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John J. McCarthy
University of Massachusetts, Amherst, jmccarthy@linguist.umass.edu

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8.1 Introduction

Traditional ideas of analogy, *SPE*'s phonological cycle, and recent proposals about Output–Output faithfulness all have the same goal: to account for surface resemblances among morphologically related words. For instance, the trisyllabic participial form *lightening* has a syllabic *n* because of its relationship to the verb *lighten*—a relationship not shared with the disyllabic noun *lightning*. Phenomena like this have figured prominently in discussions of analogy and its successors.

In one thread of recent research (see s. 8.2), words have a surface resemblance because of shared membership in a paradigm. A paradigm is a set of inflected forms based on a common lexeme or stem: ⟨*lighten*, *lightens*, *lightened*, *lightening*⟩ is an example. The idea is that members of a paradigm should have similar surface phonology, such as the syllabic *n* that appears consistently throughout the *lighten* paradigm.

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In this chapter, I will introduce a novel formalization of surface resemblance through shared paradigm membership, couched within Optimality Theory (OT: Prince and Smolensky 1993) and correspondence theory (Benua 1997*a*; McCarthy and Prince 1995, 1999). In this Optimal Paradigms model (OP), an OT constraint hierarchy evaluates candidates consisting of entire paradigms. Within a paradigm *qua* candidate, every output realization of a lexeme stands in correspondence with every other output realization of that lexeme. Faithfulness constraints on this intraparadigmatic Output–Output correspondence relation resist alternation within the paradigm. Through interaction with markedness and standard faithfulness constraints, they account for surface resemblance and failure of resemblance among members of a paradigm.

The OP model is illustrated and supported by a type of data that has not figured in previous discussions of the surface-resemblance problem. Certain properties of Classical Arabic root-and-pattern morphology, I will argue, cannot be satisfactorily explained without the OP model. This argument also shows how OP supports the minimalist goals of Generalized Template Theory (GTT), which seeks to eliminate templates and similar stipulations from linguistic theory, replacing them with independently motivated constraints. The analysis of Arabic templates sets in clear contrast the differences between OP and serial-derivational models, including proposals for melding OT with Lexical Phonology (see s. 8.4).

8.2 BACKGROUND TO AND OVERVIEW OF THE OP MODEL

This section provides an informal introduction to the Optimal Paradigms model and to the analysis of Arabic templates. Later sections fill in the details of the theory and the analysis.

Benua's (1997*a*) Transderivational Correspondence Theory (TCT) says that a morphologically derived surface form stands in a relation of Output–Output (O–O) correspondence with its morphologically simplex counterpart, called the base. For example, *lightening* is in O–O correspondence with *lighten*. Harmonic evaluation proceeds recursively, from the base outward, by a principle of Base Priority. The surface phonology of the base *lighten* is carried over, by obedience to O–O faithfulness constraints, to the derived form *lightening*. Base Priority disallows influences running in the other direction, so derived *lightening* can never influence the base *lighten* via O–O correspondence. Because of Base Priority, TCT is inherently asymmetric: if form A influences the phonology of a morphologically related form B, then form B can never influence the phonology of form A.

Another approach to the surface-resemblance problem is inherently symmetric, requiring that morphologically related words (or even individual morphemes) resemble one another without assigning priority.

(1) a. UNIFORM EXPONENCE (Kenstowicz 1996)
Minimize the differences in the realization of a lexical item (morpheme, stem, affix, word).
b. METRICAL CONSISTENCY (Burzio 1994*a*: 228)
Every morpheme must be as metrically consistent as possible.

In later work, Burzio (1996, 2002*b*) generalizes METRICAL CONSISTENCY to a principle of Anti-Allomorphy, which requires consistent realization of morphemes in all their phonological properties, not just stress. With this generalization, these principles become equivalent: morphemes, stems, or words should not vary in their phonological realizations. Unlike TCT, this theory is symmetric: it is possible for form A to influence the phonology of form B, while at the same time form B influences the phonology of form A.

These two theories of surface resemblance among related words are more complementary than competing. Transderivational Correspondence Theory deals with the classic cases of cyclic or stratal behavior, such as English *condénse*/*còndènsátion* (Chomsky and Halle 1968, Pater 2000): ranked faithfulness constraints on surface forms, formalized under correspondence theory, enforce similarity, but by virtue of Base Priority they effectively enforce it only on the derived form, not the basic form. UNIFORM EXPONENCE (UE) has been applied to paradigm-uniformity phenomena *inter alia*, preventing alternations among forms that are related inflectionally, typically where no morphologically simplex base is identifiable.

Transderivational Correspondence Theory is not applicable to inflectional paradigms because it is an asymmetric, base-prioritizing theory (*pace* Benua 1997*a*: Ch. 6). In TCT, the base is the first step in the recursive evaluation. The derived form, which is the next step in the recursive evaluation, is obtained from the base by applying a morphological operation, such as affixation. Inflectional paradigms have no base in this sense: Latin *amat* 'he loves' is not derived from *amō* 'I love' or vice-versa; rather, both are derived from the lexeme /am-/. This deficiency in TCT might be remedied by invoking morphosyntactic unmarkedness, rather than morphological underivedness, as a way of identifying the base form in an inflectional paradigm (cf. Kenstowicz 1996; Kiparsky 1998: 31–2; Kraska-Szlenk 1995; Kuryłowicz 1949; Selkirk 2001). If this criterion is applied, then Latin *amat* is presumably the base of the /am-/ verbal paradigm. But this method of base identification will not work for the Arabic example discussed here (see s. 8.4.3).

Just as TCT has difficulties with inflectional morphology, so UE runs into problems with derivational morphology. If applied to derivation, UE overpredicts surface-resemblance effects. With UE, it is possible for the derived form to influence the phonology of the base or for a bound morpheme in one word to influence the phonology of that morpheme in another word. Solid synchronic examples of these predictions do not seem to exist.[1] Furthermore, UE represents more of an intuition

[1] For example, Kenstowicz (1996) proposes that the leveling of the prefix *des-* as *deh-* in aspirating dialects of Spanish is a consequence of UE acting on all instances of this bound morpheme. But there is no evidence that this leveling occurs in the synchronic grammar: since *deh-* shows up in all contexts, there is no justification for positing underlying /des-/. Another example: Burzio (1994*a*: 201) proposes that Eng-

than a usable phonological principle. In OT, a constraint is a function from a linguistic expression to zero or more violation-marks. Injunctions like 'minimize the differences' or 'be as metrically consistent as possible' are not well-defined constraints. Moreover, expressions like 'minimize X' and 'as X as possible' incorporate into themselves part of the definition of EVAL, and so they should not appear in constraint definitions (McCarthy 2002: 40). (See van de Weijer 1999 for an improved formalization of UE and Buckley 1999 for related discussion.)

The Optimal Paradigms (OP) model proposed here synthesizes the best elements of TCT and UE. From TCT it draws the idea of using correspondence theory as a foundation. Correspondence theory supplies a range of well-defined, rankable constraints enforcing resemblance between forms. From UE, OP incorporates the idea of evaluating surface resemblance symmetrically across inflectionally related forms. The central premises of the OP model are therefore as illustrated in (2).

(2) OP in Outline

a. Candidates consist of entire inflectional paradigms, where an inflectional paradigm contains all and only the words based on a single lexeme (for similar ideas, see Bonet and Lloret 2001; Kenstowicz 1996: 385; McCarthy 1998; Raffelsiefen 1995, 1999*c*; Tesar and Smolensky 2000).[2]

b. Markedness and Input–Output faithfulness constraints evaluate all members of the candidate paradigm. The violation-marks incurred by each paradigm member are added to those incurred by all the others.[3]

c. The stem (output form of the shared lexeme) in each paradigm member is in a correspondence relation $\mathfrak{R}_{OP}$ with the stem in every other paradigm member. (That is, for every candidate paradigm P there is a relation $\mathfrak{R}_{OP}$ on PHP.) There is no distinctive base—rather, every member of a paradigm is a base of sorts with respect to every other member.[4]

lish words with the suffix *-ic* have penult stress to maintain uniformity with the same words ending in *-ical*: e.g. *académical* affects *acadénic* (cf. Chomsky and Halle 1968: 88). One problem with this analysis is that many words in *-ic* have no related form in *-ical* (*sulfuric*, *Ethiopic*, *Olympic*, *Byronic*) or they have a related form that is found in dictionaries not widely known, such as *academical*, *taxonomic*(*al*), *semantic*(*al*), *prosodic*(*al*), and *genetic*(*al*)). Another problem is that other suffixes, such as *-id* and *-ish*, have exactly the same stress behavior but no variants *-id-al* or *-ish-al*.

[2] Here, I assume that paradigms are 'flat', consisting of a list of all paradigm members. It is conceivable, however, as John Alderete and Diamandis Gafos point out, that paradigms have internal hierarchical structure. For example, Latin noun paradigms might decompose into separate subparadigms for singular and plural: ⟨<*pater*, *patris*, . . .⟩$_{sg.}$, ⟨*patreːs*, *patrum*, . . .⟩$_{pl.}$, (glosses: ⟨⟨father (nom.), father (gen.), . . .⟩, ⟨fathers (nom.), fathers (gen.), . . .⟩⟩). It is a straightforward matter to adapt OP to these structured paradigms: either OP faith is violated once for every (sub)paradigm that hosts an alternation, or there are distinct correspondence relations (and distinct OP faithfulness constraints) within and between subparadigms. This possibility, though certainly intriguing, will not be pursued here because the evidence under discussion does not require it.

[3] The violation profile of a form is a vector representing all its constraint violations in rank order, such as ⟨*, **, Ø, ***⟩ (Samek-Lodovici and Prince 1999). The violation profile of an entire paradigm is the vector sum of the violation profiles of all members of that paradigm: e.g. ⟨*, **, Ø, ***, + +Ø, *, **, Ø, = +*, ***, **, ***⟩.

[4] Limitation of the correspondence relation to the shared lexeme recalls Alderete's (1998) notion of stem-to-stem correspondence, which is required in his accounts of pre-accentuation in Cupeño and accent shift in Japanese. Since $\mathfrak{R}_{OP}$ is a relation on PHP, every member of a paradigm is also in correspondence

d. There is a set of Output–Output faithfulness constraints on the $\mathfrak{R}_{OP}$ correspondence relation.

For example, suppose we have a language with no suffix in the singular and the suffix *-i* in the plural. Suppose this language also has coronal palatalization before *i*. From the lexeme /mat/, Gen will produce such candidate paradigms as ⟨*mat*, *mati*⟩, ⟨*mat*, *matʃi*⟩, and ⟨*matʃ*, *matʃi*⟩. Each candidate paradigm brings with it a correspondence relation $\mathfrak{R}_{OP}$ that relates the stems in each paradigm member: *mat* $\mathfrak{R}_{OP}$ *matʃi* and, symmetrically, *matʃi* $\mathfrak{R}_{OP}$ *mat*. (The portions standing in OP correspondence are underlined.) The candidate ⟨*mat*, *matʃi*⟩ violates the constraint OP-Ident(high) (or whatever feature distinguishes *t* from ʧ).[5]

The OP model presupposes a distinction between inflectional morphology, which is organized into paradigms, and derivational morphology, which is organized hierarchically by the relation 'is derived from'. (See Spencer 1991: Ch. 6 for a review of the issues surrounding this assumption.) Derivational morphology, I assume, is analyzed within TCT, as before. But inflectional paradigms are different from derivational hierarchies; in paradigms, all members are co-equal in their potential to influence the surface phonology of other members of the paradigm. This is formalized by $\mathfrak{R}_{OP}$ correspondence, which gives every paradigm member a chance to affect any other member. Whether it does or does not depends on the ranking.[6]

As we will see in greater detail in ss. 8.4 and 8.5, this model predicts certain interactional patterns that set it apart from other approaches, particularly TCT. One pattern is *overapplication-only*. Given a language with a general process of coronal palatalization, there are two ways to level alternations within the paradigm of /mat/: ⟨*matʃ*, *matʃi*⟩ or ⟨*mat*, *mati*⟩. The first of these paradigms shows overapplication of the palatalization process—there is palatalization of /t/ even in the unsuffixed form, where the conditioning *i* is absent. The second paradigm shows underapplication of palatalization: the process is blocked in the suffixed form *mati* because there is no palatalization in the unsuffixed form *mat*. OP-Ident(high) is satisfied either way, but the paradigm with underapplication cannot be obtained in the OP model. (Some care is required in defining what over- and underapplication mean in the context of a

with itself. This is harmless, since self-correspondence can never lead to faithfulness violations.

[5] Technically, the paradigm ⟨*mat*, *matʃi*⟩ receives two marks from OP-Ident(high), one for the *mat* $\mathfrak{R}_{OP}$ *matʃi* correspondence relation and the other for its symmetric counterpart. The paradigm ⟨*ma*, *matʃi*⟩ incurs one violation of OP-Max for the *ma* $\mathfrak{R}_{OP}$ *matʃi* relation and one violation of OP-Dep for the *matʃi* $\mathfrak{R}_{OP}$ *ma* relation.

[6] Jeroen van de Weijer and the members of the Leiden Phonology Group raise an objection: the phonological effects of derivational and inflectional morphology are sometimes the same. For example, English stress-neutral suffixes can be both derivational (*-ness*) and inflectional (*-ing*). This is exactly as the OP model predicts: under ranking permutation, we expect to find cases where OP faithfulness constraints, which pertain to inflection, and OO faithfulness constraints, which pertain to derivation, are ranked similarly with respect to markedness. The model also predicts, however, that inflection and derivation can act differently: only derivation can show true underapplication effects, and only inflection can show phonological influences from different paradigm members simultaneously (see s. 8.4.3).

constraint-based theory like OT, so this statement should not be applied indiscriminately. See s. 5.2.)

