IO-INT >> OO-INT, can be inferred from the surface data. Given the mapping /ya, mudd, na/ → [ya-mdud-na], a learner must demote the faithfulness constraint IO-INT below the markedness constraint SYLL. Furthermore, in the presence of the surface alternation [mudd, mdud], the learner must demote OO-INT below IO-INT.

3.3 The perfect stem

We now turn to the perfect paradigm of doubled verbs. The verb 'to stretch' used so far in illustrating the analysis belongs to a class of verbs where the vowel of the imperfect is /u/, /mudd/. As discussed, in Arabic, the vocalism of verbs in Form I changes between the perfect and the imperfect. For imperfect /mudd/, the perfect is [madad-], where the second vowel is the counterpart of the /u/ of the imperfect (the first /a/ of [madad-] is an affix). Additional examples of this alternation for doubled verbs are shown below. Vowel pairs are given by listing the lexical vowel of the imperfect stem and its Perfect counterpart.

24.	**Vowel pairs**	**Imperfect**	**Perfect before -V**	**Perfect before -C**

$a^{Impf} \sim i^{Perf}$	ya-mall-u	mall-a	mal<u>i</u>l-tu	‘be weary’
$u^{Impf} \sim a^{Perf}$	ya-rudd-u	radd-a	rad<u>a</u>d-tu	‘return’
$i^{Impf} \sim a^{Perf}$	ya-_ill-u	_all-a	_al<u>a</u>l-tu	‘be lofty’

We observe that all vowel contrasts are neutralized in the perfect 3ms which is always of the shape [CaC^xC^x-]. In fact, the perfect of doubled verbs before all vowel-initial affixes, not just those before the 3ms /+a/, appears with the vowel /a/, irrespective of the quality of the lexical perfect or imperfect vowel. But before consonant-initial suffixes where the geminate splits, the vowel that appears between the two ‘halves’ of the input geminate is the proper ablaut counterpart of the vowel of the imperfect stem.[10]

The situation is shown more explicitly below, with examples from a strong verb and a doubled verb. The perfect stems, shown in the first column, are /ktab/ and /mill/. That is, as with strong verbs, we assume that the perfect stem of every doubled verb includes in its lexical entry its characteristic vocalism. These stems are combined with the perfect active voice marker /a/, henceforth /a^{PAV}/ (McOmber 1995). The vowel of the verb stem /ktab/ surfaces in the second vowel position of the perfect output stem. For the doubled verb /mill/, however, the lexical vowel /i/ surfaces only before a consonant initial suffix, [malil-naa]. The lexical vowel of the stem is in bold throughout the examples below.

25.

Stem		**Stem-suffix**		**Morphological parse**
/kt**a**b/	→	kat**a**b-a	3ms	k-a^{PAV}-t**a**b-a
/kt**a**b/	→	kat**a**b-naa	1p	k-a^{PAV}-t**a**b-naa
/m**i**ll/	→	mall-a	3ms	m-a^{PAV}-ll-a
/m**i**ll/	→	malil-naa	1p	m-a^{PAV}-l**i**l-naa

Putting aside for the moment the vocalic phenomena, the alternations of the doubled verb follow the same phonotactically motivated pattern as with the imperfect. Combining the basic stem /mill/ with a vowel-initial suffix creates the form [mall-a], the actual output (the deletion of the lexical vowel is addressed immediately below). The geminate does not split because there are no

[10] I thank Robert Hoberman for pointing this out to me.

phonotactic pressures for doing so. Once again, we may contrast this to the standard analysis: there is no need for a morphologically-conditioned syncope process to derive [mall] from [malil]. If /mill/ is assumed to be the basic (perfect) stem of the verb, then the reason for the alternation between [mall, malil] is that combining the basic form /mill/ with a consonant-initial suffix would create a triconsonantal cluster, a phonotactic violation that must be resolved.

Let us address the issue of the vocalism now. The perfect stem before vowel-initial suffixes always surfaces with a fixed vowel, /a/, irrespective of the lexical vowel of the perfect stem. This /a/ vowel expresses the perfect active voice, /a^{PAV}/. We may thus infer that the requirement for morphological expression of the perfect active voice is dominant here and suppresses the lexical vowel of the stem. This is shown in the tableau below. IO-MAX is a basic constraint of Correspondence Theory which dictates that "Input segments must have output correspondents" (i.e., the constraint bans deletion, McCarthy and Prince 1995b). There is a IO-MAX for each morpheme. In the present case, IO-MAX^{PAV} dictates that the input /a^{PAV}/ have a correspondent in the output, and IO-MAX^{LEX} dictates that the lexical vowel of the stem must have a correspondent in the output. The two constraints conflict. Candidate (a) is the actual output, and thus IO-MAX^{PAV} >> IO-MAX^{LEX}. [11]

26. Lexical vowel is replaced (priority to expression of aspect, voice)

/a^{PAV}, mill, a/	IO-MAX^{PAV}	IO-MAX^{LEX}
a. mill-a	*!	
b. ☞ ma^{PAV}ll-a		*

[11] This ranking apparently contradicts the schema Root-Faith >> Affix-Faith, which is proposed in McCarthy and Prince (1995b, p. 364) to hold between Roots and Affixes, in general. However, vocalic melodies in Semitic templates offer a good reason to believe that this ranking needs to be refined by making reference to different kinds of affixes. In our example, the vocalic melody /a/ of PAV is a marker of inflectional class. The definitional characteristic of inflection is that it is obligatory. Obligatoriness of inflection, thus, enforces 'replacement' of stem vowels. See also Gafos (1998a) and Ussishkin (2000) for further discussion on this 'replacive' aspect of non-concatenative morphology.

One way to avoid replacement of the lexical vowel is geminate fission. A candidate with geminate fission, [mal**i**l-na], gains an extra vowel position which allows both vowels of the input, /a^{PAV}/ and the lexical /**i**/, to surface. The crucial point is that this candidate violates IO-INTEGRITY. It follows that the avoidance of geminate fission takes priority over parsing the lexical vowel of the stem, IO-INTEGRITY >> IO-MAX^{LEX}.

When stems are combined with C-initial suffixes, geminate fission occurs for familiar reasons: *[mall-tu] violates the undominated SYLL constraint, as shown in (a) below. Candidate (b) has a complex onset, a violation of SYLL, and leaves the lexical vowel of the stem unrealized, a violation of IO-MAX^{LEX} (as before, under SYLL we record violations of the two syllable structure constraints VC$_x$C$_x$]$^{\sigma}$ and *COMPLEX). With fission comes an extra position which allows for the lexically specified vowel /i/ to surface. We see that the grammar, as constructed so far, correctly predicts the actual output to be as in the optimal candidate (c).

27. Geminate fission before C-initial suffix

/a^{PAV}, m**i**ll, tu/	SYLL	IO-INTEGRITY	IO-MAX^{LEX}
a. mall-tu	*!		*
b. mlal-tu	*!	*	*
c. ☞ mal**i**l-tu		*	

Alternative resolutions of the phonotactic problem created by combining stem /m**i**ll/ with a consonant-initial suffix are considered in the tableau below. The situation is parallel to that met in the imperfect. Candidates (b, c) with epenthesis, violate IO-DEP, and in the case of (c) also the constraint on proper alignment between the stem and the suffix, STEM][AFFIX. Note that (b, c) also violate IO-MAX^{LEX}, which has been shown to be lower-ranked than IO-INT, and therefore cannot be the reason for the sub-optimality of (b, c). Shortening the geminate as in (d), violates the faithfulness constraint requiring preservation of the lexically specified consonantal length, IO-IDENT^{L}.

28. Alternative candidates avoiding geminate fission before C-initial suffixes

/a^{PAV}, m**i**ll, tu/	IO-IDENT^{L}	STEM][AFFIX	IO-DEP	IO-INT
a. ☞ mal**i**l-tu				*
b. mal□l-tu			*!	*
c. mall□-tu		*	*!	
d. mal-tu	*!			

We may also consider candidate *[mall**i**-tu], where the lexical vowel of the stem appears

between the geminate and the suffix. This candidate does not violate STEM][AFFIX because /i/ is part of the stem proper. To account for the fact that all Arabic stems are consonant-final, McCarthy and Prince (1990b) propose a general canon for Arabic stems dubbed Final Consonantality, FINAL-C. We adopt this constraint as the one responsible for the failure of *[mall**i**-tu].[12]

To sum up, we can make sense of the alternation between [madd] and [madad], if we assume that the verbal stem is /madd/. This is the basic form of the stem on which inflectional affixes are attached. The other surface form of a doubled verb, /madad/, results by splitting the geminate in /madd/ when that form is combined with a consonant-initial suffix. This happens because Arabic does not permit triconsonantal clusters, *[madd-tu]. The doubled verb alternation is not arbitrary, in the sense of being morphologically conditioned, and there is no need for rules that sometimes do metathesis and sometimes deletion of vowels.

Section 5 extends the basic proposal to the so-called 'exceptional' Forms. In those Forms, the doubled verb alternation is not observed. Whereas past analyses had to stipulate that the morpho-lexical rule effecting the alternation does not apply in these Forms, our basic proposal will allows us to derive this fact without stipulation.

3.4 Alternative stems

The surface variants of any given doubled verb are [mudd, mdud]. If /mudd/ is assumed to be the verbal stem, then the alternation is accounted for by the grammar SYLL >> IO-INT >> OO-INT. The question that needs to be addressed is how does the learner of Arabic converge to the stem /mudd/. Specifically, we must consider whether there are any 'rival' stems that could also underlie the same surface forms. Given the surface set [mudd, mdud], a plausible underlying stem would be /mdud/, a form identical to the second surface variant. Yet another option is to interpret the variant [mudd] as consisting of two adjacent, identical consonants. This leads to another hypothetical stem, /mud^{1}d^2/. This section shows that these alternative stems cannot underlie the surface set [mudd, mdud].