The problem with underapplication is that it competes with overapplication. Overapplication satisfies the high-ranking markedness constraint that is responsible for the basic palatalization process, but underapplication does not. Underapplication does better on IO faithfulness, but that is irrelevant, because the assumed existence of the process in the language as a whole shows that IO-Ident(high) is ranked below the responsible markedness constraint. This means that there is only one way for underapplication to win: some other constraint must block overapplication. For an example of overapplication-only, see s. 8.4.1. For examples where overapplication is blocked and underapplication happens instead, see ss. 8.4.2 and 8.5.2. For a general evaluation of the overapplication-only hypothesis, see s. 8.5.2. And for the reduplicative parallel, upon which this argument is based, see McCarthy and Prince (1995, 1999).

A related prediction of OP is *attraction to the unmarked*. I will call a paradigm member an attractor if other members of its paradigm are forced to resemble it by visibly active OP faithfulness constraints. For example, in the leveled paradigm <*matʃ*, *matʃi*⟩ from /mat/, the form *matʃi* is the attractor, with *matʃ* forced to resemble it by OP-Ident(high). Now suppose we have a situation where there are two different ways to satisfy an OP constraint—two different ways to level a paradigm—depending on which member is acting as the attractor. That is, there are candidates ⟨A1, B1⟩ and ⟨A2, B2⟩ that equally satisfy the high-ranking OP constraint, but differ in which paradigm member is doing the attracting: in the first paradigm, A1 is the attractor, but in the second paradigm, B2 is the attractor. Unless IO faithfulness is decisive, the winning paradigm will be determined by markedness, according to the logic of:

(i) Identify the highest-ranking markedness constraint that favors A1 over A2. Call it M(A1 > A2).
(ii) Identify the highest-ranking markedness constraint that favors B2 over B1. Call it M(B2 > B1).
(iii) If M(A1 > A2) dominates M(B2 > B1), then A1 is the superior attractor and so the paradigm ⟨A1, B1⟩ wins.
(iv) But if M(B2 > B1) dominates M(A1 > A2), then B2 is the superior attractor and so the paradigm ⟨A2, B2⟩ wins.

In other words, the markedness of the attractor is what matters.

Attraction to the unmarked follows directly from the theory: in OP, the markedness violations of a candidate paradigm are the summed markedness violations of its individual members. The markedness violations incurred by ⟨A1, B1⟩ are those incurred by A1 or B1, so if the A1-favoring markedness constraint dominates the B2-favoring one, the paradigm that contains A1 is optimal.

Here are some hypothetical examples to illustrate this prediction; for real-life cases, see s. 8.4.2; Downing (this volume); and Raffelsiefen (1995, 1999*c*, this volume). Overapplication v. underapplication in ⟨*matʃ*, *matʃi*⟩ v. ⟨*mat*, *mati*⟩ is perhaps the simplest example that can be constructed; indeed, overapplication-only is a special case of attraction to the unmarked. In ⟨*matʃ*, *matʃi*⟩, the suffixed form *matʃi* is the attractor, while in ⟨*mat*, *mati*⟩ unsuffixed *mat* is the attractor. Which paradigm wins depends on which markedness constraint is higher ranked: M(*matʃi* > *mati*) or M(*mat* > *matʃ*). Under the assumption that this language has a general process of coronal palatalization, M(*matʃi* > *mati*) is top-ranked, so overapplication wins. A more complex example can be constructed from a language with a *-u* suffix in the singular and *-i* in the plural, with Japanese-style phonology of *t* before these vowels: affrication to *ts* before *u* and palatalization to ʧ before *i*. Then there is competition between two different ways to overapply, ⟨*matsu*, *matsi*⟩ v. ⟨*matʃu*, *matʃi*⟩. By attraction to the unmarked, the choice between them comes down to this question: is M(*matsu* > *matʃu*) ranked higher or lower than M(*matʃi* > *matsi*)? The answer could go either way; in fact, this might be the only situation where these two constraints can be brought into conflict.

The OP model also predicts the possibility of *majority-rules* effects, where the pattern that is most common in a paradigm acts as an attractor for others. Majority-rules effects are not a routine matter in the OP approach; the empirical circumstances and constraint rankings that will produce them are highly specific, as we will see in s. 8.5.1. But when conditions are propitious, we expect to see results like the following. Stems followed by a consonant-initial suffix alternate one way, in accordance with undominated markedness constraints. Stems followed by a vowel-initial suffix alternate another way, also in accordance with those undominated constraints. If markedness does not decide how stems with no suffix will alternate, then they will be attracted to the pattern that is more common in the rest of the paradigm, which depends on whether consonant-initial or vowel-initial suffixes happen to be more frequent. This result follows from minimization of OP faithfulness violations—though some OP faithfulness violation is unavoidable because markedness forces differences between the two suffixed conditions, fewer violations of OP faithfulness are incurred if the unsuffixed forms conform to the more common of the two suffixed patterns.

It is important to realize that attraction to the unmarked, overapplication-only, and majority-rules effects are not special stipulations or auxiliary principles. Rather, they are consequences of the OP model that devolve from its basic architecture. It is also important to realize that OP, as a theory of paradigms, asserts these claims only about inflectional morphology, not derivational. If inflectional morphology turns out to conform to these predictions, then the OP theory receives strong support. If the predictions turn out to be wrong, then the problem is profound and there is no easy way to patch around it because the predictions are so deeply connected to the tenets of the theory. Needless to say, whether they are right or wrong, our theories should always make such strong, falsifiable claims.

Much more detail and full exemplification will be provided in ss. 8.4 and 8.5. But first we need to look at the phenomenon to be analyzed, the template of the Arabic verb.

8.3 Background to and Overview of the Empirical Problem

The goal of the theory of prosodic morphology is 'to explain the character of morphology/phonology dependencies (templatic morphology, shape canons, circumscription, for example) in *independent*, *general* terms, calling on universal and language-particular principles' (McCarthy and Prince 1994*b*: A1). This theory is successful to the extent that it avoids positing its own special rules, constraints, or principles that are invoked to analyze templatic or reduplicative morphology but not applicable elsewhere.

Over the years, there has been gradual progress toward this goal. Work started with the CV-template, which was applied to root-and-pattern morphology (McCarthy 1981) and to reduplication (Marantz 1982). This was later generalized to incorporate syllabic information (Levin 1983) and prosodic structure generally (McCarthy and Prince 1986/1996), leading to the hypotheses in (3).

(3) Premises of the Theory of Prosodic Morphology
  a. The Prosodic Morphology Hypothesis
  Templates, circumscriptional domains, and canonical word-forms are defined in terms of the fundamental units of prosody: moras, syllables, feet, and prosodic words.
  b. Template Satisfaction Condition
  Satisfaction of templates is obligatory and determined by universal and language-particular requirements on the units they refer to.

These hypotheses shift much of the analytic burden from the theory of prosodic morphology itself onto the theory of prosody generally. The goal of independent, general explanation is advanced because analyses are lifted out of the domain of some specific phenomenon, such as reduplication, and embedded into the overall prosodic phonology of the language under investigation as well as the universal principles of prosodic structure.

Work on prosodic morphology within Optimality Theory (McCarthy and Prince 1993*b*) has taken these goals still further. The Template Satisfaction Condition is not a special stipulation, but rather an instantiation of constraint satisfaction generally: constraint interaction, which is the central element of OT, ensures that templates are satisfied within 'the universal and language-particular requirements on the units they refer to'. Templates themselves are also seen as consequences of interaction, with no special independent status. Markedness constraints supplied by Universal Grammar, ranked in ways that allow their effects to emerge in, say, reduplication (McCarthy and Prince 1994*a*), are arguably responsible for all phenomena that had in the past been attributed to templates.

The research program just described is called *Generalized Template Theory* (GTT). In conformity with the overall goals of the theory of prosodic morphology, GTT proposes to eliminate even the vestigial prosodic-morphology-specific principles in (3), relying on emergence of independently motivated markedness constraints and interaction with faithfulness to produce all apparent templatic effects.[7]

Like syntactic Minimalism (Chomsky 1995), which it abstractly resembles, GTT must bear a heavy analytic burden if it is to address the various phenomena previously analyzed with richer theories of templates. The templatic system of the Arabic verb presents obvious challenges.

Word formation in Arabic and other Semitic languages is the premiere example of prosodic morphology: words come in certain fixed shapes that mark various morphological distinctions, such as Classical Arabic *kataba/kattaba* 'he wrote'/'he caused to write' or *kita:bun/kutubun* 'a book (nom.)'/'(some) books (nom.)'. These morphologically governed variations in word-shape have in the past been attributed to CV templates (McCarthy 1981), syllable-and-mora templates (McCarthy and Prince 1986/1996), foot-based templates (McCarthy and Prince 1990*b*), and the combination of a single prosodic template with various affixes (McCarthy 1993; Ussishkin 2000). This earlier work has mostly focused on one important aspect of the problem: how are the different word-shapes specified? That is, how does the grammar encode the fact that causative verbs look like *kattaba* or some plural nouns look like *kutubun*?

Here, I will look at a different aspect of the problem: what are the *shared* properties of Arabic verbal templates? The Classical Arabic verb comes in as many as fifteen different derivational classes (see Appendix A for the full list), traditionally called *conjugations* (by Orientalists), *ʔawza:n* (in Arabic, singular *wazn*), or *binjanim* (in Hebrew, singular *binjan*). The 'template of templates' in McCarthy (1981) generalizes over the templates of all the conjugations, showing that they have a great deal in common (4).

(4) Template of templates for Classical Arabic verb

$$\text{(C)} \left\{ \begin{array}{l} \text{CV} \\ \text{CVC} \\ \text{CV:} \end{array} \right\} \text{CVC}$$

Why are the verb's templates limited to the expansions of this schema? How are the many stipulations inherent in (4) to be reconciled with the minimalist goals of GTT? Can they be said to emerge from independently motivated constraints?

The nominal morphology of Arabic supplies a clue. The template of templates says that verb stems must end in CVC].[8] There are, then, verb stems like faʕal, faʕʕal, and

[7] Works discussing Generalized Template Theory and kindred notions include Alderete et al. (1999); Carlson (1998); C. W. Chung (1999); Downing (1999*b*); Gafos (1998); Hendricks (1999); Ito, Kitagawa, and Mester (1996); McCarthy and Prince (1994*a*, *b*, 1995, 1999); Spaelti (1997); Struijke (1998, 2000*a*, *b*); Urbanczyk (1996, 1999); Ussishkin (1999, 2000); and Walker (2000).

[8] This is properly true only for 'sound' verbs, those without glides or double consonants in the root. See s. 8.4.4.

daħraħ.[9] But noun stems are not so restricted (see Appendix B). Nouns can have stems ending in CVC, CV:C, and CVCC: faʕal, faʕa:l, faʕl, etc. Verb templates differ from noun templates in this respect.

The template of templates also says that verb stems can begin with [CV or [CCV: *faʕal*, *faʕʕal* v. *ftaʕal*, *stafʕal*, etc. But the stems of Arabic nouns (except for obviously deverbal nouns) always begin with a single consonant: *faʕal*, *faʕi:l*, *faʕl*, etc. In this case, it is the nouns, rather than the verbs, that are subject to the more stringent requirement.

The templates of verbs and nouns are different in these two respects. This observation suggests that some independent difference between nouns and verbs plays a role in determining their phonological shapes. Just one independent difference has the potential to do that: verbs and nouns inflect differently. The inflectional system of Arabic nouns is quite limited. There are no inflectional prefixes, and the inflectional suffixes are all vowel initial (5).

(5) Inflectional suffixes of Classical Arabic noun

Singular	-u	'nominative'
	-i	'genitive'
	-a	'accusative'
Dual	-a:	'nom.'
	-aj	'gen./acc.'
Plural	-u:	'nom. masculine'
	-i:	'gen./acc. masc.'

The singular suffixes are followed by *-n* if the noun is indefinite; the dual and plural suffixes are followed by *-ni* and *-na*, respectively, if the noun is not in the construct state. There is in addition a feminine plural suffix *-a:t*, which is followed by the singular desinences in (5). Clitic pronouns that mark possession come after these case- and number-marking suffixes: *baqar-a:t-u-hu* 'cow-pl.-nom.-his = his cows'.

The paradigm of the Classical Arabic verb is much larger, exceeding 150 members if some less common distinctions of mood are included. The verbal paradigm includes inflectional prefixes, all of the form CV-, and inflectional suffixes, both V-initial and C-initial. The list at (6) is limited to those inflectional affixes that attach directly to the verb stem.

(6) Stem-affixing Inflections in the Classical Arabic Verb

a. Perfective

C-initial suffixes

-tu	'1st singular common'
-ta	'2nd sg. masc.'
-ti	'2nd sg. feminine'

[9] Throughout, I will give examples as they appear in standard handbooks, using the citation triliteral root √fʕl 'do' and the citation quadriliteral root √dħrʒ 'roll'.

-tuma:	‘2nd dual com.’
-na:	‘1st plural com.’
-tum	‘2nd pl. masc.’
-tunna	‘2nd pl. fem.’
V-initial suffixes	
-a	‘3rd sg. masc.’
-at	‘3rd sg. fem.’
-a:	‘2nd du. masc.’
-ata:	‘2nd du. fem.’
-u:	‘3rd pl. masc.’

b. Imperfective indicative[10]

CV prefixes	
ʔa-	‘1st sg. com.’
ta-	‘2nd com., 3rd sg. and du. fem.’
ja-	‘3rd masc., 3rd pl. fem.’
na-	‘3rd pl. com.’
C-initial suffix	
-na	‘2nd and 3rd pl. fem.’
V-initial suffixes	
-u	‘1st and 3rd sg. com., 2nd sg. masc., 1st pl. com.’
-i:na	‘2nd sg. fem.’
-a:ni	‘du.’
-u:na	‘2nd and 3rd pl. masc.’