Consider first the hypothesis that /md^{1}ud^2/ underlies the set [ya-mudd-a, ya-mdud-na]. This is to say that input /md^{1}ud^2/ is realized as [ya-mudd-a] before a vowel, and as [ya-mdud-na] before a consonant. In [ya-mud^{1}d^2-a], the two separate /d/s of the hypothetical stem /md^{1}ud^2/ are adjacent. This is a violation of the Obligatory Contour Principle (Leben 1973, McCarthy 1979, 1986), defined in (26). In Optimality Theory, the Obligatory Contour Principle has the status of a constraint which applies on the output representation like any other markedness constraint. In addition, the LINEARITY constraints are violated. OO-LIN is violated because of the disparity in the linear order between the two surface forms, [mud^{1}d^2, md^{1}ud^2], and IO-LIN is violated in the mapping /md^{1}ud^2/ → [ya-mud^{1}d^2-u]. These violations are shown in (a) of the tableau below. Given the grammar, the predicted optimal realization of the hypothetical stem is not (a) but (b), where no constraint violations are involved. We see, thus, that the stem /md^{1}ud^2/ cannot underlie the surface forms [ya-mdud-na, ya-

[12] Note that even though candidate [mall□-tu] inserts a vowel between the stem and the affix, that vowel is not part of the stem. Hence, this candidate does not incur a violation of FINAL-C, as the stem /mall/ is consonant-final.

mudd-u].[13]

29. OCP: Adjacent identical elements are prohibited (here, 'elements' stands for segments)

30. Fate of stem /md^{1}ud^{2}/

/md^{1}ud^{2}/	OCP	OO-LIN	IO-LIN
a. ya-mud^{1}d^{2}-u, ya-md^{1}ud^{2}-na	*	*	*
b. ☞ ya-md^{1}ud^{2}-u, ya-md^{1}ud^{2}-na			

The learner would be faced with a choice between stem /mudd/ and stem /mdud/, if both stems could underlie the observed surface forms. A concrete example of this situation was the case of /kutb/ and /ktub/ stems, both mapping to the surface form [-ktub-]. However, in the present case, our hypothetical stem /md^{1}ud^{2}/ gives rise to the set [md^{1}ud^{2}-u, md^{1}ud^{2}-na], a different set from [mudd-u, mdud-na]. Consequently, the set of possible stems that can derive the surface set [mdud-na, mudd-u] does not include the form /md^{1}ud^{2}/. This confirms the earlier point that if /md^{1}ud^{2}/ is the basic form from which [mudd] is to be derived, then the doubled verb facts cannot be accounted for in purely phonological terms. As was noted, a morpho-lexical rule must be set up in the analysis which takes /md^{1}ud^{2}/ to be the basic form.

The analysis above does not show that /md^{1}ud^{2}/ is an impossible stem. It only shows that if such

[13] In this tableau, OCP is shown to dominate IO-LIN. This ranking is not crucial for our purposes. Any ranking between these two constraints will give the same result. The specific ranking shown is assumed here because it is consistent with the independent proposal in the acquisition literature that markedness constraints dominate IO faithfulness constraints in the initial state of the grammar. In Arabic, given that the surface facts present no instances of two adjacent, identical consonants (a violation of the OCP), it follows that the ranking relation OCP >> IO-LIN persists into adult grammars (Tesar and Smolensky 1998). The ranking OO-LIN >> IO-LIN was inferred in §2.

a stem is 'fed' to the grammar, it would surface as [md^{1}ud^2] in all contexts. Just like a triliteral stem, the surface realization of stem /md^{1}ud^2/ would show no alternation. This prediction is borne out. A small class of stative verbs show precisely this invariable shape. Thus, we find the perfect forms [šarur-a] 'to be bad', not *[šarr-a], [Sakik-a] 'to be weak-kneed', not *[Sakk-a], [Dabib-a] 'to abound in lizards', not *[Dabb-a], and [labub-a] 'to be wise', not [labb-a] (Wright 1896, Part 2, §120; also mentioned in McCarthy 1986, p. 247). These verbs do not undergo the alternation seen in the doubled verbs. In our analysis, the perfect stems for these verbs are /Skik/, /Dbib/, and /šrur/ respectively. These differ from the stems of doubled verbs which have final geminates, as in /madd/. The phonotactic pressures for the doubled verb alternation do not apply to verbs like /Skik/, just as they do not apply to strong verbs like /ktub/. Note that this analysis does not explain the rarity of stems like /Skik/ in Classical Arabic. However, in modern Arabic dialects and other branches of Semitic, stems like /Skik/ abound. See Heath (1987) on Moroccan Arabic, Borg (1985) on Cypriot Arabic, Bat-El (1989) on Hebrew, and Petros (1997) on Chaha. Moreover, at least for Arabic dialects, the two identical consonants of underived stems like /Skik/ behave as two independent consonants for all purposes (see Heath 1987, pp. 7, 231-234 for Moroccan Arabic).

Consider now another potential stem for the doubled verbs, namely, the form /mud^{1}d^2/ with two identical consonants. Can this stem give rise to the surface set [ya-mudd-a, ya-mdud-na]. If these forms are realizations of /mud^{1}d^2/, then violations of the OCP, OO-LIN, and IO-LIN are incurred, as shown in (a) below. Avoiding the faithfulness violations incurs more violations of the OCP and a SYLL violation because of the geminate coda. The predicted optimal realizations of /mud^{1}d^2/ are as in (c). The ranking between OO-LIN and IO-LIN was inferred in §2. The constraints OCP, SYLL are shown higher ranked than IO-LIN for the same reasons as in the preceding tableau.

31. Fate of stem /mud^{1}d^2/

/mud^{1}d^2/	OCP, SYLL	OO-LIN	IO-LIN
a. ya-mud^{1}d^2-u, ya-md^{1}ud^2-na	*	*!	*
b. ya-mud^{1}d^2-u, ya-mud^{1}d^2-na	** *		
c. ☞ ya-md^{1}ud^2-u, ya-md^{1}ud^2-na			**

Hence, stem /md^{1}ud^2/ does not underlie the surface set [ya-mdud-na, ya-mudd-u]. This stem underlies the surface set [ya-md^{1}ud^2-u, ya-md^{1}ud^2-na].

To sum up, doubled verbs show two surface forms [-mudd-, -mdud-]. We have seen that the only form which can underlie this set is /mudd/. There are no rival stems.

4. Deriving Greenberg's Asymmetry

We have inferred that the stem for doubled verbs takes the form /mVdd/, with a final geminate. Such geminate-final stems surface in two forms [mVdd-V, mdVd-C]. The first variant has a *final* geminate, and the second has a *final* sequence of two identical consonants separated by a vowel. In Arabic, there are no surface forms with *initial* gemination or with an *initial* sequence of two identical consonants (Greenberg 1950). This section shows that this systematic asymmetry is a lawful consequence of the segmental make-up of the affixes in the paradigms (perfect, imperfect), the presence of intra-paradigmatic identity constraints in the grammar, and independently necessary phonotactics. When these three factors are taken into account, we can show that stems with initial gemination (§4.1) and stems with initial repetition (§4.2) are impossible stems in the sense of the term defined in §2.

4.1 Impossibility of initial gemination

Crucial to understanding the absence of /mmVd/ stems is the fact that the verbal paradigm of the perfect is prefix-less. More accurately, the perfect paradigm does not have prefixes that end in vowels. Lack of such prefixes exposes the initial geminate of a hypothetical stem /mmVd/ to word-initial position. In Classical Arabic, as in other languages with long consonants like Italian or Japanese, length is neutralized at the edges of words (Ladefoged and Maddieson 1996, p. 92, Fromkin 2000, p. 626). We assume that this is due to a markedness constraint which disallows geminates in that position, *EDGE-GEM. Hence, a stem /mmVd/ would lead to a violation of *EDGE-GEM in the perfect.[14] The fact that no such violations are attested in Arabic means that the markedness constraint penalizing edge geminates is ranked higher than the faithfulness constraint requiring preservation of consonantal length, IDENT^{L}. The two relevant constraints and the resolution of their conflict are shown below.

32. *EDGE-GEM: Edge geminates are not allowed

IDENT^{L}: A segment in S_1 and its correspondent in S_2 must have identical length

33. Impossibility of initial gemination in the perfect: *EDGE-GEM >> IO-IDENT^{L}

/a, mmVd, u/	*EDGE-GEM	IO-IDENT^{L}
a. mmad-u	*!	
b. ☞ mad-u		*

Thus, the perfect form of a hypothetical stem /mmVd/ would be [mad-], with loss of initial gemination. Recall now that the imperfect paradigm supplies a set of (consistently) vowel-final prefixes. Hence, a stem /mmVd/ could in principle surface as [ya-mmVd-u] in the imperfect, without

[14] Noting the absence of initial geminates, Ratcliffe (1998, p. 51) proposes that the phonotactic problem is a ban against CC clusters word-initially (under standard assumptions, geminates occupy two C positions on the skeletal tier). Note, however, the existence of languages like Italian which permit initial CC clusters, but no initial geminates.

neutralization, as the V-final prefix would protect the geminate from exposure to word-initial position. However, the resulting surface set would be [mvd-u, ya-mmvd-na], a non-uniform paradigm with respect to consonant length. Non-uniformity implies violation of OO-IDENT^{L}, the OO faithfulness constraint requiring identity of consonantal length between correspondent consonants of the perfect and the imperfect stem. Since this allomorphy is not seen in the verbal system of Arabic, we infer that OO-IDENT^{L} >> IO-IDENT^{L}. As shown below, the dominant OO-IDENT^{L} disallows length alternations between the perfect and imperfect stem. In effect, OO-IDENT^{L} suppresses the length contrast also in the context where the constraint against edge geminates is not in effect, that is in the imperfect paradigm.