The inflectional affixes of the verb are obviously much more diverse than those of the noun. Nouns have suffixes only, but verbs also have CV prefixes in the imperfective. The shape of noun suffixes is always V-initial, but verbs have both V-initial and C-initial suffixes. From this difference in inflections, it is possible to make sense phonologically of the templatic differences between nouns and verbs. I begin here with an informal sketch of how to analyze one of the two main problems: verb stems must end in CVC], but noun stems are not so restricted. The rest of the analysis will be found in s. 8.4.

Suppose, in conformity with OT's thesis of richness of the base (McCarthy 2002: 68–82; Prince and Smolensky 1993), that the lexicon supplies verb stems that are as diverse as noun stems. This means that alongside the actual verb stem *faʕal* there are also hypothetical verb stems *faʕa:l* and *faʕalk*. We seek to explain why these other verb stems are not merely hypothetical but impossible.

The starting point is to consider some candidate paradigms derived from one of these hypothetical verb stems, *faʕa:l* (7). In candidate (7a), the whole paradigm is faithful to the input verb stem /faʕa:l/, preserving the long vowel throughout the paradigm. This is fatal, however, because medial superheavy syllables like *ʕa:l* are ruled out

[10] The vowel of the imperfective prefix is *u* in the passive voice. It is also *u* in conjugations II, III, and IV and the first quadriliteral conjugation. The suffix *-u* is replaced by *-a* in the subjunctive.

(7) Candidate Paradigm Remarks

	Candidate Paradigm	Remarks
a.	⟨faʕa:la, faʕa:ltu, . . .⟩	The form *faʕa:ltu* is phonotactically bad because of the medial superheavy syllable *ʕa:l*.
b.	⟨faʕa:la, faʕaltu, . . .⟩	This paradigm has closed-syllable shortening. It is phonotactically OK, but vowel length alternates within the paradigm.
c.	⟨faʕala, faʕaltu, . . .⟩	This paradigm has no vowel-length alternations and no phonotactic problems. But it is indistinguishable from the paradigm of *faʕal*.

for markedness reasons.[11] In the terminology of rule-based phonology, closed syllable shortening has underapplied in (7a).

Candidate (7b) is the most interesting one: this candidate preserves the underlying long vowel when it is phonotactically permitted, before V-initial suffixes, but shortens it when the phonotactics demand, before C-initial suffixes. Candidate (7b) is non-optimal, however. The alternation between *a:* and *a* within the paradigm is detected by faithfulness constraints on $\mathfrak{R}_{OP}$, the intraparadigmatic correspondence relation. By the central hypothesis of OP, there are correspondence relations between the stems in every pair of paradigm members: *faʕa:la* $\mathfrak{R}_{OP}$ *faʕaltu*, symmetrically *faʕaltu* $\mathfrak{R}_{OP}$ *faʕa:la*, and so on. The faithfulness constraint OP-Ident-Wt (cf. Urbanczyk 1996) is breached whenever vowel length alternates within a paradigm. If OP-Ident-Wt is ranked above its Input–Output faithfulness counterpart IO-Ident-Wt, then (7b) is ruled out because it tolerates intraparadigmatic alternation that is avoidable by shortening throughout the paradigm, as in (7c).

Candidate (7c) wins. It is completely unfaithful to *faʕa:l*'s underlying long vowel; no trace of that vowel's length can be found anywhere in the paradigm—in rule-based terms, closed syllable shortening overapplies. This paradigm wins precisely because of the ranking just described, which has an OP weight faithfulness constraint ranked above an IO weight faithfulness constraint. And because (7c) wins, an input verb stem like *faʕa:l* is pointless, since it everywhere neutralizes to *faʕal*. This is what Prince and Smolensky (1993) call 'Stampean occultation', in tribute to Stampe (1973*a*, *b*). Though the underlying form *faʕa:l* is in principle possible under richness of the base, learners will never be moved to set it up as an actual lexical item because it is hidden or 'occulted' by the actually occurring form *faʕal*, with which it always neutralizes (for a previous application of Stampean occultation to paradigms, see McCarthy 1998).[12]

This section began with the problem of explaining why Arabic verbal templates must end with CVC], but nominal templates can also end with CV:C] and VCC].

[11] Superheavy syllables can occur in absolute phrase-final position ('in pause'). $[CV{:}C]_\sigma$ syllables can also occur when the coda C is the first half of a geminate: *masa:mmi:* 'porous'. I will disregard these complications here, since they do not bear on the main point.

[12] After an earlier version of this chapter was circulated, Diamandis Gafos provided me with a copy of a manuscript (Gafos 2001) in which a similar argument is presented. This convergence of independent lines of research is perhaps an indication that this analysis is on the right track.

This problem emerges from Generalized Template Theory, which demands explanations in terms of independently motivated constraints, abjuring mere stipulations like (4). The analysis just sketched is a first installment on this explanation. The crucial constraints—the markedness of superheavy syllables and the faithfulness constraint OP-Ident-Wt—are, respectively, an uncontroversial element of markedness theory and a basic entailment of the OP model and correspondence theory. The role of OP in this explanation is clear: it supplies a way of precisely controlling alternations within paradigms using correspondence theory. Subsequent sections fill in the details of this analysis and show how this and other results are obtained from OP.

8.4 Optimal Paradigms Theory and Arabic Templates

The preceding section identified two main problems in the analysis of Arabic templates. Verbal templates always end in CVC], but nominal templates can also end in CV:C] and VCC]. Verbal templates can begin with [CV or [CCV, but nominal templates can only begin with [CV. I sketched a solution to the first problem that relies on the OP model and the observation that verbs have more diverse suffixing inflection than nouns do. The formal details of that solution are supplied in ss. 8.4.1, and 8.4.2 extends the solution to the second problem. In s. 8.4.3, serial approaches to the same phenomena are compared with OP and found lacking. Finally, s. 8.4.4 describes some of the conditions where OP faithfulness constraints are violated in Arabic, resulting in paradigms that are not completely leveled. This is, of course, fully expected in OT: any constraint, including OP faithfulness, is violable.

8.4.1 Suffixing inflection and the right edge of the template

Arabic verbs inflect with suffixes that are both V-initial and C-initial, but Arabic nouns only inflect with V-initial suffixes. With the OP model and some independently motivated syllabic phonology of Arabic, these templatic restrictions on the right stem-edge can be explained.

The story begins with syllable phonotactics. In Classical Arabic, sequences like [$C_1V{:}C_2C_3V$] or [$C_1VC_2C_3C_4V$] are never found (though see n. 11). Under richness of the base, we cannot assume that they are conveniently absent from inputs; rather, their ill-formedness must be derived from constraint interaction. Markedness constraints that rule out the various ways of parsing these sequences must dominate some relevant faithfulness constraint, so that any instances of these sequences that occur in the input are treated unfaithfully in the output: e.g. /$C_1V{:}C_2C_3V$/ [$C_1VC_2C_3V$]. Among these markedness constraints are $*\mu\mu\mu]_\sigma$, which prohibits trimoraic syllables, and

*App-σ which prohibits linking a coda consonant directly to the σ node as an appendix (see Sherer 1994 and references there). There are other ways of faithfully parsing [$C_1V{:}C_2C_3V$] that must also be excluded, such as syllabifying C_2 as a nucleus or having it share a mora with the preceding vowel, or parsing C_2C_3 as a complex onset. Here I will focus on just $*\mu\mu\mu]_\sigma$ and *App-σ with the understanding that constraints against these other configurations are ranked similarly.

As was just noted, $*\mu\mu\mu]_\sigma$ and *App-σ must dominate some relevant faithfulness constraint(s) if they are to succeed in ruling out the forbidden sequences. Alternations that occur in external sandhi tell us what those faithfulness constraints are. Sequences with a long vowel are resolved by closed-syllable shortening (8a), and sequences with a triconsonantal cluster lead to epenthesis (8b).

(8) (The period/full-stop marks syllable boundaries.)

a. Closed-syllable Shortening

/fiː l-naːs-i/	/abuː l-waziːr-i/
fin.naː.si	a.**bul**.wa.ziː.ri
'among the people'	'the vizier's father'

b. Epenthesis

/qaːl-at smaʕ/	/muħammad-un l-nabijju/
qaː.la.**tis**.maʕ	mu.ʔam.ma.du.**nin**.na.bij.ju
'she said "listen!"'	'Mohamed the prophet'

Closed-syllable shortening supplies an argument that the markedness constraints $*\mu\mu\mu]_\sigma$ and *App-σ dominate the Input–Output faithfulness constraint IO-Ident-Wt (9).

(9) $*\mu\mu\mu]_\sigma$ and *App-σ ≫ IO-Ident-Wt

/abuː l-waziːr-i/	$*\mu\mu\mu]_\sigma$	*App-σ	IO-Id-Wt
a. ☞ a.**bul**.wa.ziː.ri			*
b. a.**buːl**$_\mu$.wa.ziː.ri	*!		
c. a.**buːl**$_\sigma$.wa.ziː.ri		*!	

The notation l_μ betokens *l*'s status as a moraic coda to a superheavy syllable, and l_σ indicates an appendix to a heavy syllable. Neither is a possible analysis because the respective markedness constraints against them are top-ranked. Instead, vowel shortening results, violating low-ranked IO-Ident-Wt.

In principle, /$C_1V{:}C_2C_3V$/ sequences could be resolved by epenthesizing a vowel or deleting a consonant instead. That this does not occur shows that other Input–Output faithfulness constraints, IO-Dep-V and IO-Max-C, dominate IO-Ident-Wt (10). IO-Max-C is unviolated in Classical Arabic, but IO-Dep-V is violated with triconsonantal clusters, where vowel shortening is simply not an option (11).

(10) IO-Dep-V, IO-Max-C $\gg$ IO-Ident-Wt

/abu: l-wazi:r-i/	IO-Dep-V	IO-Max-C	IO-Id-Wt
a. ☞ a.bul.wa.zi:.ri			*
b. a.bu:.li.wa.zi:.ri	*!		
b. a.bu:.wa.zi:.ri		*!	

(11) $*\mu\mu\mu]_\sigma$, *App-σ, IO-Max-C $\gg$ IO-Dep-V($\gg$ IO-Ident-Wt)

/qa:l-at smaʕ/	$*\mu\mu\mu]_\sigma$	*App-σ	IO-Max-C	IO-Dep-V
a. ☞ qa:.latis.maʕ				*
b. qa:.lats$_\mu$.maʕ	*!			
c. qa:.lats$_\sigma$.maʕ		*!		
d. qa:.lat.maʕ			*!	

To summarize, superheavy syllables or equivalent configurations are avoided by vowel shortening or, when shortening is not possible, by vowel epenthesis (cf. Yawelmani in Kisseberth 1970). The top-ranked constraints in (11) rule out superheavy structures and consonant deletion; the lower-ranking constraints express the preference for shortening over epenthesis.

The constraint ranking given in (11) is sufficient background for analyzing the phonology of the right edge of the verb stem template. As I will now show, the same markedness constraints that are active in (11), $*\mu\mu\mu]_\sigma$ and *App-σ, also affect the right edge of verb stems. Verbal suffixes are both V-initial and C-initial. When a suffix is C-initial, then $*\mu\mu\mu]_\sigma$ and *App-σ force unfaithful analysis of any putative verb stem ending in CV:C] or CVCC]. The constraints of the OP model transmit that unfaithful analysis throughout the paradigm, even to forms with V-initial suffixes.[13] Nouns, though, are effectively immune from this leveling process because nouns do not have C-initial inflections.

In the verb, the crucial conflict is between the paradigm constraints OP-Dep-V/ OP-Ident-Wt and their IO counterparts. With the OP constraints ranked above the IO constraints, uniformity within the paradigm takes precedence over faithfulness to the input. This can be seen with the candidate paradigms of *faʕa:l*, which appeared previously in (7).

[13] This analysis, then, uses the form of the inflectional morphemes to predict properties of the stem templates. Why should the explanation go this way? That is, why stipulate the form of the inflectional morphemes and then use that to explain the stem templates, instead of stipulating the stem templates and using them to explain the inflectional morphemes? The inflectional morphemes are a closed class and they must be listed in any case, but the stems are an open class. The grammar, then, is responsible for explaining which stem shapes are and are not permitted, but it is not responsible for explaining why the handful of noun inflections are all vowel-initial C; this is just an accident. (Thanks to Linda Lombardi for raising this point.)

(12) OP-Ident-Wt ≫ IO-Ident-Wt

/faʕa:l/ + {a, tu, . . .}	*μμμ]$_{\sigma}$	*App-σ	OP-Id-Wt	IO-Id-Wt
a. ☞ ⟨faʕala, faʕaltu, . . .⟩				**
b. ⟨faʕa:la, faʕa:l$_{\sigma}$tu, . . .⟩		*!		
c. ⟨faʕa:la, faʕa:l$_{\mu}$tu, . . .⟩	*!			
d. ⟨faʕa:la, faʕaltu, . . .⟩			*!	*

The candidates, in order of appearance, include a paradigm (12a) where the input long vowel has been shortened throughout, two paradigms (12b, c) where the input long vowel has been preserved throughout at the cost of greater markedness, and an alternating paradigm (12d), where the input long vowel is preserved before V-initial suffixes and shortened before C-initial suffixes.[14]

In the OP model, a markedness constraint assigns marks to a whole paradigm by summing over the marks assigned to each of its members. Candidates (12b) and (12c) are shown with one mark each from the constraints *App-σ and *μμμ]$_{\sigma}$, respectively. In fact, there are many more such marks, once the whole paradigm is considered. In the perfective and imperfective indicative, there are ten forms with C-initial suffixes, so a paradigm that is faithful to input /faʕa:l/ will have ten violations of *App-σ or *μμμ]$_{\sigma}$. Whether one or 10, these marks are of course fatal.