34. Leveling of initial consonant length to the imperfect through dominant OO-FAITH

/ya, mmvd, u/	*EDGE-GEM	OO-IDENT^{L}	IO-IDENT^{L}
a. ya-mmvd-u		*!	
b. ☞ ya-mvd-u			*

The absence of stem-initial gemination exemplifies another global consequence of local phonotactics. The phonotactic *EDGE-GEM effects a local change in the realization of the stem in the perfect paradigm. Due to the dominant OO-IDENT^{L}, this local effect is transmitted to the realizations of the stem in all contexts, that is, also in the imperfect where the local phonotactic pressure is not present. This is how an underlying contrast between /mvd/ and /mmvd/ is neutralized to [mvd] on the surface.

We are now in a position to apply Lexicon Optimization to derive the absence of /mmvd/ stems in Arabic. The following paradigm tableau compares the two competing stems, /mmvd/ and /mvd/, on their mapping to the set [mad-tu, ya-mvd-na]. OO-F and IO-F stand for OO-IDENT^{L} and IO-IDENT^{L} respectively. Stem /mmvd/ in (a) incurs two violations of IO-F. Clearly, stem /mvd/ in (b) provides the most harmonic mapping, with no violations of any constraint. Hence, /mmvd/ → [mad-tu, ya-mvd-na] is more harmonic ('_') than /mvd/ → [mad-tu, ya-mvd-na].

35. Demonstration of /mvd/ _ /mmvd/

Stems	Surface set	*EDGE-GEM	OO-F	IO-F
a. /mmvd/	☞ mad-tu, ya-mvd-na			**
b. ☞ /mvd/	☞ mad-tu, ya-mvd-na			

In sum, Lexicon Optimization at the level of the paradigm derives the absence of /mmvd/ stems without stipulating a ban on such stems from the inventory of inputs in this language. The absence of V-final prefixes in the perfect, the independently necessary phonotactic *EDGE-GEM, and intra-

paradigmatic identity constraints conspire for the absence of /mmVd/ stems from the lexical inventory of the language.

4.2 Impossibility of initial repetition

Consider now a stem /m^1m^2Vd/, a triliteral with two identical consonants at the left edge of the stem. In the perfect, this stem would surface as [m^1am^2Vd-], a phonotactically unproblematic form. In the imperfect, however, realizing /m^1m^2Vd/ is bound to phonotactic problems. If the stem is realized faithfully, as [m^1m^2Vd], OCP is violated. This is shown in candidate (a) below. To avoid the OCP violation(s), the two identical consonants may be separated by the lexical vowel as in [ya-m^1Vm^2d-a] of candidate (b). But since some imperfect suffixes are consonant-initial or null, this realization incurs a violation of SYLL. Alternatively, the stem may be realized as [m^1Vm^2d] before a vowel and as [m^1m^2Vd] before a consonant as in candidate (c). In any case, violations of the OCP or SYLL are unavoidable.

36. Fate of /m^1m^2Vd/ in the imperfect: Violations of OCP, SYLL

/m^1m^2Vd/	OCP	SYLL	OO-LIN	IO-LIN
a. ya-m^1m^2Vd-a, ya-m^1m^2Vd-na	**			
b ya-m^1Vm^2d-a, ya-m^1Vm^2d-na		*		**
c. ya-m^1Vm^2d-a, ya-m^1m^2Vd-na	*		*	*

The situation is fully parallel to that of /mmVd/ stems. The only difference is in the local context where the phonotactic violations are met and in the nature of the relevant phonotactic. For /mmVd/ stems, the phonotactic is one against edge geminates, and its violation is met in the prefix-less perfect. For /m^1m^2Vd/, the phonotactics are the OCP and SYLL, and their violation is met in the imperfect.

Note that the same phonotactic problems arise with a variant of /m^1m^2Vd/, the stem /m^1Vm^2d/. This is depicted in the following tableau. In the imperfect, this stem leads to a violation of either the OCP or SYLL.

37. Fate of /m^1Vm^2d/ in the imperfect: Violations of OCP, SYLL

/m^1Vm^2d/	OCP	SYLL	OO-LIN	IO-LIN
a. ya-m^1Vm^2d-a,		*		

ya-m^1vm^2d-na				
b. ya-m^1vm^2d-a, ya-m^1m^2vd-na	*		*	*
c. ya-m^1m^2vd-a, ya-m^1m^2vd-na	**			**

Thus, hypothetical stems /m^1m^2vd/, /m^1vm^2d/ result in violations of a markedness constraint, either the OCP, SYLL. Violations of these constraints are never attested on the surface forms of Arabic. The grammatical counterpart of this fact in OT is a ranking between these markedness constraints and some faithfulness constraint that preserves the segmental make-up of hypothetical inputs that would lead to such violations. Specifically, that ranking must be OCP, SYLL >> IO-MAX, where IO-MAX is the faithfulness constraint requiring that all segments of some stem be realized. This ranking is illustrated in the following two tableaux, one for each of the two hypothetical stems with initial repetition /m^1m^2vd/ and /m^1vm^2d/. This is an instance of the general ranking MARKEDNESS >> IO-FAITH, which is argued to be part of the initial state of Universal Grammar. Candidate (b) in both tableaux also violates IO-LIN which however is lower-ranked than SYLL.

38. Impossibility of initial repetition in the imperfect (stem /m^1m^2vd/)

/m^1m^2vd/	OCP	SYLL	IO-MAX
a. ya-m^1m^2vd-na	*!		
b. ya-m^1vm^2d-na		*!	*
c. ☞ ya-mvd-na			*

39. Impossibility of initial repetition in the imperfect (stem /m^1vm^2d/)

/m^1vm^2d/	OCP	SYLL	IO-MAX
a. ya-m^1vm^2d-na		*!	
b. ya-m^1m^2vd-na	*!		
c. ☞ ya-mvd-na			*

Now, in the perfect, hypothetical stem /m^1m^2vd/ would surface as [m^1am^{2}vd-na] with no violation of the OCP. However, OO-MAX prevents this by requiring that all surface forms of a given stem consist of the same set of consonants. Once again, this ranking is an instance of the schema MARKEDNESS, OO-FAITH >> IO-FAITH, assumed to be part of the initial state of the grammar.

40. Leveling of absence of initial identity to the perfect through OO-MAX

/m^1m^2Vd, u/	OCP	OO-MAX	IO-MAX
a. m^1am^2Vd-u		*!	
b. ☞ mad-u			*

The effect of this ranking is that the surface realizations of /m^1m^2Vd/ are [mad-tu, ya-mVd-na], the same set as that obtained with stem /mVd/, [mad-tu, ya-mVd-na]. Applying Lexicon Optimization, we can show that learners will settle for stem /mVd/ rather than /m^1m^2Vd/, since the former supplies a more harmonic mapping than the latter.

41. /mVd/ → [mad-u, ya-mVd-na] _ /m^1m^2Vd/, /m^1Vm^2d/ → [mad-u, ya-mVd-na]

Stems	Surface set	OCP	OO-MAX	IO-MAX
a. /m^1m^2Vd/	☞ mad-tu, ya-mVd-na			**
b. /m^1Vm^2d/	☞ mad-tu, ya-mVd-na			**
c. ☞ /mVd/	☞ mad-tu, ya-mVd-na			

In the core of all past accounts for the absence of stems /mmVd/, /m^1m^2Vdd/ or /m^1Vm^2d/ is a stipulation about the admissible inputs to the lexicon. Consider first stems with initial gemination, /mmVd/. In past analyses, these are excluded by a tacit assumption that root consonantism is devoid of any prosodic properties such as length. Such prosodic properties are to be derived via mapping to template, as in the medial gemination for Form II, or associated operations like the metathesis rule for /mdVd-V/ → [mVdd-V] discussed earlier. No such assumptions about lexical inputs are available in the theory adopted in this article. Indeed, no such assumptions are necessary because the absence of stems with initial gemination is derivable by the independently necessary phonotactics of the language (here, no edge gemination), and the inflectional context of the paradigms (here, no vowel-final prefixes in the perfect).

Stems with initial identity /m^1m^2Vd/, /m^1Vm^2d/ are excluded in past analyses by stating that the OCP applies on input representations: the triliteral root |m^1m^2d| underlying such stems is banned by the OCP (McCarthy 1979 *et seq*). Once again, no such assumption is available in OT, a theory of grammar where Richness of the Base disallows restrictions on the inventory of lexical inputs. Any systematic gaps in the lexicon must derive indirectly from the grammar. Indeed, as argued here, the *|m^1m^2d| gap is derivable from the ranking OCP, OO-MAX >> IO-MAX. Finally, this ranking is an

instance of the schema MARKEDNESS, OO-FAITH >> IO-FAITH, which is assumed to be part of the initial state of the grammar.

5. The 'exceptional' Forms

Forms II and III are characterized as exceptional, because doubled verbs in these Forms do not show the alternations discussed earlier (Schramm 1962). The same applies to Forms V and VI which are derived from II, III respectively by prefixation of /ta-/. This section shows that the 'exceptionality' of these Forms does not need to be stipulated, but in fact derives from the interaction of constraints on syllabic well-formedness and morphological expression, as in the core analyses of this paper. We focus on II and III here. The analysis readily extends to their respective derived conjugations.