Candidate (12d) is the important one. In the OP model, every candidate brings with it a correspondence relation among all the stems within the paradigm. In candidate (12d), the relation is *faʕa:la* $\Re_{OP}$ *faʕaltu*, placing long *a:* in correspondence with short *a*.[15] But with OP-Ident-Wt ranked above IO-Ident-Wt, intraparadigmatic length alternations are avoided by shortening the vowel throughout the paradigm, even before V-initial suffixes. Hence, candidate (12a) emerges as the winner. It has no fatal markedness violations and no vowel-length alternations—at the cost of obliterating every trace of the underlying long vowel of /faʕa:l/. Because it shortens the vowel throughout the paradigm, it incurs as many marks from IO-Ident-Wt as there are forms in the paradigm, but that does not matter because IO-Ident-Wt is ranked at the bottom.

The tableau at (13) makes the same point for the matched pair of faithfulness constraints OP-Dep-V and IO-Dep-V. Candidates (13b) and (13c) have the same markedness problems that afflict (12b) and (12c). In candidate (13d), there is vowel epenthesis to relieve the forbidden triconsonantal cluster. But this leads to an intraparadigmatic

[14] Vowel length alternations are observed in the paradigms of verbs like *jaqu:mu*/*jaqumna* 'he arises'/ 'they (f.) arise'. See s. 8.4.4.

[15] When the whole paradigm is considered, long *a:* stands in correspondence with short *a* many, many times. The perfective and imperfective indicative paradigm has ten forms with C-initial suffixes and fourteen forms with V-initial suffixes. There are, then, 280 ordered pairs where *a:* stands in correspondence with *a* (280 = 10 × 14 × 2, because the correspondence relation is fully symmetric).

(13) OP-Dep-V ≫ IO-Dep-V

/faʕl/ + {a, tu, . . .}	*μμμ]$_σ$	*App-σ	OP-Dep-V	IO-Dep-V
a. ☞ ⟨faʕila, faʕiltu, . . .⟩				**
b. ⟨faʕla, faʕlσtu, . . .⟩		*!		
c. ⟨faʕla, faʕlμtu, . . .⟩	*!			
d. ⟨faʕla, faʕiltu, . . .⟩			*!	*

vowel/zero alternation: *fa̲ʕ̲la* $\Re_{OP}$ *fa̲ʕ̲i̲ltu*. This alternation violates OP-Dep-V (or, symmetrically, OP-Max-V). In (13a), epenthesis metastasizes throughout the paradigm, even in forms where it is not required for markedness reasons. This candidate is optimal because OP-Dep-V dominates IO-Dep-V.

We now have all the elements of an explanation for the fact that Arabic verb stem templates never end in CV:C] or VCC]. In OT, an output structure [X] is absolutely ill formed in a language L if the grammar of L maps all inputs to outputs other than [X] (see McCarthy 2002: 68–82, 195–200 and references there). Tableaux (12) and (13) show that the grammar of Classical Arabic maps the inputs /faʕa:l/ and /faʕl/ onto paradigms that do not preserve the stem-final CV:C or CVCC. Before C-initial suffixes, these inputs must be changed by shortening or epenthesis, and this change carries over to paradigm members that have V-initial suffixes because of the high-ranking OP constraints OP-Dep-V and OP-Ident-Wt.

To complete this part of the argument, it is necessary to show that *no* input will map to paradigms that preserve stem-final CV:C or CVCC. The inputs /faʕa:l/ and /faʕl/ are merely the most likely suspects; there are other inputs that could conceivably mapped onto one of the forbidden paradigms. We can quickly reason through these possibilities. Clearly, having more long vowels or more consonants in the input, or combining the two (/fa:ʕl/), presents no danger, since the interactions in (12) and (13) cover these situations too. Inputs without long vowels or clusters, such as /faʕal/ or /faʕ/, are not a problem either, because Classical Arabic has no phonological processes that could create long vowels or consonant clusters. In sum, given the rankings in (12) and (13), literally no input will map to a verbal paradigm with surface stem-final CV:C or CVCC.

Noun stems are different. Because nouns only have V-initial suffixes, the markedness constraints *App-σ and *μμμ]$_σ$ are satisfied without further ado. The noun stems *faʕa:l* and *faʕl* remain unchanged throughout the nominal paradigm: *faʕa:l-u*, *faʕa:l-a*, etc. Because noun stems never have to accommodate to C-initial suffixes, the OP constraints have no real work to do in the noun.

This analysis has shown that the observed restriction on the right edge of the verb-stem template and the absence of this restriction in the noun can be derived from independently motivated constraints of markedness theory and the OP model. No special template of templates like (4) is needed. More generally, there is no need for an apparatus of rules, representations, or constraints that are designed specifically for prosodic morphology. What we have, then, is exactly the kind of explanation required by Generalized Template Theory.

The same kind of reasoning can be applied to another templatic generalization about the right stem-edge: verb and noun stems never end in a vowel.[16] Imagine a vowel-final stem like **faʕa*. Since both verbs and nouns have vowel-initial suffixes, there will always be at least some paradigm members where combining this stem with a suffix threatens to yield hiatus: **faʕa.a*, **faʕa.at*, **faʕa.uː*, **jafʕa.u*. for verbs; **faʕa.u*, **faʕa.i*, **faʕa.a* for nouns. Hiatus is intolerable, however, because ONSET is undominated in Arabic. Hiatus is resolved by epenthesizing ʔ, so an input like /faʕa-at/ will surface as *faʕaʔat*. From there, it is clear how to proceed: the epenthetic ʔ, which is forced before vowel-initial suffixes by ONSET, metastasizes to forms with consonant-initial suffixes because OP-DEP-C dominates IO-DEP-C. The ranking argument has the same basic structures (13), *mutatis mutandis*. Readers can work out the details for themselves.

The analysis of Classical Arabic in this section illustrates one of the OP model's consequences described in s. 8.2, overapplication-only. In the paradigm ⟨*faʕala*, *faʕaltu*, . . .⟩ from input /faʕaːl/, the process of closed-syllable shortening is observed to overapply, since the vowel has been shortened in forms like *faʕala* where the syllable is not closed. In the competing paradigm *⟨*faʕaːla*, *faʕaːltu*, . . .⟩ shortening notionally underapplies: the form **faʕaːltu* has no shortening, thereby preserving resemblance with its faithful fellow paradigm member **faʕaːla*. Tableau (12) reveals why underapplication cannot win. The candidates with underapplication, (12b) and (12c), violate the top-ranked markedness constraints $*\mu\mu\mu]_\sigma$ and *APP-σ. The only constraint that unambiguously favors these candidates, the IO faithfulness constraint IO-IDENT-WT, must be ranked below $*\mu\mu\mu]_\sigma$ and *APP-σ because the language as a whole has an active process of closed-syllable shortening. (If IO-IDENT-WT were ranked above $*\mu\mu\mu]_\sigma$ and *APP-σ, then there would simply be no closed-syllable shortening anywhere, and this is not what is meant by the term 'underapplication'.) The only way to redeem (12b, *c*) would be for some additional constraint, ranked above the markedness constraints, to tip the balance in favor of underapplication (see s. 8.4.2 for an example). In short, although both underapplication and overapplication satisfy OP faithfulness constraints, underapplication cannot win because it loses to overapplication (cf. McCarthy and Prince 1995, 1999).

The account of why there are no vowel-final stems also exemplifies overapplication-only. The competing level paradigms are *⟨*faʕa.a*, *faʕatu*, . . .⟩, with underapplication of ʔ epenthesis, and ⟨*faʕaʔa*, *faʕaʔtu*, . . .⟩, with overapplication. Because the paradigm with underapplication has as many ONSET violations as there are vowel-initial suffixes, and ONSET is an undominated constraint, underapplication is a sure loser. The only way to level a paradigm in OP is by overapplication (unless it is blocked—see ss. 8.2 and 8.4.2).

[16] This statement does not hold for words whose final root consonant is a high glide. See s. 8.4.4.

Overapplication-only distinguishes the OP model from TCT (see s. 8.2). Because TCT has a principle of Base Priority, there can be underapplication of a process in a derived form in order to maintain similarity with the base. English examples like *còndènsátion* are typical; the process of sonorant de-stressing underapplies in the syllable *den* in order to maintain similarity with the main-stressed syllable of the base *condénse*.Underapplication does seem to be an authentic characteristic of derivational morphology, where the base can be identified morphologically.[17] But the OP model, which is limited to inflectional morphology, treats all members of a paradigm equally; there is no special base form, so there is no base priority, and hence true underapplication is impossible. The empirical question of whether true underapplication ever actually occurs in inflectional morphology is revisited in s. 8.5.2. The circumstances where underapplication is possible are discussed in the next section.

8.4.2 prefixing inflection and the left edge of the template

At the left edge of the verb stem, the permitted structures are richer than in the noun. Verb stem templates can begin with [CV or [CCV sequences, but noun stems (except for nominalized verbs) can only begin with [CV. As I will show, this difference follows from the fact that verbs have CV- inflectional prefixes, but nouns do not. The idea is that the presence of a CV- prefix in the imperfective verb forces an underlying /CCV. . ./ stem to surface faithfully, and this cluster carries over to the prefixless perfective through the agency of OP correspondence.

The analysis starts with the restriction on nouns—a restriction that verbs violate. The non-existence of [CCV nouns entails that any input of this shape receives an unfaithful analysis. Since we know from (8b) that there is vowel epenthesis in Arabic, a hypothetical noun stem like /fʕa:l/ must be mapped onto the paradigm ⟨*fiʕa:lu*, *fiʕa:la*, . . .⟩. To ensure this result, some markedness constraint violated by faithful *⟨*fʕa:lu*, *fʕa:la*, . . .⟩ must be ranked above IO-Dep-V.

This markedness constraint comes from the Align family. We also know from (8) that Arabic has syllabification across word boundaries. Though nouns never have prefixes, a putative [CCV noun like **fʕa:lu* would show up in all phrasal contexts with the *f* parsed as a coda:

(14) Syllabification of impossible [CCV noun **fʕa:lu*
- *a*. After pause
  - ʔif.ʕa:.lu
- *b*. After C-final word
  - . . .Cif.ʕa:lu

[17] Similarly, the UE model of Kenstowicz (1996) allows a particular member of the paradigm to have priority. This is invoked in Kenstowicz's analysis of over- and underapplication of a vowel-raising process in Polish diminutive paradigms. The problem with this example is that the raising process itself is exceedingly irregular and unproductive (Buckley 2000; Gussmann 1980: Ch. 4; Sanders 2002), so it does not supply convincing evidence for base priority within inflectional paradigms.

c. After V-final word
. . .Vf.ʕa:lu

In short, the stem-initial *f* of **fʕa:lu* is never syllable-initial because of the way that syllabification and epenthesis work in Arabic. The markedness constraint responsible for the ill-formedness of *⟨*fʕa:lu*, *fʕa:la*, . . .⟩ is therefore Align-L(Stem, σ), which requires that stem-initial segments also be syllable-initial.[18] Input /fʕa:l/ cannot map faithfully to *⟨*fʕa:lu*, *fʕa:la*, . . .⟩ because stem-initial *f* is never syllable-initial in any context. The tableau in (15) certifies this ranking argument.

(15) Align-L(Stem, σ) ≫ IO-Dep-V

	Align-L(Stem, σ)	IO-Dep-V
a. ☞ ⟨.*f*iʕa:lu, .*f*iʕa:la, . . .⟩		**
b. ⟨*f*.ʕa:lu, *f*.ʕa:la, . . .⟩	**!	

To aid in determining alignment violations, the stem-initial consonant is italicized and nearby syllable boundaries are indicated by a period/full-stop. As tableau (15) shows, epenthesis is forced by left stem-edge alignment, which is also known to block prothesis or resyllabification in other languages (McCarthy and Prince 1993*a*, 1993*b*).

By virtue of this ranking, the paradigm resulting from the input /fʕa:l/ is indistinguishable from the paradigm derived faithfully from the input /fiʕa:l/. By the logic of Stampean occultation, there are no [CCV noun templates in Arabic because the grammar always maps them onto surface forms with [CV templates, so there is no reason for learners to set up underlying /CCV. . ./ nouns.

But verbs do have [CCV templates. In a verbal paradigm like ⟨*s.tafʕala*, *jas.tafʕilu*, . . .⟩ (conjugation X in the traditional Western nomenclature), some greater imperative overrides Align-L(Stem, σ). To identify that imperative, we need to look at the competition (16).

(i) In *⟨*.sitafʕala*, *ja.sitafʕilu*, . . .⟩, underlying /stafʕal/ undergoes epenthesis everywhere, thereby satisfying Align-L(Stem, σ) perfectly. The problem, which will be explained shortly, is that prefixed **ja.sitafʕilu* has marked prosodic structure that the winner *jas.tafʕilu* does not.
(ii) In *⟨*.sitafʕala*, *jas.tafʕilu*, . . .⟩, underlying /stafʕal/ undergoes epenthesis only when unprefixed, just like the noun in (15). So the unprefixed members of the verbal paradigm (the perfectives) satisfy Align-L(Stem, σ)—not perfectly, but better than the winner ⟨*s.tafʕala*, *jas.tafʕilu*, . . .⟩. Furthermore, with no epenthesis in the prefixed form, there is no problem with marked prosodic structure. None the less, *⟨*.sitafʕala*, *jas.tafʕilu*, . . .⟩ fails because it exhibits intraparadigmatic vowel/zero alternations, a breach of OP faithfulness.

[18] The responsible alignment constraint may actually be the more general Align-L(Stem, PrWd), as argued in McCarthy and Prince (1993*a*, 1994*b*). This matter, though relevant to foundational issues in Generalized Template Theory, is tangential to the point here.

I will now fill in the details of this analysis, beginning with the candidate in (ii).

The failed candidate in (ii) shows that vowel/zero alternations within the paradigm are avoided at the cost of poor alignment. This is a straightforward generalization of the results in s. 8.4.1, where the OP faithfulness constraints prohibiting vowel/zero alternations were also important. In the required ranking, OP-Dep-V (or OP-Max-V) is ranked above Align-L(Stem, σ), as (16) shows.

(16) OP-Dep-V ≫ Align-L(Stem, σ)

{ja, . . .} + /stafʕal/ + {a, u, . . .}	OP-Dep-V	Align-L(Stem, σ)
a. ☞ ⟨s.taf.ʕa.la, jas.tafʕilu, . . .⟩		**
b. ⟨.sitafʕala, jas.tafʕilu, . . .⟩	*!	*

The paradigm in (16b) includes corresponding pairs like *<u>sitafʕal</u>a* $\Re_{OP}$ *ja<u>stafʕil</u>u*, which violate OP-Dep-V. The winning candidate avoids this violation by leveling, even though it means that Align-L(Stem, σ) is violated throughout the paradigm. Compare this tableau with (13), which likewise shows the paradigm-leveling effect of OP-Dep-V.

The failed candidate in (i), *⟨*si.tafʕala*, *ja.si.tafʕilu*, . . .⟩, has a level paradigm with no OP faithfulness violations. Furthermore, it satisfies Align-L(Stem, σ) perfectly. Nonetheless, it loses for prosodic reasons involving the interaction of stress and syllable weight—reasons that turn out to be irrelevant in nouns because they lack prefixes. To see this, we first require some background about Arabic prosody specifically and prosodic theory generally.[19]

There is no direct testimony about Classical Arabic stress from the native grammatical tradition. Still, some inferences can be drawn from internal evidence like versification and from consistencies among the stress patterns of the modern Arabic dialects. Classical Arabic stress was without doubt quantity-sensitive, treating heavy (CVC and CV:) syllables differently than light (CV) syllables. It surely also had extrametricality of final syllables. All modern dialects have bounded stress systems (that is, binary feet); Bedouin dialects are often iambic, and sedentary dialects are always trochaic. Most of the trochaic dialects have right-to-left foot assignment, but Egyptian goes the other way. The iambic dialects all have left-to-right footing, as expected since right-to-left iambic stress is probably universally impossible (Hayes 1995*b*: 262 ff.; Kager 1993; McCarthy and Prince 1993*b*). The analysis I present below is worked out under the assumption that Classical Arabic stress is right-to-left trochaic with final syllable extrametricality, but the results are the same if stress is left-to-right iambic or trochaic. (I do not present the details of the responsible stress constraints since they can be easily gleaned from any of the standard texts, such as Kager (1999*b*).)

On the theoretical side, Gouskova (2003) argues that the constraint called SWP

[19] I am grateful to Jonathan Bobaljik, Yoonjung Kang, and the editors of this volume for their questions about a previous analysis, which prompted some significant revisions.

(for Stress to Weight Principle (cf. Prince 1990)) is responsible for compelling syncope processes in many languages. Stress to Weight Principle assigns a violation-mark to any stressed light syllable. *Inter alia*, it favors feet consisting of a single stressed heavy syllable—('H) feet—over feet consisting of two light syllables, one of which is stressed—('LL) or (L'L) feet. When it is ranked above Max-V, SWP can force one of the vowels to delete in a sequence of light syllables: /fiʕal-aw/ (*'fiʕ*)*law* in Iraqi Arabic.

In Classical Arabic, however, the ranking of Max-V and SWP is just the opposite: there is no general syncope process, as shown by the tableau at (17).[20]

(17) IO-Max-V ≫ SWP

	IO-Max-V	SWP
a. ☞ 〈(**fáʕa**)lu, (**fáʕa**)la, . . .〉		**
b. 〈(fáʕ)lu, (fáʕ)la, . . .〉	**!	

In (17a), the feet consist of two light syllables, so SWP is violated. The candidate paradigm (17b) corrects these violations, but at the expense of deleting input vowels. With this ranking and with constraints against vowel or consonant lengthening equally high ranked, SWP cannot compel unfaithfulness to the input.

Though it cannot force syncope in Classical Arabic, SWP blocks satisfaction of Align-L(Stem, σ) by epenthesis when it would create additional (LL) feet. This effect can be seen by comparing the winning paradigm <*s.tafʕala*, *jas.tafʕilu*, . . .> and its better-aligned competitor *<*.sitafʕala*, *ja.sitafʕilu*, . . .>. Prefixed (*jàs*)(*táf*)*ʕilu* has only (H) feet, while *(*jàsi*)(*táf*)*ʕilu* has one (LL) foot, thereby violating SWP. From this, we can conclude that SWP dominates Align-L(Stem, σ) (18).

(18) SWP ≫ Align-L(Stem, σ)

{ja, ta, . . .} + /stafʕal/ + {a, tu, u, na, . . .}	SWP	PrincipleAlign-L
a. .☞ 〈*s*.(táf)ʕala, *s*.(tàf)(ʕál)tu, (jà*s*).(táf)ʕilu, (jà*s*).(tàf)(ʕíl)na, . . .〉		****
b. 〈.*s*i(táf)ʕala, .*s*i(tàf)(ʕál)tu, (**jà.*s*i**)(táf)ʕilu, (**jà.*s*i**)(tàf)(ʕíl)na, . . .〉	**	

Because suffixes can affect foot parsing, I have included representative paradigm members with both V-initial and C-initial suffixes. Tableau (18) shows that, despite being ranked below IO-Max-V, SWP is active in Classical Arabic, blocking epenthesis in

[20] The first conjugation of the Arabic verb has a vowel/zero alternation *faʕala/jafʕalu* that has sometimes been taken as evidence for an active syncope process (Brame 1970; McCarthy 1981). If this is indeed a syncope process, then it is completely isolated, since there are no other such alternations in the classical tongue. It seems more plausible to regard the alternation as allomorphic. Allomorphy is most often observed in high-frequency, underived forms, such as the English strong verbs. The Arabic first conjugation is similar: it is the most common conjugation and it is the one that is unmarked morphologically.

prefixed [CCV verb stems even at the expense of inferior alignment. One might think of this as a kind of anti-syncope: though it has no syncope process, the language is blocked from creating configurations of the type that are known to undergo syncope in other languages. This is an expected result of OT's inherently typological nature and constraint violability. Like SWP in Arabic, a constraint can be active even when crucially dominated.[21]

This proposed ranking for SWP must be checked against three conditions. First, it must account for all extant [CCV verb stems in Arabic. Second, it must not permit [CCV noun stems, and this should be related to the absence of CV- prefixes in the noun. Third, it must not interfere with the results about the right stem-edge in s. 8.4.1, since constraint interactions must be consistent within the language. I address each of these tests of the analysis in turn.

The existing Arabic [CCV verb templates include conjugation VII /nfaʕal/, conjugation VIII /ftaʕal/, conjugation IX /fʕalal/, conjugation X /stafʕal/, the rare conjugations XI–XV, and the rare third quadriliteral conjugation (see Appendix A). The rare conjugations all have the same prosodic structure as /stafʕal/: an initial consonant followed by a heavy syllable. In all relevant respects, they will behave exactly like the candidates in (18) and need not detain us further.

Conjugations VII, VIII, and IX also have the same prosodic structure as one another, so an analysis that is valid for one can be readily extended to the others. With, say, VIII /ftaʕal/ as the input, the candidates of current interest are the winner ⟨*f.*(*táʕa*)*la*, (*jàf*).(*táʕi*)*lu*, . . .⟩ and the perfectly aligned loser *⟨.*fi*(*táʕa*)*la*, (*jà.fi*)(*táʕi*)*lu*, . . .⟩. Winner and loser both violate SWP, but the loser does worse (19).

(19)

{ja, ta, . . .} + /ftaʕal/ + {a, tu, u, na, . . .}	SWP	Align-L
a. ☞ ⟨*f*.(táʕa)la, *f*.ta(ʕál)tu, (jà*f*).(táʕi)lu, (jà*f*).ta(ʕíl)na, . . .⟩	**	****
b. ⟨.*f*i(táʕa)la, .(*f*ìta)(ʕál)tu, (jà.*f*i)(táʕi)lu, ja.(*f*ìta)(ʕíl)na, . . .⟩	*****!	

Perfect satisfaction of SWP could be achieved by syncope, but as I have already shown in (17), IO-Max-V's high rank excludes that possibility. Though perfection is not possible, SWP is still doing its job, blocking epenthesis in the prefixed forms *(*jà.fi*)(*táʕi*)*lu* and *ja.*(*fita*)(*ʕíl*)*na*.

The second test of the analysis is whether SWP interferes with epenthesis in noun stems. If SWP were to block epenthesis in nouns, then it would undermine the results of the ranking argument in (15). It turns out that SWP is not decisive in nouns because the relevant candidates tie in their performance, leaving the choice up to Align-

[21] The argument in (18) does not depend on knowing whether Classical Arabic had trochaic or iambic feet. The foot (*jàsi*) violates SWP either way. This is a welcome result, since the evidence is inconsistent about whether Classical Arabic feet were iambic or trochaic.

L(Stem, σ), exactly as in (15). As we will now see, the reason why they tie is that nouns lack prefixes and so SWP never comes into play.

Consider the putative cluster-initial noun stem /fʕal/. Since observed noun templates never begin with clusters, this input must be mapped unfaithfully onto the winning paradigm ⟨*.fiʕalu*, *.fiʕala*, . . .⟩, much the same as (15). The interesting competitor is *⟨*f.ʕalu*, *f.ʕala*, . . .⟩—interesting because it is faithful but impossible for a noun. The winner better satisfies Align-L(Stem, σ), but since SWP dominates Align-L(Stem, σ), it is important to check that SWP does not favor the loser. And in fact it doesn't, as the tableau at (20) shows.[22]

(20)

/fʕal/ + {u, a, i}	SWP	Align-L(Stem, σ)
a. ☞ ⟨.(*f*íʕa)lu, .(*fí*ʕa)la, . . .⟩	**	
b. ⟨*f*.(ʕálu), *f*.(ʕála), . . .⟩	**	**

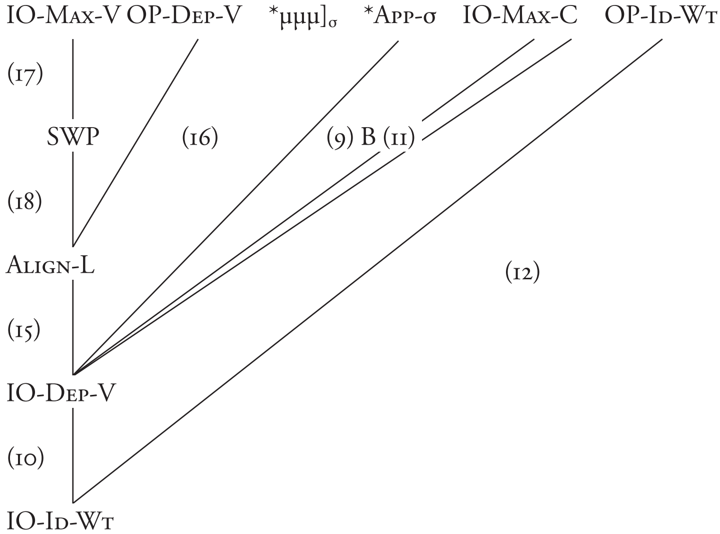
Both candidates have (LL) feet throughout, so both violate SWP equally. This leaves the decision up to Align-L(Stem, σ), which favors the candidate without an initial cluster, exactly as in (15). The same argument can be made for other hypothetical cluster-initial noun templates like /fʕa:l/, /dħaraħ/ and /dħarħ/.

Because verbs have CV- prefixes, epenthesis into the stem-initial cluster that immediately follows a prefix creates an immediate danger of violating SWP, as examples like *(*ja.fi*)(*taʕi*)*lu* show. But nouns lack inflectional prefixes and, as (20) indicates, this means that nouns are not big enough for SWP to be decisive. It is possible, however, to imagine a noun template that is big enough to allow SWP to block epenthesis. For example, the invented stem /fʕalakt/ yields the candidate noun paradigms ⟨*f.ʕa*(*lák*)*tu*, *f.ʕa*(*lák*)*ta*, . . .⟩ and ⟨.(*fiʕa*)(*lák*)*tu*, .(*fiʕa*)(*lák*)*ta*, . . .⟩. Stress to Weight Principle favors the former even though it has an initial cluster. But noun stem templates like /fʕalakt/ are ruled out for an entirely different reason. Arabic templatic nouns, like the verbs, are built on roots of two, three, or at most four consonants. Three-consonant roots can be extended by derivational affixes and still be templatic (e.g. *mifta:ħ* 'key', from /ftħ/ 'open'), but four-consonant roots with the same affixes are non-templatic by independent criteria (see Appendix B). Nouns like hypothesized /fʕalakt/ with five consonants or more are non-templatic, lying outside the basic root-and-pattern morphological system of the language. They are therefore irrelevant to the analytic goals of this chapter.

Earlier, I noted that there are three tests of the analysis presented in this section. Two have already been addressed; the third is a test for consistency: do the constraint interactions of this section fit with those of s. 8.4.1? The first step is to assemble all the ranking results into a single diagram, with the highest-ranked constraints at the top (21).

[22] A possible variation on candidate (20b) is *⟨*f*.(*ʕa*)*lu*, *f*.(*ʕa*)*la*, . . .⟩, depending on how Non-Finality is ranked with respect to Ft-Bin. Either way, SWP is violated.

(21)



The lines indicate proven constraint domination; the numbers are those of the examples where the ranking argument is presented.

The diagram (21) is useful first as a check for incompatible ranking results; there are none. The diagram also suggests where to look for further ranking arguments. For example, the undominated markedness constraints $*\mu\mu\mu]_\sigma$ and *APP-σ might be brought into conflict with some of the higher-ranked constraints in the main chain along the left, and the same might be done with the OP faithfulness constraints.