Our task is complicated by the fact that Form III is sometimes reported to show the alternation. Schramm (1962) writes: "the second and fifth conjugations pattern exactly as do those of strong verbs", but the "third and sixth conjugations show variants which resemble the strong verb, while parallel forms resemble the geminate stems in other conjugations" (p. 503). Hence, for Form II we find [maddad-a], *[madd-a], [maddad-tu], and for Form III, we find before vowel-initial suffixes either [maadad-a] or [maadd-a], and before consonant-initial suffixes always [maadad-tu] (examples are schematic with biliteral root /md/; actual examples follow).

We begin with Form III. The invariant property of Form III is the presence of a long vowel in the first syllable of the stem. There are different ways to express this property in the grammar. One is by a templatic requirement, say TEMPL=Hσ or TEMPL=CVVCVC , which dictates that the first syllable in a bisyllabic sequence must be heavy (McCarthy 1981). Alternatively we may assume that the morphology of Form III is affixational, adding a moraic affix to a base, along the lines of McCarthy (1993). The precise shape of that affix depends on our assumption of what the base is. If the base is the perfect stem /ktab/, then a long vowel would be affixed, /+aa, ktab/ → [kaatab]. Alternatively, if the base is the derived perfect form [k-a^{PAV}-tab], then a short vowel or a mora would be affixed, /+a, katab/ → [kaatab] (see McCarthy and Prince 1995a, p. 330).

For doubled verbs in Form III and their derivatives in VI, Schramm (1962) reports variation in the output form between [maadd-a] and [maadad-a] (e.g., [_aajj-a], [_aajaj-a] 'he argued'). Again, note that it is only before a vowel-initial suffix that the form with the final geminate may occur. When that happens the form surfaces with an non-final CVVC syllable. This is the key to why [_aajj-a] is avoided. In Classical Arabic, such superheavy syllables are marked, usually found in word-final position, before a pause only. Hence, let us assume a constraint expressing this fact, *CVVC. The variation between [maadad-a] and [maadd-a] can be expressed as driven by the relative ranking of *CVVC and IO-INTEGRITY. When syllable phonotactics dominate, that is when *CVVC >> IO-INTEGRITY, splitting of the geminate is enforced. The optimal form then is [maadad-a]. When IO-INTEGRITY dominates, instead, we get [maadd-a], with the marked syllable structure. Templatic requirements, if any, and lexical vowel parsing requirements are assumed to be ranked lower than IO-INTEGRITY (as already inferred in Form I).

42. Variation through variable ranking *CVVC >?> IO-INTEGRITY

{+aa^{III}, m**a**dd, -a^{Infl}}	*CVVC	IO-INTEGRITY

a. maad**a**d-a		*
b. maadd-a	*	

Hence, assuming that the base is /madd/, we can show that the behavior of Form III can be expressed by the interaction of the faithfulness constraint IO-INTEGRITY, and syllabification, *CVVC, exactly as is the case with the basic analysis of the alternation in Form I. This analysis, of course, does not explain why there is variation and no analysis known to us does that. The reasons for this are beyond the scope of this paper. Perhaps they are to be sought in the relatively limited instances in the morphology where evidence for a ranking between *CVVC and *SPLIT could be obtained (i.e., number of verbs in Form I which have derivatives in Forms III, VI). We know of one more instance where marked CVVC syllables are generated. In participles one finds [yadullu, daallun] vs. [yaktubu, kaatibun].

Turning to Form II, we assume that the morphology of II consists of the affixation of a mora to the basic verbal stem /madd/, and that this mora must be realized by medial gemination (see McCarthy and Prince 1990b, pp. 45-47). Assuming that the input stem for a doubled verb is /madd/, some representative candidates are shown in the tableau in (37) below. In candidate (a), the affixal mora is left unrealized, a violation of the constraint on morphological realization we call REALIZEMORPH (Samek-Lodovici 1993). In (b), the affixal mora is attached to the coda of the first syllable. This creates an usyllabifiable sequence /ddd/, violating SYLL. In the optimal form, (c), the affixal mora finds its realization as the moraic part of the medial geminate /dd/. The input geminate is split so that its output correspondent is the non-contiguous sequence /dad/, where the first /d/ is the second part of the medial geminate. We infer from candidates (a, c) that the constraint on the morphological expression of Form II, REALMORPH, takes priority over the faithfulness constraint IO-INTEGRITY (the other constraint relation shown, SYLL >> IO-INTEGRITY, was inferred in tableau 14).

43. Form II, Ranking argument: REALMORPH >> INTEGRITY^{IO}

$\{\mu^{Affix}$, m**a**dd, -$a^{Infl}\}$	SYLL	REALIZEMORPH	IO-INTEGRITY
a. m**a**dd-a		*!	
b. m**a**Cdd-na μ^{Affix}	*		
input ~dd~ c. ☞ m**a**ddad-na μ^{Affix}			*

There is one interpretation of candidate (a) above, [madd-a], that deserves special attention. We may interpret [madd-a] as realizing the affix mora by gemination. But then it must be that the mora

of the input geminate has been deleted and its place given to the affix mora (which is filled by spreading of the /d/). Equivalently, in this interpretation of [madd] the input geminate shortens. This kind of alternation between a basic form with /dd/ and another form with /d/ is not met anywhere else. As we have seen in Form I, the phonotactic problem met in the consonant cluster of *[madd-na] is not resolved by shortening the geminate as in *[mad-na], but rather as in [madad-na]. Doubled verbs in all their surface forms throughout the morphology never appear with an ungeminated consonant. Hence, a constraint disallowing the alternation between /dd/ and /d/ is dominant here. This is the faithfulness constraint IO-IDENT^{L}, requiring preservation of distinctive consonantal length. It is this constraint that excludes the interpretation of [madd-a] discussed here.

Note that the constraints which interact in deciding the fate of candidates (a, c) above are crucially different from those that decide the outcome of the vascillating Form III. In Form III the constraints in conflict were a syllable well-formedness constraint *CVVC and the constraint IO-INTEGRITY. Sometimes *CVVC gives in to satisfy IO-INTEGRITY, but other times the syllable markedness constraint takes priority, and splitting of the geminate results. In Form II, instead, the conflict is between IO-INTEGRITY, the faithfulness constraint, and a constraint on the morphological expression of the conjugation, the definitional characteristic of Form II. Since morphological expression of conjugation class is at stake, it is not surprising that allomorphy (violation of faithfulness) is admitted in this case. In other words, IO-INTEGRITY is violated to satisfy that requirement on the expression of Form II.

The absence of variation in Form II can also be interpreted as an argument that Form II in Arabic is the result of affixation of a mora as opposed to a templatic requirement that dictates gemination in some way. This is the same position as the that taken in McCarthy and Prince (1990b, p. 45), and McCarthy (1993). If the morphology consisted of a templatic requirement that specifies a heavy syllable in the form of a geminate, then *[madd-a] would be a legitimate output. Thus, we must assume that the morphology is affixational, consisting of the addition of a mora to the input stem.[15]

To conclude, the 'exceptionality' of Forms II, V and also Forms III, VI derives from the interaction of independently necessary constraints on phonotactics and morphological expression of the corresponding Forms. The present analysis obviates elaborations of the Syncope/Metathesis rule of the standard analysis whose effect is to make that rule applicable only to the Forms where the alternation is present.

[15] This does not mean that all cases of stem-internal gemination in Semitic should be derived by affixation. See Buckley (1997), for instance, for an argument that, in Tigrinya, gemination in the Imperfect of a class of verbs, the so-called class A, is the result of a templatic requirement that the first syllable of the stem be heavy. See also Hudson (1991, 1995) for relevant discussion of the interesting issue of medial gemination in Ethiopian languages.

6. Implications

In this section, we discuss implications of the main proposals in this paper.

6.1 Prospects for stem-based morphology

We have claimed that the basic verbal stem of doubled verbs is /CvC^{x}C^{x}/. This claim is relevant to some recent proposals on word-formation in Arabic. On the one hand, some well known studies of Arabic morphology have established that a stem, a unit which includes consonants and vowels, and not just the bare consonantal root, is the base on which morphology operates (e.g., noun broken plurals, Hammond 1988, McCarthy and Prince 1990a, Ratcliffe 1998). These studies have shown that surface properties of the singular noun stem such as vocalic and consonantal length condition in crucial ways the form of the corresponding plural stem.

On the other hand, in verbal morphology traditionally derivation operates on the consonantal root (Cantineau 1950, Fleisch 1956, Goldenberg 1994, Chekayri and Scheer 1996, among others). Yet, more recently, work by various authors suggests that the stem-based view of verbal morphology in Classical Arabic is worth exploring (McCarthy 1993, McOmber 1995, Ratcliffe 1998, Benmamoun 1999). As noted in the introduction, a pressing problem for all such proposals is doubled verbs, whose behavior is thought to crucially rely on root-based derivation. Consider, for instance, McCarthy's (1993) recent reanalysis of verb morphology in which the different verb Forms are related to each other by affixation, not by root-based derivation. McCarthy concludes in that paper that "[e]ssentially all morphological relationships in which one word is derived from another in Arabic are affixational. Mapping to a template is not used in word-based word formation; it is used only to derive words from consonantal roots" (p. 25). The latter part of this conclusion refers to the pattern of /madad/. This pattern is thought to derive from a biliteral root /md/ mapped to the template CVCVC, which is the perfect form of triliteral roots. Since the root /md/ is biliteral and the template has three C positions the single consonant /d/ of the root is assumed to spread to the final C templatic slot (McCarthy 1981).

The proposed view of doubled verbs resolves the inconsistency in the current state of knowledge about Arabic morphology. There is no need for getting from the root /md/ to /madad/ in a first step, treating that as an intermediate, canonical form, and then reducing it to /madd/ whenever necessary. The form /madad/ appears only before consonant initial suffixes as a result of a phonotactically-driven alternation (the constraint SYLL). It is a surface variant of /madd/, which is the verbal stem (in the perfect). As soon as doubled verbs are properly understood, they cease to provide crucial evidence for root-based derivation, and thus for the view admitting two distinctly different modes of word formation in the same language, root-based derivation for verbs and stem-based derivation for nouns.[16]

6.2 Mode of association impasse resolved

Since the pioneering work of McCarthy (1979), considerable discussion has been devoted to the issue of the various phonological shapes verbs take in the verbal system of Arabic. Two patterns have received special attention. One is the pattern exemplified with Form II, kattab and Form V,

[16] See Bat-El (1994, pp. 591-594) and Ussishkin (1999) for critiques of roots in Hebrew.

takattab, with the characteristic medial gemination. The other pattern is that of Form IX ktabab, Form XI ktaabab, and also the quadriconsonantal QIV, Fξazalal, with final consonant duplication. This latter pattern of final duplication also seems to appear with doubled verbs in Form I, in the standard analysis, where /madad/ is the canonical form generated from the root |md|. In what follows, we will only talk about Form II and Form IX since these are representatives of the two different patterns, medial gemination and final consonant duplication, in all relevant respects.

There are two species of proposals about these Forms, depending on which one is considered as exemplifying the assumed default method of mapping consonants to templates. One species holds that consonants are associated to templates in a left-to-right mode. After all consonants have been associated to templatic positions one-to-one, any unfilled template positions are filled by spreading of the final consonant. As already discussed, this is how the Form I /madad/ is derived according to this model of association to template. This model also readily accounts for verbs in Form IX with final duplication. However, special treatment is required for Form II with medial gemination (see rule of II, V Erasure in McCarthy 1981, p. 392).

The other species of proposals holds that the default mode of association is edge-in. Now the medial gemination Form II is the canonical one, and Form IX requires special treatment (Yip 1988, Hoberman 1992). Yip, for instance, asks "why are the triliteral IX and XI binyanim, ktabab and ktaabab, realized with spreading of the final rather than the medial consonant?" (1988, p. 560). Yip's answer is that "they require double linking of the final consonant, and this overrides the general association principles". The same issue arises with 'biliterals'. In /samam/, the repetition of the second consonant is effected by a leftward spreading rule "that follows the completion of initial association, and applies to unassociated slots." (Yip 1988, p. 559). Either mode of association, left-to-right or edge-in, is bound to such overriding of its default association principles, if we take both patterns, Form II kattab and Form IX ktabab, at face value.

This mode of association impasse is bypassed in our analysis. Stems in IX and the other Forms "with final doubling" XI, QIV, take the form ktabab only before consonant-initial suffixes. These forms are surface alternants of the basic forms of stems with final geminates. The following examples illustrate this. Verbs in Form IX derive from corresponding adjectives of color and bodily defect by the addition of a suffixal mora, /Sfar-/$^{\text{Adj-stem}}$ + μ → /Sfarr-/$^{\text{Verb-stem}}$. Once the verbal stem is put in the context of its inflectional paradigm, it is clear that what is involved in the allomorphy between [zi-Sfarr-a] 'he became yellow' and [zi-Sfarar-tu] 'I became yellow' is the familiar by now phonotactically conditioned alternation. The same applies to verbs in Form QIV, [-šmazall-a] 'he hastened', [-šmazlal-tu] 'I hastened' (Schramm 1962, p. 499).

44.

Adjective			Derived verb in Form IX (perfect)		
			Stem + V	Stem + C	
za-Sfar-u	'yellow'	→	zi-Sfarr-a	zi-Sfarar-tu	'he/I became yellow'
za-_mar-u	'red'	→	zi-_marr-a	zi-_marar-tu	'he/I blushed'
za-qbal-u	'cross-eyed'	→	zi-qball-a	zi-qbalal-tu	'he/I became cross-eyed'

Cf. Verb /radd/ (perfect stem) → radd-a radad-tu 'he/I returned'

Traditionally grammars identify Form IX with the pattern ktabab (Wright 1896). All subsequent work in the generative tradition known to us has assumed that ktabab is the canonical form of a verb in IX (McCarthy 1981 *et seq*). However, it is important to note that *actual stems* in IX exemplify the form ktabab only before consonant-initial suffixes, for familiar reasons by now. We conclude that the allegedly canonical form of verbs in IX, ktabab is not derived by mapping to template. Rather, this form is a phonologically-conditioned surface variant of the stem /ktabb/.[17]

Consequently, the left-to-right spreading of standard analysis of verbs in Form IX and doubled verbs in Form I is epiphenomenal. This direction of spreading is meant to capture the right edge 'polarity' in consonant repetition of Form I [madad-], not *[mamad-], and in Form IX [Sfarar-], not *[SSafar-]. Under our analysis, the polarity is the effect of two things, the fact that the verbal stems involved are geminate-final, and the fact that some suffixes are consonant-initial, a property of the inflectional context in which geminate-final stems are realized. The same criticism applies to the reanalysis of final repetition in Gafos (1998a) who employs morphological reduplication, as opposed to autosegmental spreading, to derive final duplication in |md| → [madad]. In that analysis too, the reduplicant inducing copying of the final root consonant must be stipulated to be a suffix. No such stipulation is necessary once the interaction between stem and inflectional context is recognized.

Moreover, in the spreading or the reduplication analysis, the fact that the rightward polarity of repetition is the same for Form I doubled verbs and Form IX verbs is accidental. This is to say that doubled verbs in Form I could take the form [mamad-] with leftward repetition, while verbs in Form IX show rightward repetition, [-_marar-], as attested. In the present analysis, verbs in Form IX and doubled verbs in Form I are predicted to behave identically, since both are geminate-final, and the alternation between [madd] and [madad] is a matter of phonology.

Finally, the nature of the grammatical mechanism which effects medial-gemination in Form II and Form V is an independent issue which cannot be addressed in this paper. For relevant discussion see the proposals in McCarthy (1979, 1981), Lowenstamm and Kaye (1986), McCarthy and Prince (1990b), Yip (1988), Farwaneh (1990), and Hoberman (1992).

7. Geminate splitting

We have claimed that in the doubled verb alternation, the surface form [mdud] derives from a stem /mudd/ with a final geminate. Specifically, we represent the phonological relation between /mudd/ and [mdud] by the configuration in (39) below. We refer to this configuration as 'geminate splitting'. In our analysis, geminate splitting takes place to avoid the phonotactic problem with the combination of /mudd/ with a consonant-initial suffix, and because alternative resolutions of this phonotactic problem such as shortening of the geminate or epenthesis of a default vowel at the stem-affix juncture are impossible in Arabic.

[17] This is seen most clearly in those modern dialects which have retained Form IX and also eliminated the doubled verb alternation. For instance, in Syrian Arabic (dialect of Damascus, Cowell 1964), verbs in Form IX, also called 'Inchoatives', are derived from the corresponding adjectives by adjunction of a final mora: /zaHmar/ 'red' → [Hmarr] 'to become red, to blush', /zaSfar/ 'yellow' → [Sfarr] 'to become yellow, turn pale', /zaswad/ 'black' → [swadd] 'to become black', and so on (Cowell 1964, pp. 250, 294). As always, the derived verbal form is realized in the context of the (im)perfect paradigm, [Hmarr] 'to blush.Perfect.3ms', [bye-Hmarr] 'to blush.Imperfect.Indicative.3ms', [bye-Hmarr-u] 'to blush.Imperfect.Indicative.3p' (for the full paradigm see Cowell 1964, p. 101).

45. INTEGRITY violation:

m u dd		Input (S_1)
f h		
m d u d		Output (= S_2)

INTEGRITY: No segment of S_1 has multiple correspondents in S_2

However, geminates are known for their resistance in splitting, a property known as geminate integrity (Kenstowicz and Pyle 1973, Guerssel 1977, 1978, Steriade 1982, Hayes 1986, Schein and Steriade 1986). In this section, we argue that geminate splitting is attested independently in languages of the Semitic stock.

Consider the data below from the dialect of Moroccan Colloquial Arabic described in Heath (1987). For each example, two consonant positions in the derived word are occupied by the two 'halves' of the base geminate. Note that geminates split independent of their position. A final geminate splits in the Passive participle /k_bb/ → /m-kbub/, and a medial geminate splits in the Professional noun /s^{w}kkaR/ → /skakR-i/.[18] The examples are drawn from word-formation in nouns (a-c) and verbs (d-f). For verbs, the derived form (left column) is the imperfect stem shown here in the third masculine singular 'he *Verbs*', which is the only unsuffixed form of the verb. The symbol /_/ denotes a rounded, short vowel. All page numbers refer to Heath (1987).

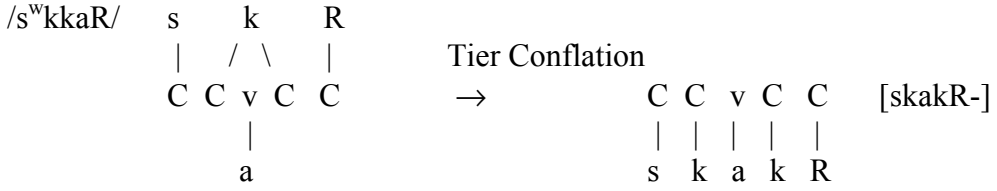
[18] We do not give examples of bases with initial geminates because initial geminates are extremely rare in MCA. There are a handful of particles and prepositions with initial geminates but these do not have any derivatives (Heath, p. 204). There is also one verb /ddi/ 'take away' and two nouns, /BBa/ 'father' and /MM$^{(w)}$-/ 'mother' (capitals denote pharyngealization). Of these, the first two do not have derivatives that exhibit geminate splitting, but 'mother' does in its diminutive form /mwim-t-/ (loss of pharyngealization intended), where /t/ is a feminine singular suffix (Heath 1987, pp. 115, 132).