The result of these lucubrations is an argument that $*\mu\mu\mu]_\sigma$, *APP-σ, OP-DEP-V, and OP-IDENT-WT all dominate SWP. The argument is based on the candidates in (12) and (13), where vowel shortening or vowel epenthesis occur at the right stem-edge before C-initial suffixes and thence are transmitted to the rest of the paradigm. Because shortening and epenthesis create light syllables, they can potentially introduce violations of SWP. Those violations are tolerated because SWP is dominated by the responsible constraints. The tableaux (22)–(25) clarify the details of these arguments. In the winner (22a), the paradigm members with V-initial suffixes all violate SWP. This viola-

(22) $*\mu\mu\mu]_\sigma$, *APP-σ, OP-DEP-V ≫ SWP (cf. (13))

/faʕl/ + {a, tu, . . .}	$*\mu\mu\mu]_\sigma$	*APP-σ	OP-DEP-V	SWP
a. ☞ ⟨(fáʕi)la, fa(ʕíl)tu, . . .⟩				*
b. ⟨(fáʕ)la, (fáʕl_σ)tu, . . .⟩		*!		
c. ⟨(fáʕ)la, (fáʕl_μ)tu, . . .⟩	*!			
d. ⟨(fáʕ)la, fa(ʕíl)tu, . . .⟩			*!	

tion is compelled by the joint action of the two markedness constraints and OP-Dep-V, which forces epenthesis before a V-initial suffix to match the phonotactically driven epenthesis before a C-initial suffix.

(23) $*\mu\mu\mu]_\sigma$, *App-σ, OP-Ident-Wt ≫ SWP (cf. (12))

/faʕa:l/ + {a, tu, . . .}	$*\mu\mu\mu]_\sigma$	*App-σ	OP-Id-Wt	SWP
a. ☞ ⟨(fáʕa)la, fa(ʕál)tu, . . .⟩				*
b. ⟨fa(ʕá:)la, fa(ʕá:l_σ)tu, . . .⟩		*!		
c. ⟨fa(ʕá:)la, fa(ʕá:l_μ)tu, . . .⟩	*!			
d. ⟨fa(ʕá:)la, fa(ʕál)tu, . . .⟩			*!	

Again, the winner (23a) violates SWP, but this is unavoidable because of the high-ranking markedness and OP faithfulness constraints.

Now that all the elements of the analysis are in hand, we are in position to bring them together and see how it works, with our eyes on the goal of reconciling the facts of Arabic with the tenets of Generalized Template Theory. A [CCV noun stem like /fʕal/ undergoes epenthesis to improve alignment, and epenthesis is not blocked by SWP (24).

(24)

/fʕal/ + {u, a, i}	SWP	Align-L(Stem, σ)	IO-Dep-V
a. ☞ ⟨.(*f*íʕa)lu, .(*f*íʕa)la, . . .⟩	**		**
b. ⟨*f*.(ʕálu), *f*.(ʕála), . . .⟩	**	**	

A [CCV verb stem like /ftaʕal/ is misaligned, however, because SWP disfavors epenthesis in the prefixed form, and this lack of epenthesis is carried over to the rest of the paradigm by OP faithfulness (25).

(25)

{ja, ta, . . .} + /ftaʕal/ + {a, tu, u, na, . . .}	OP-Dep-V	SWP	Align-L (Stem, σ)
a. ☞ ⟨*f*.(táʕa)la, (jà*f*).(táʕi)lu, . . .⟩		**	**
b. ⟨.*f*i(táʕa)la, (jà.*f*i)(táʕi)lu, . . .⟩		***!	
c. ⟨.*f*i(táʕa)la, (jà*f*).(táʕi)lu, . . .⟩	*!	**	*

But in nouns, which lack prefixes, SWP is not decisive, so the well-aligned candidate wins. That is why nouns do not have [CCV templates. Like the right stem-edge, the observed templatic conditions on the left stem-edge follow from a combination of markedness requirements (SWP, alignment) and OP faithfulness.

Here is a less formal summary. Verbs and nouns differ in the shape of inflectional suffixes and the availability of inflectional prefixes. This difference has consequences for their form. At the right edge of the stem, verbs are less diverse than nouns because only verbs must deal with both -V and -CV suffixes. At the left side of the stem, verbs are more diverse than nouns because only verbs take prefixes. These differences in inflectional morphology, combined with independently motivated markedness and OP faithfulness constraints, explain the templatic differences between nouns and verbs. There is no need for a template per se nor for special templatic constraints or similar mechanisms. Deriving templatic effects from independently motivated constraints, as in this analysis, is in accordance with the reductionist goals of Generalized Template Theory.

In s. 8.2, I described several consequences that can be deduced from the OP model. One of them is attraction to the unmarked, referring to the special role that markedness constraints have in determining which members of the paradigm will influence others via OP faithfulness. The analysis presented in this section illustrates attraction to the unmarked.

As shown in (25), there are two ways to satisfy OP faithfulness, the winner ⟨*f.*(*táʕa*)*la*, (*jàf*).(*táʕi*)*lu*, . . .⟩, which has no epenthesis anywhere in the paradigm, and the loser *⟨*.fi*(*táʕa*)*la*, (*jà.fi*)(*tàʕi*)*lu*, . . .⟩, which has epenthesis in every member of the paradigm. In the winner, the prefixed form *jaftaʕilu* is acting as the attractor, forcing its stem-initial cluster on the unprefixed form *ftaʕala* in spite of Align-L(Stem, σ). In the loser, it is unprefixed **fitaʕala* that is acting as the attractor, with its epenthetic vowel spreading throughout the paradigm. In situations like this, where the OP constraint is satisfied either way and where the relevant IO faithfulness constraints are ranked too low to make a difference, the winning paradigm is the one whose attractor is least marked relative to the attractors in competing paradigms.

Refer again to tableau (25). Candidate (25c) has an intraparadigmatic vowel/zero alternation that is fatal, given OP-Dep-V's high rank. Candidates (25a) and (25b) differ in which form is doing the attracting, as I've already noted. Since (25a) and (25b) satisfy the OP constraint equally well and since IO faithfulness is ranked too low to matter, the choice between them is made by the highest-ranking markedness constraint on which they differ. That is, the markedness of the attractor is what distinguishes between (25a) and (25b). The tableau in (26) limits the comparison to just these candidates and the two markedness constraints, with shared violation-marks cancelled (McCarthy 2002: 6, Prince and Smolensky 1993).

(26)

		SWP	Align-L(Stem, σ)
a. ☞	⟨*f*.(táʕa)la, (jà*f*).(táʕi)lu, . . .⟩		**
b.	⟨.*f*i(táʕa)la, (jà.*f*i)(táʕi)lu, . . .⟩	*!	

These two candidates differ exactly in the markedness of the attractor. In (26b), the attractor is *(*jàfi*)(*táʕi*)*lu*, and it contributes an uncanceled violation of SWP. In (26a), the attractor *f*(*táʕa*)*la* contributes uncanceled violations of Align-L(Stem, σ). Paradigm (26b) is non-optimal for this reason: its attractor has a higher-ranking uncanceled markedness violation than the optimal candidate's attractor. This is attraction to the unmarked: the attractor is optimized relative to the highest-ranking markedness constraint.

The analysis in this section also illustrates another consequence of the OP model, overapplication-only (cf. s. 8.4.1), though in a somewhat backhanded way. To a cursory inspection, the ⟨*ftaʕala*, *jaftaʕilu*, . . .⟩ paradigm looks like underapplication of epenthesis, with the losing paradigm *⟨*fitaʕala*, *jafitaʕilu*, . . .⟩ being an example of overapplication of epenthesis. In one sense, this interpretation is correct: underapplication can only win when overapplication is blocked by a high-ranking constraint, and here SWP is blocking overapplication. In another sense, though, even this case of underapplication is really overapplication. It is overapplication of the blocking constraint itself. (Speaking very loosely, a markedness constraint overapplies if its effects are transmitted through the paradigm via OP faithfulness constraints.) SWP blocks epenthesis in the prefixed form and, via OP correspondence, it indirectly blocks epenthesis in the unprefixed form. True underapplication is predicted never to occur for the reasons given in s. 8.2 and 8.4.1.

8.4.3 Comparison with other models

This is a good opportunity to compare OP with standard derivational approaches to resemblance among related words. These approaches include not only the cycles of Chomsky and Halle (1968) but also the strata of the theory of Lexical Phonology (Borowsky 1986; Hargus 1985; Hargus and Kaisse 1993; Kiparsky 1982*a*, *b*, Mohanan 1986; Rubach 1993; Strauss 1982) and Stratal OT, which organizes several OT grammars into a series of strata.[23] Since these various theories are more similar to each other than to OP, I will lump them together and refer to them as LP.

LP analyzes all phonological resemblances between related forms with a serial derivation. To return to an example in s. 8.1, the word *lightening* has a syllabic *n* because, earlier in the derivation, it was *lighten*. Base Priority is an automatic and unavoidable consequence of this theory; the base has priority because, in the temporal metaphor of derivational phonology, it existed prior to the derived form.

The results and predictions of OP are not duplicated in LP. For LP, the base of some form X is identified morphologically: it is just X minus the results of the last morphological operation, usually affixation. Though this may be appropriate for derivational morphology, there is no general, non-arbitrary way to identify a base in this sense in an inflectional paradigm—inflected forms are derived separately from the shared lexeme, not from each other. So the LP model is a poor fit to the morphological structure of paradigms (see s. 8.2).

[23] Versions of stratal or cyclic OT can be found in the following works, among others: Bermúdez-Otero (1999); Black (1993); Cohn and McCarthy (1994/1998); Hale and Kissock (1998); Hale, Kissock, and Reiss (1998); Ito and Mester (2002); Kenstowicz (1995); Kiparsky (1998); McCarthy (2000*b*); McCarthy and Prince (1993*b*); Potter (1994); Rubach (2000); and many of the contributions to Hermans and van Oostendorp (1999) and Roca (1997).

Because LP is committed to identifying the base by its derivational priority, it cannot explain or even describe attraction to the unmarked. In the previous section, I showed how the OP model identifies the attractor in a paradigm by its phonology, using the markedness constraints as ranked in the language as a whole. I also argued that this is the right way to understand Arabic. But in LP, the attractor is just the derivational predecessor—attractors, then, can only be identified on morphological grounds, so attraction to a phonologically unmarked form is inexplicable, unless the derivational predecessor also just happens to be unmarked.

A further point about OP—and a corollary to attraction to the unmarked—is that different paradigm members may act as attractors with respect to different phonological properties. In Classical Arabic, the phonology of the right stem-edge is determined by those paradigm members that have C-initial suffixes; the phonology of the left stem-edge is determined by those paradigm members that have CV- prefixes. Tableau (27) shows how these different attraction effects are negotiated within a single, consistent constraint ranking.

(27)

{ja, ta, . . .} + /stafʕa:l/ + {a, tu, u, na, . . .}	OP-Dep-V	OP-Id-Wt	SWP	Align-L	IO-Dep-V	IO-Id-Wt
a. ☞ ⟨*s*.(táf)ʕala, *s*.(tàf)(ʕál)tu,						
(jà*s*).(táf)ʕilu, (jà*s*).(tàf)(ʕíl)na, . . .⟩				4		4
b. ⟨.*s*i(táf)ʕala, .*s*i(tàf)(ʕál)tu,						
(jà.*s*i)(táf)ʕilu, (jà.*s*i)(tàf)(ʕíl)na, . . .⟩			2!		4	4
c. ⟨*s*.(tàf)(ʕá:)la, *s*.(tàf)(ʕál)tu,						
(jà*s*).(tàf)(ʕí:)lu, (jà*s*).(tàf)(ʕíl)na, . . .⟩		4!		4		2
d. ⟨.*s*i(táf)ʕala, .*s*i(tàf)(ʕál)tu,						
(jà*s*).(táf)ʕilu, (jà*s*).(tàf)(ʕíl)na, . . .⟩	4!			2	2	4
e. ⟨.*s*i(tàf)(ʕá:)la, .*s*i(tàf)(ʕál)tu,						
(jà*s*).(tàf)(ʕí:)lu, (jà*s*).(tàf)(ʕíl)na, . . .⟩	4!	4!		2	2	2

To keep the tableau reasonably sized, the actual count of violation-marks is reported, and the only candidates considered are those that obey the undominated markedness and IO faithfulness constraints (e.g. $*\mu\mu\mu]_\sigma$ and IO-Max-V). The winner, (27a) (=(18a)), has a level paradigm at the expense of poor alignment and unfaithfulness to the input's long vowel. Its first competitor, (27b) (=(18b)), improves alignment by epenthesizing a vowel after the stem-initial consonant. Though epenthesis is in general possible because of IO-Dep-V's low rank, it is not permitted here because it introduces violations of SWP. The remaining candidates, (27*c*–*e*), present various ways of achieving better alignment, satisfaction of SWP, and greater faithfulness to the input's long vowel. None survives, however, because all incur violations of one or both OP faithfulness constraints.

The winning candidate (27a) illustrates the main point of this discussion: different paradigm members can act as attractors with respect to different phonological properties. The prefixed imperfectives are acting as attractors with respect to the phonology of the left edge, blocking epenthesis in the perfective via OP-Dep-V. The forms with C-initial suffixes, both perfective and imperfective, are acting as attractors with respect to the phonology of the right edge, forcing vowel shortening via OP-Ident-Wt. There is no identifiable base to charge with the responsibility of accounting for both these attraction effects.

The diehard supporter of LP would be forced to scour the paradigm looking for a suitable base form that has both a CV- prefix and a C-initial suffix and then derive all other forms from that. It is possible to find such a form—the 2nd and 3rd feminine plural *tastafʕilna* and *jastafʕilna*—but LP can offer no principled explanation as to why this form is chosen as the base. It certainly seems far-fetched to claim, as the LP supporter must, that feminine plural verbs are morphologically less marked than any other members of the paradigm.