46. Examples of geminate splitting in word-formation

a. Professional Noun, p. 140	s^{w}kkaR	'sugar'	→	skakr-i	'dealer in sugar'
b. Nominal Plural, p. 103	fddan	'field'	→	fdad^{e}n	
c. Nominal diminutive, p. 114	m_xx	'brain'	→	m^{w}xiy^{e}x	
d. Factitive-Causative, p. 79	šemm	'smell'	→	šmmem	
e. Passive participle, p. 92	k_bb	'pour'	→	m-kbub	
f. Agentive, p. 134	k_bb	'pour'	→	kbbab	

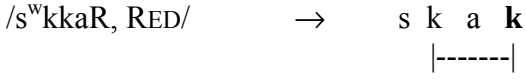
Our goal is to argue that the relation between the base /s^{w}kkaR/ and its derivative [skakR-i] involves the configuration in (39) above. To show this, we must first consider and exclude alternative interpretations of this data that bypass the violation of geminate integrity. One such interpretation is that the mechanism effecting consonant repetition in /s^{w}kkaR/ → [skakR-i] is autosegmental spreading. This is illustrated in (41). The first step in the derivation is to establish associations between the consonants of the base and the C positions in the Professional Noun template [CCaCC-i] (see McCarthy 1979, 1981, Mester 1986, Yip 1988, Hoberman 1992 on specific proposals about 'mapping strategies'). After mapping takes place, the next step is a rule known as *Tier Conflation* which linearizes the representation so that consonants and vowels end up on the same plane (see McCarthy 1986). As shown in (41), the consonants of the base noun are assumed to occupy a different plane from that of the characteristic vocalism of the template, here the vowel /a/. This assumption is necessary to allow for the spreading of base consonants. Since /k/ fills both consonant slots around the vowel /a/, the vowel /a/ and the consonant /k/ must reside on different planes (see McCarthy 1979, 1989). If derivation proceeds in this way, then there is no violation of geminate integrity, because there is no direct relation between the base geminate /kk/ and the two instances of /k/ in the derived word. It is the root consonant /k/ which spreads to two positions in the template.

47. Spreading analysis of /s^{w}kkaR/ 'sugar' → [skakR-i] 'dealer in sugar'



Yet another interpretation of the relation between /s^{w}kkaR/ → [skakR-i] is to propose that the mechanism involved in effecting the repetition of the consonant is morphological reduplication. The derived word is formed by concatenation of the base /s^{w}kkaR/ with a reduplicative infix RED.

48. Reduplication analysis of /s^{w}kkaR/ 'sugar' → [skakR-i] 'dealer in sugar'



The reduplicative infix would induce copying of the geminate /kk/, as in */s**kk**a**kk**r-i/. The two instances of the geminate would then shorten in conformity to the template shape CCaCC-i to give the output [s**k**a**k**R-i]. It is an independently attested fact that in MCA geminates shorten in conformity to templatic requirements (as shown immediately below). If this is the right analysis, then no geminate integrity violation is involved in the relation between /s^{w}kkaR/ and [skakR-i].

We must then address the nature of the mechanism that effects consonant duplication closely before any conclusions on geminate integrity can be reached. This is the goal of the next two sections which consider first a spreading analysis and then a reduplication analysis of the facts.

Before proceeding, let us secure that what we refer to as geminates in MCA are distinct from sequences of two consonants, and from sequences of two identical consonants separated by a vowel. We illustrate these distinctions with Verbal noun formation in MCA. The verbal noun is formed on the template CCCaC. When the verbal stem is of a /CCvC/ shape its verbal noun takes the form CCiC, CCaC, or CCuC: /Hmel/ 'carry' → [Hmil], /rkeb/ 'ride, mount' → [rkub], /xser/ 'lose' → [xsar-a]. When verbal stems contain a geminate as in /CC$_x$C$_x$eC/ they map to the template by degemination: /t-grrez/ 'belch' → [t-graz]/, /t-xrre_/ 'graduate' → [t-xri_], /nqqeZ/ 'jump' → [t-nqaZ].[19] However, when the verbal stem begins with a triconsonantal cluster, /C$_x$C$_y$C$_z$eC/, the cluster is preserved: /t-xRbeq/ 'mess around' → [t-xRbiq], /t-šlweš/ 'shake down' → [t-šlwiš]. This shows that geminates are different from sequences of two consonants. (It also shows that the templatic constraints are violable under pressure from higher ranked constraints, here the requirement that all consonants in verbal stem must surface in the derived word.)

A second observation establishes that in underived stems /...C$_x$vC$_x$.../ sequences are distinct from /...C$_x$C$_x$.../ sequences. Consider a stem like /hrnen/ 'speak nasally'. The derived verbal noun is [t-hrnin]. This form does not show loss of /n/. Such loss would be expected if the stem /hrnen/ comes from a root /hrn/, which should behave like other triliterals in giving *[t-hrren]. In other words, /hrnen/ behaves just like a regular quadriliteral verb. In other words, /...C$_x$vC$_x$.../ sequences are qualitatively distinct from /...C$_x$C$_x$.../ sequences. The latter shorten to satisfy templatic requirements, but the former do not. The same distinctions can be illustrated with data from other templates, such as the Nominal plurals and Agentives.

7.1 Autosegmental spreading

Any model which effects consonant repetition by spreading is derivational. This is because spreading of consonants over vowels necessitates a segregated representation, where vowels and consonants occupy different planes. But the final output of phonology must be a linear sequence of segments. This is achieved only after Tier Conflation applies. The inherently derivational nature of spreading is at odds with certain robust properties of MCA phonology.

An important aspect of MCA word-formation is a rule "inserting a schwa between ungeminated

[19] Heath uses the symbol ʿCʾ for what I write as /z/, the voiced counterpart of the pharyngeal fricative /H/. In Heath's words, this sound "has some characteristics of a stop and is perceived largely in terms of /a/ – colored on – and off-glides flanking it. In MCA, it is not glottalized as it is in Mauritanian Hassaniya" (Heath 1987, p. 13)

Cs (i.e. C_xC_y) directly following the ablaut V under certain conditions" (Heath 1987, p. 55). The rule is referred to as the rule of *Schwa Insertion*, and is part of Heath's post-mapping rules. This is a set of rules effecting changes to derived words after mapping to template has taken place. Schwa Insertion applies to all derived verbs and participles, and the nominal and adjectival plurals and diminutives (Heath 1987, p. 343). In (43), we give actual examples from adjectives mapping to the templates CuCC for the Plural, and C^wCiCC for the Diminutive.

49. Schwa Insertion in final CC clusters of templates

Adj(ective) Stem		CuCC, Adj. Plural	C^wCiCC, Adj. Diminutive
kHel	'black' →	kuH^el	k^wHiH^el, k^wHiy^el (pejorative variant)
Hmeq	'crazy' →	Hum^{e}q	Hmim^{e}q
Hwel	'cross-eyed' →	Hiw^{e}l	Hwiw^{e}l

The crucial fact is that the schwa is not present when the base stem ends in a geminate. In Heath's words, "Schwa Insertion in a CC cluster following a full ablaut V is prohibited when the corresponding inputs Cs form a geminate C_xC_x" (Heath 1987, p. 106). In (44), we show some examples illustrating this property drawn from the formation of the Reciprocal, Active Participle, Nominal plural, and Nominal diminutive (Heath 1987, pp. 65, 94, 108, 127 respectively). For each of these morphological categories, we give a base ending in a geminate and a base that does not end in a geminate. The outputs of the geminate-final bases never undergo Schwa Insertion, whereas the outputs of the other bases always do.

50. Geminates do not split to $C_x{}^eC_x$

Reciprocal:	šemm 'smell'	→	t-šamm	*t-šam^{e}m
cf.	qtel 'kill'	→	t-qat^{e}l	
Active participle:	Hell 'open'	→	Hall	*Hal^{e}l
cf.	qtel 'kill'	→	qat^{e}l	
Nominal plural:	mxadd-a 'pillow'	→	mxadd	*mxad^{e}d
cf.	sarut 'key'	→	swar^{e}t	
Nominal diminutive:	m_xx, 'brain'	→	m^{w}xiy^{e}x	*m^{w}xix^{e}x
cf.	bir 'well (water)'	→	bwiy^{e}r	

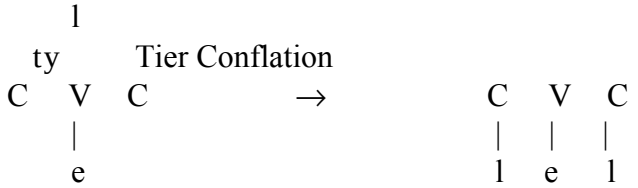
We are now in a position to see the problem with spreading. There are two possible ordering relations between the rule of Schwa Insertion and Tier Conflation. None of these orderings can provide an account of the generalization above. Let us see why by considering each ordering in turn.