This is not to say that description of the Arabic facts is beyond the power of LP. For example, Bobaljik (2002) proposes to analyze the right-edge stem restriction with cyclic closed-syllable shortening: /faʕa:l/ shortens to *faʕal* on the first cycle, and then the final syllable is opened up by the addition of a V-initial suffix on the second cycle, yielding *faʕala*. This analysis requires the stipulation that verb stems but not noun stems are cyclic domains, since there is no shortening in *faʕa:l-u*. Mere description is possible, then, but true explanation remains elusive: the difference between nouns and verbs is what we seek to explain, not to stipulate. In the OP account, this difference is derived from the lexical fact of what the affixes are, which any analysis must specify. The array of results and predictions obtained from the OP model show what kinds of explanations it is capable of.

8.4.4 Domination of OP Faithfulness

The fundamental thesis of OT is that constraints are violable. Violation is never gratuitous, but a constraint must be violated if all compliant candidates have been ruled out by higher-ranking constraints. Any proposed revision to the OT constraint set, then, must be examined through the lens of violability.

The OP faithfulness constraints in (21) are unviolated in examples seen thus far. Through ranking permutation, there are languages where these same constraints are crucially dominated and not visibly active. For example, the modern Arabic dialects permit intraparadigmatic vowel/zero alternations, which violate OP-Dep-V. More importantly, ranking permutation also predicts a middle ground, where OP faithfulness constraints are visibly active in some circumstances but not others. In fact, this is the situation in Classical Arabic.

The analysis of Arabic thus far has focused on what are traditionally called *sound verbs* ('sound' in the sense of healthy). As we have seen, sound verbs resist various intraparadigmatic alternations. The so-called *weak verbs* have complex alternations, however, including some that sound verbs avoid. The weak verbs are identifiable on phonological grounds and fall into two classes: *geminate verbs*, whose last two root consonants are identical (e.g. /smm/ 'poison'); and verbs with a high glide *w* or *j* as one of their underlying root consonants (e.g. /wld/ 'bear a child', /qwm/ 'rise', /rmj/ 'throw'). The analysis of these verbs, especially those with a glide, presents many difficult questions (see Rosenthall 2002 for recent discussion). Here, I will focus on just one alternation that involves the geminate verbs.

As we have seen, OP-Dep-V is an active, high-ranking constraint in the grammar of Classical Arabic, but it is not necessarily nor in fact unviolated. The paradigms of geminate verbs exhibit vowel/zero alternations, indicating that OP-Dep-V is dominated (as is OP-Max-V). (For another case where a paradigm-leveling constraint is crucially dominated, see Raffelsiefen (1999*c*: 153–5).) In geminate verbs, the identical consonants are fused into an actual geminate unless a C-initial suffix follows.

(28) Vowel/Zero Alternations in the Verb

a. Biliteral roots (McCarthy 1981)

/samam/

samamtu	'I poisoned'
samma	'he poisoned'

/ja-smum/

jasmumna	'they (f.) will poison'
jasummu	'he will poison'

b. Ninth and eleventh conjugations

/ħmarar/

ħmarartu	'I reddened'
jaħmarirna	'they (f.) will redden'
ħmarra	'he reddened'
jaħmarru	'he will redden'

Stems of the form . . . $VC_iV_jC_i$ show deletion of V_j before vowel-initial suffixes, while stems of the form . . . $CC_iV_jC_i$ metathesize V_j with the preceding consonant in the same context.

The markedness constraint responsible for this alternation is something of a vexed question (see Gafos 2001 and Rose 2000 for proposals). The configuration being ruled out is $.C_iV.C_iV$, with identical consonants in the onsets of successive syllables. Presumably, this is connected with dissimilatory processes in other languages, but the details of this connection are obscure. Having nothing more to offer at this time, I will simply invoke the ad hoc constraint $*.C_iV.C_iV$.

The constraint $*.C_iV.C_iV$ must dominate the Input–Output faithfulness constraint IO-Max-V to allow for unfaithful mappings like /ħmarar-a/ → ħ*marra*. It must also dominate the intraparadigmatic faithfulness constraint OP-Max-V for the same reason. Tableau (29) supplies the details of these ranking arguments.

(29) $*.C_iV.C_iV \gg$ IO-Max-V, OP-Max-V

{ja, ta, . . .} + /ħmarar/ + {a, tu, u, na, . . .}	$*.C_iV.C_iV$	IO-Max-V	OP-Max-V
a. ☞ ⟨ʔmarra, ħmarartu, jaħmarru, jaħmarirna, . . .⟩		**	****
b. ⟨ʔmarara, ħmarartu, jaħmariru, jaħmarirna, . . .⟩	**!		

In the losing candidate (29b), the underlying stem shape remains intact throughout the paradigm, so both IO and OP faithfulness constraints are obeyed. But the price is fatal violation of the markedness constraint $*.C_iV.C_iV$ in all paradigm members with V-initial suffixes. The winner (29a) avoids the marked structure by deleting a vowel despite the resulting imperfect uniformity of the paradigm. A parallel argument can be made for metathetic forms like /jasmum-u/ → *jasummu*.

In the parlance of rule-based phonology, the alternation in (29) would be called 'normal' application—there is neither underapplication nor overapplication of vowel deletion between identical onset consonants (cf. s. 8.2). Underapplication is out because it violates top-ranked $*.C_iV.C_iV$. Paradigm uniformity could in principle be achieved by overapplication, however, yielding paradigms like *⟨*ʔmarra*, *ħmarrtu*, *jaħmarru*, *jaħmarrna*, . . .⟩ with the vowel deleted between the identical consonants before both V-initial and C-initial suffixes. Overapplication is, however, ruled out by markedness considerations: tautosyllabic geminates violate the constraints introduced in s. 8.4.1, $*\mu\mu\mu]_\sigma$ and *App-σ.

This example shows that perfect paradigmatic uniformity is not always achieved, even in languages where the OP faithfulness constraints are visibly active. Whether, where, and when there is paradigm uniformity is a matter of constraint interaction, as always in OT.

8.5 FURTHER CONSEQUENCES

The OP model makes typological predictions that happen not to be exemplified in the analysis of Classical Arabic. This section discusses two of them, both of which were introduced in s. 8.2: the potential for majority-rules effects and the claim that underapplication effects in inflectional morphology always involve blocked overapplication.

8.5.1 The majority rules

In OT, violations of a markedness constraint are summed over all instances of a marked structure in a form. For example, if a word contains five syllables, three of which lack onsets, then it will receive three violation-marks from the constraint ONSET. In OP, constraint violations are also summed over all the forms in a paradigm. For example, if a paradigm has three members, one with a single onsetless syllable and another with two onsetless syllables, then it receives three violation-marks from ONSET.

This calculus of violation means that it should be possible to see majority-rules effects. In a majority-rules effect, the pattern that is most common in a paradigm acts as an attractor to other paradigm members. Under certain rather special ranking conditions, majority-rules effects are predicted to occur by the OP model. Here I argue that this aspect of OP can solve a long-standing problem in the phonology of Moroccan Arabic (Benhallam 1990; Boudlal 2001; Harrell 1962).

The distribution of ə in Moroccan Arabic is almost fully predictable. Two undominated markedness constraints establish the milieu: ə is banned from open syllables (*$ə]_σ$) and clusters of three consonants are prohibited (*CCC).[24] When a word contains three consonants and no other vowels, there are in principle two ways to satisfy these constraints: CəCCand CCəC. In these words, the choice between CəCCand CCəC is automatic, but the conditions are different for nouns and verbs.

In nouns, with few exceptions, the choice between CəCCand CCəC is determined by sonority conditions:

(30) Moroccan Arabic CCC nouns
a. $C_1əC_2C_3$ if $C_2 > C_3$ in sonority or C_2C_3 is a geminate
kəlb 'dog'
bərd 'wind'
dənb 'sin'
ʃəmʃ 'sun'
ləʕb 'game'
mʷəxx 'brain'
b. $C_1C_2əC_3$ if $C_2 \# C_3$ in sonority
rʒəl 'leg'
ktəf 'shoulder'
ħbəl 'rope'

[24] Though I use the constraint *$ə]_σ$ for simplicity, the limitation of ə to open syllables should perhaps be derived from constraint interaction, as Diamandis Gafos points out. If *COMPLEX-ONSET dominates NO-CODA, then e.g. *kətbu* is more harmonic than **ktəbu*. See Gafos (2002) for more about the phonetics and phonology of ə in Moroccan Arabic.

bɣəl	'mule'
wtəd	'peg'
kfən	'shroud'

To avoid a digression, I will defer detailed analysis and call the constraint(s) responsible for this pattern SonCon.[25]

In verbs, however, only the pattern CCəC is possible, regardless of sonority: *ktəb* 'he wrote', *ʃrəb* 'he drank', *kbər* 'he grew', *rʒəʕ* 'he returned', *ʕləb* 'he played', *rbətˤ* 'he tied'. This can lead to noun/verb minimal pairs when C_2 is more sonorous than C_3: *ʃərb* 'drinking; love of alcoholic drink' v. *ʃrəb* 'he drank'. So SonCon is crucially dominated by some constraint that only affects verbs. This difference between nouns and verbs is a classic puzzle in the study of this language.

The explanation for this difference comes from differences in noun and verb inflection. The modern Arabic dialects, including Moroccan, lost the case-marking inflection of the classical language. Clitic pronouns are suffixed to the noun, but clitics are outside the inflectional paradigm. Nouns like those in (30) do not form plurals by suffixation. In short, there are no inflectional suffixes on the nouns of interest, so their paradigms contain only a single member, the noun stem itself. In that situation, the OP faithfulness constraints are vacuously satisfied, so they can have no effect on the outcome. The constraints subsumed by SonCon are the sole determinants of the distribution of ə in nouns.

The Moroccan verbal paradigm, though, retains some of the richness seen in Classical Arabic. In (31), the full paradigm of the perfective verb is shown, organized according to the position of ə in the stem.

(31)	CCəC		CəCC	
	ʃrəb	3 m. sg. pf.		
	ʃrəb-t	1 c. sg. pf.	ʃərb -u	3 c. pl. pf.
	ʃrəb-na	1 c. pl. pf.	ʃərb-ət	3 f. sg. pf.
	ʃrəb-ti	2 c. sg. pf.		
	ʃrəb-tu	2 c. pl. pf.		

Except for unaffixed *ʃrəb*, the undominated markedness constraints $*ə]_\sigma$ and *CCC fully determine the distribution of schwa in verb stems throughout the paradigm. The CəCC stem occurs before V-initial suffixes, where CCəC cannot appear because ə is banned from open syllables: **ʃrəbu*. Before a C-initial suffix, CCəC is required and CəCC is impossible, since triconsonantal clusters are prohibited: **ʃərbna*.

Given this basically phonological distribution, why does the unaffixed 3rd masculine singular perfective verb consistently have CCəC shape, instead of accommodat-

[25] Maria Gouskova suggests the following analysis of the nominal pattern. Assume that the consonant immediately following ə is a mora-bearing coda. Cross-linguistic evidence shows that there is a constraint favoring mora-bearers of higher sonority (Zec 1995), and this constraint will prefer $C_1əC_2C_3$ just in case C2 is more sonorous than C3. Then $C_1C_2əC_3$ is favored in the equal-sonority condition if *Complex-Coda dominates *Complex-Onset.

ing to sonority conditions as otherwise identical nouns do? The answer is that verbs, unlike nouns, have non-trivial paradigms, so OP faithfulness is potentially active, and the relevant OP constraint is ranked above the sonority constraints that are determinative in nouns. The tableau in (32) presents the overall framework of the analysis.[26]

(32)

/ʃərb/ + {t, na, ti, tu, u, ət}	*ə]$_\sigma$	*CCC	OP-Max-V	Son Con	IO-Max-V	IO-Dep-V
a. ☞ ⟨**ʃrəb**, **ʃrəb**t, **ʃrəb**na, **ʃrəb**ti, **ʃrəb**tu, ʃərbu, ʃərbət⟩			20 *'s	*	5 *'s	5*'s
b. ⟨**ʃərb**, ʃrəbt, ʃrəbna, ʃrəbti, ʃrəbtu, **ʃərb**u, **ʃərb**ət⟩			24 *'s!		4 *'s	4 *'s
c. ⟨**ʃrəb**, **ʃrəb**t, **ʃrəb**na, **ʃrəb**ti, **ʃrəb**tu, **ʃrəb**u, **ʃrəb**ət⟩	**!			*	7 *'s	7 *'s
d. ⟨**ʃərb**, **ʃərb**t, **ʃərb**na, **ʃərb**ti, **ʃərb**tu, **ʃərb**u, **ʃərb**ət⟩		****!				

The input is here taken to be /ʃərb/, but /ʃrəb/, /ʃərəb/, or even /ʃrb/ would do just as well, because the IO faithfulness constraints are ranked at the bottom. Candidates (32c, d) have leveled the paradigm to avoid all ə/zero alternations. Neither is satisfactory, because both contain forms like **ʃrəbu* and **ʃərbti* that violate undominated markedness constraints against ə in open syllables and triconsonantal clusters.

The phonotactically viable candidates, then, are (32*a*, *b*), which differ only in whether the 3rd person masculine singular verb is *ʃrəb* or **ʃərb*. OP-Max-V, the next constraint in the ranking, favors *ʃrəb* because the CCəC stem pattern is better represented in the rest of the paradigm. The calculus of violations proceeds like this. In (32*a*), there are five forms with the stem *ʃrəb-* and two forms with the stem *ʃərb-*. This makes for a total of twenty (5 × 2 × 2) ordered pairs like (*ʃrəb*, *ʃərbu*) and (*ʃərbu*, *ʃrəb*) where there is an intraparadigmatic vowel/zero alternation and hence a violation of OP-Max-V. In (32b), on the other hand, there are four forms with the stem *ʃrəb-* and three forms with the stem *ʃərb-*. This makes for a total of twenty-four (4 × 3 × 2) ordered pairs with a vowel/zero alternation. Since OP constraints disfavor alternation within

[26] For simplicity, I present the analysis here using only the perfective verb. The full paradigm includes the imperfective as well, as I have argued for Classical Arabic. The result still goes through when the imperfective is considered, though some additional analysis is required to account for prefixed forms like *nəʃrəb* 'I drink'.

the paradigm as a whole, they can detect even this modest advantage that comes from assigning unaffixed *ʃrəb* to the more populous class of stem shapes.[27] (See Kenstowicz (this volume) for an alternative analysis of this problem.)