· **Schwa Insertion before Plane Conflation**. Assume that Schwa Insertion applies at some stage in the derivation before tiers are conflated. This ordering deprives us of an account of the generalization that final geminates do not split to $C_x{}^eC_x$. If Schwa Insertion applied before Tier Conflation, then it would split final geminates to $C_x{}^eC_x$ sequences.[20]

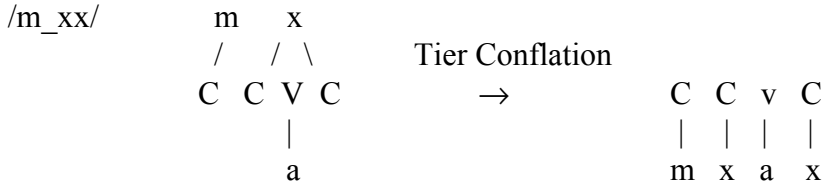
[20] That the ordering of epenthesis rules before Tier Conflation leads to a problem with geminates is also

The banned $C_x{}^eC_x$ sequences are detectable only after Tier Conflation applies. Before Tier Conflation a doubly-linked consonant configuration is indistinguishable from any other doubly-linked consonant configuration. For instance, consider the two instances of doubly-linked consonants below. Case (a) is an application of the rule of Schwa Insertion. Since vowels and consonants reside on different planes, the rule of Schwa Insertion can apply freely. The /l/ arches over the inserted vowel, which comes from another plane. In (b), /x/ arches over the templatic vowel /a/. The two representations in (a, b) are formally identical at this stage in the derivation, that is, before Tier Conflation. However, the first representation is never attested, but the second is widely attested.

51. a. Non-attested spreading configuration: /Hell/ 'open' → *[Hal^{e}l], Participle



b. Attested spreading configuration: /m_xx/ 'brain' → [m^{w}xax], Plural



· **Schwa Insertion after Tier Conflation**. An attempt to eliminate this problem would be to propose that Schwa Insertion applies after Tier Conflation. This ordering is consistent with Heath's characterization of Schwa Insertion as a post-mapping rule. This ordering leads to another problem, however. Before Tier Conflation, there is no information in the representation about where the vowels will eventually appear in relation to the consonants. There is also no information as to which vowels will appear between any two consonants. Yet this information is crucial in determining the C slots to which a consonant associates.

Let us illustrate this with two examples. Consider the diminutive [m^{w}xiy^{e}x] from /m_xx/ 'brain'. The template has four C slots. Consonant /x/ is associated to the final (fourth) C slot of the template, but it is not associated to its preceding (third) C slot. This slot is instead filled with the glide /y/

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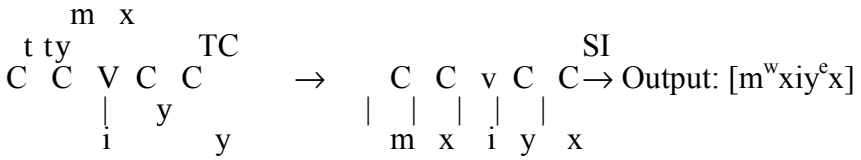
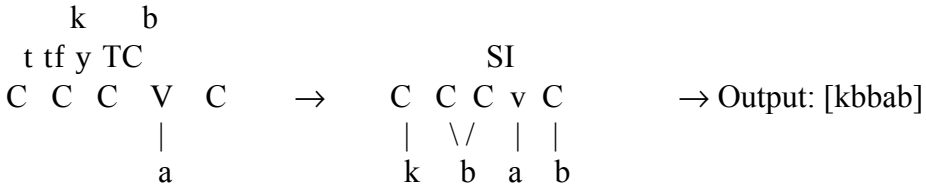
discussed in Kenstowicz (1994, p. 420).

which must occupy a different plane from that of the base consonants so as to allow for spreading of the /x/. In the example from Agentives, however, the /b/ is associated to the fourth C slot and its immediately preceding C slot. Observe that whether the third C slot is skipped or not is a function of the linear order between certain vowels and consonants. In the Diminutive, the vowel that eventually ends up between the two final consonants is the vowel of Schwa Insertion. But in Agentives the vowel that eventually falls between the two final consonants is /a/. However, this information is not present at the stage where the mapping is executed ('TC' Tier Conflation, 'SI' Schwa Insertion).

52. a. Diminutive template is CCCvC: /m_xx/ 'brain' → [m^{w}xiy^{e}x]

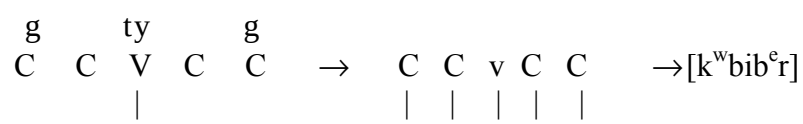


b. Agentive template is CCCvC: /k_bb/ 'pour' → [kbbab]



In the adjectival diminutives, we meet a similar problem. The canonical way for triliteral adjectives to map onto the diminutive CCVCC template is by repetition of the medial consonant of the adjective. An example is shown in (a) below. To effect consonant repetition by spreading, association must apply at a stage before Tier Conflation, as shown here for /kbir/ 'big' → [k^{w}bib^{e}r]. This mode of association is known as edge-in (Yip 1988, Buckley 1990, Hoberman 1992). However, for /qlil/ 'few' → [q^{w}liw^{e}l, q^{w}liy^{e}l], this mode of association predicts diminutive *[q^{w}lil^{e}l]. This output is avoided because of the final [l^{e}l] sequence. Once again, crucial to the ungrammaticality of *[q^{w}lil^{e}l] is the fact that the templatic vowel does not appear between the two final consonants; the template is CCvCC, not CCCvC. But at the stage when association of consonants to template slots applies, that is before Tier Conflation, the location of vowels is inaccessible.

53. a. /kbir/ 'big' → /k^{w}bib^{e}r/, */k^{w}biy^{e}r/



i k b i b r

b. /qlil/ ‘few’ → /q^{w}liw^{e}l/ or /q^{w}liy^{e}l/ but not */q^{w}lil^{e}l/

q l l
g ty g
C C V C C → C C v C C → *[qlil^{e}l]
| | | | |
i q l i l l

Similar data are found in the Imdlawn dialect of Tashlhiyt Berber (ITB), described insightfully in Dell and Elmedlaoui (1992) and other papers by these authors. The relevant template from ITB takes the shape is a(C)CCaCC-iy. Derived words on this template are nouns and adjectives, denoting “someone whose trade or occupation involves X”, where X is the base (Dell and Elmedlaoui 1992, pp. 105-109). The examples in (a) show that a geminate in the base noun splits to fill in the third C slot of the template. Those in (b) show that when the final two consonants of the base are identical, a glide fills in the third C slot of the derived word. The same argument for the ineffectiveness of spreading, as just seen in MCA, applies here (‘!’ in /a-!lzzaz/ denotes pharyngealization throughout /lzaaz/).

54. ITB geminate splitting in (a), and its failure in (b)

a.	a-skkif	‘soup’	→	a-skakf-iy
	l-brrad	‘teapot’	→	a-brard-iy
	a-qššb	‘smock’	→	a-qšašb-iy
b.	a-Hmmam	‘hammam’	→	a-Hmaym-iy
	a-!lzzaz	‘plant used as shampoo’	→	a-!lzayz-iy
	a-qllal	‘head of slaughtered animal’	→	a-qlayl-iy

The same template in ITB provides yet another argument for the ineffectiveness of spreading as the mechanism effecting consonant repetition. Geminates split in derivation when the base has three consonants, /l-brrad/ ‘teapot’ → [a-brard-iy], as in (49) below. But when the base has two consonants, with at least one being geminate, the geminate splits but does not associate to C^3 of the template, /l-!btta/ ‘bottle’ → [a-!btayt-iy], *[a-!btatt-iy]. The OCP is irrelevant in ruling out *[a-!btatt-iy], since in this form the pre-suffixal /tt/ is the result of a multiply-linked /t/ (by the assumption of spreading). The answer is that gemination is avoided as a way of satisfying the final CC cluster of the template a(C)CCa**CC**-iy.

55. Output-sensitive geminate splitting

a.	l-brrad ‘teapot’	→	a-brard-iy
	a-qššb ‘smock’	→	a-qšašb-iy
	a-skkif ‘soup’	→	a-skakf-iy
	!ssbbat ‘show’	→	a-!sbabt-iy

b.	l-!fss-t	‘lucerne (alfalfa)	→	a-!fsays-iy	*a-!fsass-iy
	l-!btta	‘bottle’	→	a-!btayt-iy	*a-!btatt-iy
	a-!stta	‘loom’	→	a-!stayt-iy	*a-!statt-iy
	šškk	‘incredulous, doubt’	→	a- kayk-iy	*a- kakk-iy

The alleged spreading is permitted in examples like /l-brrad/ ‘teapot’ → [a-brard-iy]. However, spreading cannot generate a ‘local geminate’ as in /šškk/ ‘incredulous, doubt’ → *[a-ška**kk**-iy]. In ITB, the output condition that drives template mapping is a ban on geminates in CC clusters of templates. Spreading of consonants must take place before Tier Conflation. But before Tier Conflation, a long-distance geminate is indistinguishable from a local geminate, because the vowels are on a different plane. Hence, before Tier Conflation, it is impossible to know whether a vowel appears between two C positions.

The same problem with spreading arises in cases where the long-distance geminate is disallowed but the local geminate is admitted. One particularly telling example of this situation is Sierra Miwok, a Penutian language of California, described in detail in Freeland (1951), and later analyzed in an autosegmental framework by Smith (1985) and Goldsmith (1990) . The Sierra Miwok verbal system includes three types of stems: type I stems with the template CVCVVC (e.g., kicaaw ‘to bleed’); type II, with a CVCCV template (e.g., celku ‘to quit’); and type III, with a CVCCV template, where the medial consonant is a geminate (e.g., hamme ‘to bury’). Examples are shown in (50). In addition to these *basic stem* types, there are three modified forms that can be found for each stem. Freeland calls these the *second*, *third*, and *fourth* stems. The second stem has the template CVCVCC with a final geminate, the third has the template CVCCVC with a medial geminate, and the fourth has the template CVCCV where the second and third C positions cannot host a geminate.

56.

	Basic Stem	Second Stem	Third Stem	Fourth Stem	Gloss
		CVCVCC	CVCCVC	CVCCV	
Type I	kicaaw	kicaww	kiccaw	kicwa	‘bleed’
	huteel	hutell	huttel	hutle	‘roll’
Type II	celku	celukk	celluk	celku	‘quit’
	nakpa	nakapp	nappak	nakpa	‘catch up with’
Type III	hamme	hamezz	hammez	hamze	‘bury’
	liwwa	liwazz	liwwaz	liwza	‘speak’

In Goldsmith (1990, pp. 83-95), this templatic system is analyzed as employing V/C planar segregation. The details of that analysis are not of interest here. What is relevant for current purposes is the behavior of type III stems: when these biconsonantal stems appear in the second, third, and fourth stem form (CVCVCC, CVCCVC, and CVCCV respectively) the extra consonantal positions of the corresponding template are filled by epenthesis of a default /z/ consonant and local gemination in the underlined CC clusters. Apparently the long-distance spreading option is never taken. For example, the second stem of hamme ‘bury’ is hamezz, not *hamemm. The generalization that stands out then is that the long-distance geminate is not permitted, but crucially the local geminate must be

admitted, e.g., kica**ww**, na**pp**ak etc. Under V/C planar segregation, however, the two kinds of geminates are indistiguishable. In both cases, a single Root node establishes multiple-linking to two or more C positions of the template. When this linking is established, vowels reside on a different plane, and therefore it is impossible to know whether multiple-linking will eventually result in a 'local' or a 'long-distance' geminate.

Let us summarize the problem with effecting consonant repetition by spreading. For spreading to operate, vowels and consonants must reside on different planes. This implies that the linear sequencing of vowels in relation to the consonants is inaccessible at the stage when consonant spreading applies. Association principles, left-to-right or edge-in, assigning consonants to templatic positions have access only to the segregated linear sequence of consonants. However, in the cases discussed above template filling is driven by output conditions that make crucial reference to the presence or absence of a vowel between two consonants. In MCA, the output condition is the ban on [d^{e}d] sequences. In ITB, the output condition is the ban on geminates in CC clusters of templates. In Sierra Miwok, the output condition is the ban on long-distance geminates. Spreading is inherently incompatible with this state of affairs. Spreading must take place before Tier Conflation, but before Tier Conflation there is no information about which vowel (if any) would fall between any two C positions in the template. Yet this information is crucial in determining whether a consonant spreads or not. The conclusion is that, in the general case, the mechanism effecting duplication of consonants cannot be autosegmental spreading.

7.2 Morphological reduplication

We now turn to show that the mechanism effecting consonant repetition in /skakR-i/, derived from /s^{w}kkaR/, cannot be morphological reduplication. We begin by assuming that the morphology of the Professional Noun involves infixation of a reduplicative morpheme to the base /s^{w}kkaR/. Due to its reduplicative nature, this morpheme induces copying of a base consonant, as in /skka**kk**^{RED}R-i/. However, this form is impossible because the template is CCaCC-i. As seen earlier, geminates shorten to satisfy templatic requirements. Thus, to avoid this violation of the templatic shape, the two instances of /k/ in /skka**kk**^{RED}R-i/ must be simplified to a non-geminate consonant resulting in the desired output [ska**k**R-i].

Let us consider more examples from the Professional Noun in (51). As can be seen in (a), quadriliterals show no reduplication. This fact is compatible with a reduplication analysis. In such an analysis, copying does not take place for quadriliterals because for these the underived stem contains enough consonants to satisfy the template CCaCC-i. Such an approach is possible in a theory of grammar where principles are violable. The reduplicative morpheme does not always copy a consonant because templatic size limitations disallow any copying. Such an analysis is proposed explicitly in Gafos (1998b) to account for cases of apparent consonantal spreading across a vowel in Hebrew and Temiar (an Austroasiatic language of Malaysia), two languages with non-concatenative morphology.

57. MCA Professional Noun

a.	fnDeq	fnaDq-i	'livery stable'
	_uRnal	_Ranl-i	'newspaper'

b.	s^{w}kkaR	skakR-i	‘sugar’
	Sbben	Sbabn-i	‘wash clothes’
c.	nšeT	nšayT-i	‘be lively’
	sker	skayr-i	‘get drunk’

The facts in (b, c) indicate a contrast between ‘geminate triliteral’ forms like /s^{w}kkaR/ ‘sugar’ and simple triliteral forms like /sker/ ‘get drunk’. Geminate triliterals extend on a CCvCC template by consonant repetition, but simple triliterals employ glide epenthesis. The reduplication analysis cannot account for the fact that reduplication takes place only if the base contains a geminate. The reasoning so far would predict that reduplication should also apply in these cases too, because there are only three consonants in the base /sker/ and the template has four positions. Proposing that glide epenthesis is preferred over reduplication predicts epenthesis also for the case of /Sbben/ → *[Sbayn] rather than [Sbabn-i]. We conclude that the repetition of the consonant in [Sbabn-i] cannot be attributed to reduplicative morphology.

7.3 Recapitulation: phonological copying

We have seen that the mechanism effecting consonant repetition in /skakR-i/, derived from /s^{w}kkaR/, cannot be spreading or morphological reduplication. We may now safely conclude that MCA exhibits a genuine instance of geminate splitting. The phonological aspects of the relation between /s^{w}kkaR/ and [skakR-i] are formalized via a correspondence relation between the two words. The two instances of [k] in the derived word [skakR-i] correspond, in the formal sense of this word, to the geminate [kk] in the base /s^{w}kkaR/. In other words, to say that there are two consonants in the derived form /skakR-i/ whose source is single segment /kk/ in the base [s^{w}kkaR] is to say that the segment /kk/ has two correspondents in the derived form (McCarthy and Prince 1993a, 1995a). This implies that geminate splitting is independently attested. We refer to the consonantal repetition in the derived form as an instance *non-reduplicative copy* or *phonological copy*.

In all examples of pairs like /s^{w}kkaR/ ‘sugar’ ~ [skakR-i] (Professional Noun) or /kbir/ ‘big’ ~ [k^{w}bib^{e}r] (Adjectival Diminutive) used to illustrate the need for phonological copy, the derived word is formed on a template. As we have seen, our analysis of the doubled verb relation between /mudd/ and [ya-mdud-na] does not necessarily involve a template. However, the issue of the presence of a template is orthogonal to the issue of what phonological relations are admitted between two linguistic forms. Specifically, it has been shown that the pair /s^{w}kkaR/ ~ [skakR-i] involves a *phonological* relation where the two instances of [k] in the derived word [skakR-i] correspond to the geminate [kk] in /s^{w}kkaR/. This suffices to establish the fact that such relations must be admitted. There is no a priori reason to restrict such relations only to cases where the output involves a template.

8. Conclusion

Schramm (1991) writes that “the conventional statement of Semitic morphological typology for the last thousand years or so has always reflected the view that all verbs and most nouns are to be derived by a process of interdigitating discontinuous consonantal root morphemes, expressing lexical

content, and vocalic pattern morphemes which express grammatical content." (p. 1402). This is the standard view in the background of all past and current work. For reviews see Goldenberg (1994, and Hoberman (1995).

From the perspective of modern linguistic theory, a level of linguistic representation (e.g., syllables, feature trees, moras) earns its right of existence on the basis of evidence that it allows us to explain phenomena that would otherwise remain unexplained. This paper re-examines a number of well-known issues in the morphology and phonology of the Arabic strong and doubled verb which were thought to provide crucial support for consonantal roots. Parting with tradition, these issues are examined by considering verbal forms not in isolation but in the context of the inflectional paradigm in which they are realized. This perspective allows us to explore the extent to which systematic patterns in the behavior of the verb as well as systematic patterns of the lexicon are lawful consequences of independent properties of the language as opposed to consequences of morpheme structure constraints applying on roots. Explanation of the systematic patterns discussed here is based on 'vowelled' stems and generally accepted constraints on phonological outputs built on these stems. We find no evidence for principles applying exclusively at the level of the root. In fact, we argue that the stem-based analysis consistently results in a better solution to the problems discussed in this paper. A summary of these problems and the specific results obtained follows.

First, we have asked why should the form of the triliteral verb be /CCVC/, as posited by Schramm (1962), Kury_owicz (1972) and others. We have seen that the /CCVC/ form arises as a consequence of the inflectional context of the paradigm, a situation we refer to as stem molding. A rigid inflectional context 'molds' the shape of the stem to 'fit' into the context of the paradigm. Stem molding is expressed formally using standard OT resources: a grammar constructed from a set of constraints requiring preservation of lexically-specified properties (IO-Faithfulness), constraints requiring identity between related forms within the paradigm (OO-Faithfulness), and markedness constraints that express well-formedness conditions on phonological forms (e.g., OCP, no edge geminates, syllabification).

Second, in all respects relevant to morphology and phonology, Arabic doubled verbs have stems with lexically-specified vocalism and consonantal length, e.g., 'to stretch' has perfect stem /madd/ and imperfect stem /mudd/. This allows us to make sense of the behavior of doubled verbs in ways that have not been possible before. Specifically, the stem-based view of doubled verbs developed in this paper allows us to explain why the alternation between [madd] and [madad] takes place using independently necessary phonotactics of the language. This proposal also allows one to derive the behavior of stems with final geminates in the so-called 'exceptional' Forms II, III. Last but not least, the proposal resolves a well-known problem with parametric association-to-template approaches to templatic morphology, and also inconsistencies with the treatment of verbal morphology.

Finally, the well-known feature of the Arabic lexicon, the absence of *ssam, *sasam, either as stems or surface realizations of such stems, versus the presence of samm, samam is another consequence of stem molding. It is shown that the systematic absence of *ssam, *sasam emerges from the interaction of the inflectional context of the paradigm coupled with the phonotactics of the language and identity constraints between related forms in the paradigm.

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