We know that SonCon favors *ʃərb* over *ʃrəb* because *ʃərb* is the noun derived from this root, and sonority is decisive for stem-shape in nouns. Because OP-Max-V is successful in favoring *ʃrəb* as the verb form, it must dominate SonCon. Nouns, however, have paradigms with only a single member, so OP-Max-V is vacuously satisfied. This leaves the choice of noun stems up to the low-ranking SonCon, which emerges to favor a sonority-based distribution of ə in nouns. To paraphrase Thoreau, nouns constitute a majority of one.

This result about majority-rules effects, though it has some intuitive appeal, is rather surprising, since it might seem to imply a vote-counting approach to phonology. As usual in OT, however, it is not counting but comparison that is crucial: the paradigm in (32a) is better than the one in (32b) according to OP-Max-V; the absolute number of violations is not given any interpretation by the theory.

Majority-rules effects seem to be unusual, and this may be because they are permitted by the OP model only when three special conditions are met simultaneously:

(i) The competing attractors must not differ in markedness. The competing paradigms in (32a, b) differ in which stem-form is acting as the attractor, CCəC or CəCC. As I have argued (ss. 8.2, 8.4.2), the OP model entails attraction to the unmarked: the winning attractor better satisfies the markedness constraints, as ranked in the language in question, than its competitors. A majority-rules effect is possible, then, only when the markedness constraints ranked above OP faithfulness do not favor one attractor or the other. That is the case in (32a, b), since these two paradigms equally satisfy the top-ranked markedness constraints $*ə]_\sigma$ and *CCC.

(ii) Total leveling of the paradigm must be ruled out by constraints ranked above OP faithfulness. If there are viable candidates with no intraparadigmatic alternations, then OP faithfulness is fully satisfied and the majority becomes unanimity. In Moroccan Arabic, the candidates with level paradigms (32c, d) violate undominated markedness constraints so they are non-viable.

(iii) Because a majority-rules effect involves performance on a single OP constraint, it follows that the competing attractors must have the same kind of alternation, so their competition on that specific constraint is decisive. Moroccan Arabic meets this condition because the competing attractors CCəC and CəCC involve the same alternation of ə with zero. A majority-rules effect is not predicted when the competing attractors exhibit different alternations, such as CCəC and CC, the latter with consonant deletion.

[27] Bobaljik (2002) notes a related prediction: words with defective paradigms can reverse the usual majority and thereby exhibit a different phonological pattern. Since majority-rules effects are rare for reasons given in the text, and defective paradigms are also quite unusual (and usually principled (Hetzron 1975), which can affect this prediction), crucial examples will not be easy to find.

Classical Arabic, as analyzed in s. 8.4, does not exhibit majority-rules effects. That is because it does not meet either of the first two conditions. The first condition for majority-rules says that the competing attractors must not differ in markedness. But in Classical Arabic, as shown in (25), the high-ranking markedness constraint SWP favors one attractor over the other. Attraction to the unmarked invariably trumps majority-rules because of the way OT works: satisfaction of a higher-ranking constraint always takes precedence over minimizing violation of a lower-ranking constraint. The second condition for majority-rules says that the competing paradigms must not be level, but in Classical Arabic the competition is between paradigms that have been leveled in the relevant dimension. Therefore, majority-rules effects are neither expected nor observed in Classical Arabic.

8.5.2 Underapplication in inflectional paradigms

In ss. 8.2 and 8.4, I showed that the OP model produces overapplication effects, limiting underapplication to situations where overapplication is blocked by some high-ranking constraint. This is a strong claim, though to grasp it fully it is necessary to be clear about what over- and underapplication mean in the context of a constraint-based theory like OT.

The over- and underapplication terminology is inherited from rule-based phonology, specifically from Wilbur's (1974) work on reduplication/phonology interactions. A rule is said to overapply if its structural description is met in only one reduplicative copy but it applies in both: a process of coronal palatalization overapplies in hypothetical /RED-pat-i/→*patʃ-patʃi*. A rule is said to underapply if its structural description is met in only one copy but it applies in neither: if a language has an otherwise general process of coronal palatalization, /RED-pat-i/→*pat-pati* is a case of underapplication.

This terminology was transposed to the study of reduplication in OT by McCarthy and Prince (1995, 1999) and further to the study of Output–Output faithfulness by Benua (1995, 1997*a*). OT's nearest analogue to a process is a hierarchy where some markedness constraint M is crucially ranked above an antagonistic faithfulness constraint F.[28] M can then force an unfaithful, F-violating mapping. A process, in this sense, overapplies if the same mapping occurs in another member of the reduplicative or Output–Output pair where there is no danger of violating M: in *patʃ-patʃi*, the markedness constraint against *ti* accounts for the second ʧ, and this effect carries over to the first ʧ, even though it is not followed by *i*. A process underapplies if M is violated in one member of the pair because it is vacuously satisfied in the other: in *pat-pati*, the markedness constraint against *ti* is breached because the first *t* is not followed by *i*.

The theory of reduplication in McCarthy and Prince's work and the OP model presented here have a common characteristic: true underapplication is predicted not to occur. The reason is that underapplication always competes with overapplication,

[28] This is a necessary but not a sufficient condition for a process. See McCarthy (2002: 67–8) for the full story.

since both achieve perfect identity between the reduplicative copies or the paradigm members. And overapplication normally wins this competition because it satisfies the markedness constraint responsible for the process but underapplication does not. For instance, *patʃ-patʃi* and *pat-pati* perform equally on base-reduplicant identity constraints, but the first is more harmonic because it also satisfies the markedness constraint against *ti*. OP has the same basic logic as base-reduplicant identity, so it similarly predicts that underapplication is only possible in inflectional paradigms when overapplication is ruled out by some high-ranking constraint.[29] See ss. 8.4.1 and 8.4.2 for exemplification.

Underapplication certainly occurs in derivational morphology, where it is predicted by TCT and other theories that have a notion like the base. But OP is a theory of the phonology of inflection, not derivation, which leads to a typological question: does true underapplication ever occur in inflectional paradigms, contrary to this prediction of OP? A possible case comes from Tiberian Hebrew. Benua (1997*a*: Ch. 4) argues that vowel epenthesis in Hebrew, though it applies normally in nouns, underapplies in verbs in situations where it threatens paradigm uniformity. Here, I will sketch an analysis that is consistent with the principles of OP: epenthesis underapplies in verbs because overapplication is blocked by a higher-ranking constraint.[30]

In general, Tiberian Hebrew prohibits word-final consonant clusters, resolving them by vowel epenthesis: /malk/ → *mɛlɛk̲* 'king'; /dammaɕq/ → *damˈmɛɕɛq* 'Damascus'.[31] (For details, see Coetzee 1999*a*, b; Garr 1989; Malone 1993; McCarthy 1979; Prince 1975; or Gesenius 1910.) Verbs, however, can end in a cluster under certain conditions. Certain verbs—those with roots ending in *w* or *j*—have vowel-final stems on the surface: *jib̲ˈkɛ* 'he will cry'. In the inflectional categories known as the jussive and *waːw*-consecutive,[32] the final vowel of the imperfective is truncated, leaving a word-final cluster in its wake: ˈ*jeːb̲k* 'let him cry'. (For further details, see Benua 1997*a*; Prince 1975; Speiser 1926; or the handbooks.)

This looks like underapplication. An otherwise general process of epenthesis is blocked in words like ˈ*jeːb̲k* in order to maintain similarity with its paradigmatic comrade *jib̲ˈkɛe*. The candidate where epenthesis has applied normally, *ˈ*jib̲EPSk̲*, is ruled out because it has a vowel between *b* and *k* that has no correspondent elsewhere in the paradigm.

[29] Allophonic processes can pose a trap for the unwary by creating the illusion of underapplication (McCarthy and Prince 1995: 355–9, 1999: 285–9). For example, Tokyo Japanese has an alternation between *g* initially and *ŋ* medially: *gai-koku* 'foreign country' v. *koku-ŋai* 'abroad'. In reduplicated mimetics, there is *g* initially and medially: *gara-gara* 'rattle'. At first glance, this looks like underapplication of a process changing medial *g* to *ŋ*. A better alternative, though, is to see *g* nasalization as a general process that is blocked by a constraint against initial *ŋ*. In effect, it is the constraint against initial *ŋ* that is overapplying. See McCarthy and Prince (1995) and Ito and Mester (1997).

[30] Benua (1997*a*: Ch. 4) also discusses a case in Tiberian Hebrew where processes underapply in the affix of the 2nd feminine singular perfective verb allegedly to maintain similarity with the affix of the 3rd feminine singular perfective verb. This analysis is incompatible with OP and, as far as I can tell, with TCT as well. Polish has also been claimed to exhibit paradigmatic underapplication (Kenstowicz 1996). See n. 17.

[31] In Hebrew examples, underlining indicates post-vocalic spirantization.

[32] The meaning of the jussive is hortatory. The *waːw*-consecutive is a narrative tense, always preceded by the conjunction 'and', which is spelled with the letter *waːw*.

The basic principles of OP entail that underapplication is possible only when overapplication is ruled out by some higher-ranking constraint. In other words, if OP is right, there must be some constraint that rules out the paradigm *⟨*jib̲əˈk̲ɛ*, *ˈjib̲ɛk̲*, . . .⟩ in favor of ⟨*jib̲ˈkɛ*, *ˈjeːb̲k*, . . .⟩.[33] And in fact there is: *jib̲əˈk̲ɛ* is out because it has ə in a VC__CV context, which is generally impossible in Tiberian Hebrew. In other words, the constraint against schwa in this context crucially dominates the markedness constraint against final clusters. The tableau at (33) is intended only to show the logic of the argument, using ad hoc markedness constraints.

(33)

	*VCəCV	OP-Max-V	*CC#
a. ☞ ⟨jib̲ˈkɛ, ˈjeːb̲k, . . .⟩		*	*
b. ⟨jib̲əˈk̲ɛ, ˈjib̲ɛk̲, . . .⟩	*!	*	
c. ⟨jib̲ˈkɛ, ˈjib̲ɛk̲, . . .⟩		**!	

All three candidates violate OP-Max-V at least once because the jussive is related to the imperfective indicative by truncation (cf. Horwood 1999). But (33c) incurs an additional violation of this constraint because it has a vowel/zero alternation in the *b*__*k* context. Paradigm (33b) shows overapplication of epenthesis, but this is ruled out because it requires ə in an impermissible context. That leaves the candidate with underapplication, (33a), as the winner despite its final cluster.[34]

There is no evidence of true underapplication here. Rather, this is a case of underapplication as an alternative to blocked overapplication, much like the Arabic example of s. 8.4.2. Other cases of inflectional underapplication may very well exist. The remarks here certainly do not address them all, but rather they suggest the overall approach that can be taken within the strictures of OP.

8.6 Conclusion

In this chapter, I have introduced the Optimal Paradigms model of the interaction of phonology with inflectional morphology. Candidates in OP consist of entire inflectional paradigms. Within each candidate paradigm, there is a correspondence relation from every paradigm member to every other paradigm member. Faithfulness constraints on this intraparadigmatic correspondence relation resist alternation within the paradigm.

This model was illustrated and supported with a type of evidence that has not figured in previous discussions, the templatic structure of the Classical Arabic verb. A goal was to show that certain restrictions on Arabic templates could be derived from

[33] The vowel ɛ is the regular realization of ə in a closed syllable (Coetzee 1999*b*, Garr 1989; Prince 1975). That is why these vowels are paired in ⟨*jib̲əˈk̲ɛ*, *ˈjib̲ɛk̲*, . . .⟩.

[34] When the final cluster would contain a sonority reversal or a coda guttural, then candidates like (33c) win anyway: *ˈjɛg̲ɛl*, **ˈjeːg̲l* 'let him uncover'; *ˈjaʕaɛ*, **ˈjaʕɛ* 'let him make'. This shows that OP-Max-V is crucially dominated by other markedness constraints (cf. s. 8.4.4).

independently motivated constraints, as required by Generalized Template Theory.

Some of the questions for future research are suggested by the preliminary results reported in s. 8.5. OP predicts the possibility of majority-rules effects and it denies the possibility of true underapplication within paradigms. It will be interesting to see whether these predictions are fully borne out.

Appendix A: The Classical Arabic conjugations

Conjugation	Perfective (3 sg. m. active)	Imperfective (3 sg. m. indic. active)
1	faʕala	jafʕalu
2, 5	faʕʕala, tafaʕʕala	jufaʕʕilu, jatafaʕʕalu
3, 6	fa:ʕala, tafa:ʕala	jufa:ʕilu, jatafa:ʕalu
4	ʔafʕala	jufʕilu (*from* /juʔafʕilu/)
7	nfaʕala	janfaʕilu
8	ftaʕala	jaftaʕilu
9	fʕalla (*from* /fʕalala/—cf. fʕalaltu (1 c. sg.))	jafʕallu (*from* /jafʕalilu/—cf. jafʕalilna (3 pl. f.))
10	stafʕala	jastafʕilu
11 (rare)	fʕa:lla (*from* /fʕa:lala/—cf. fʕa:laltu (1 c. sg.))	jafʕa:llu (*from* /jafʕa:lilu/—cf. jafʕa:lilna (3 pl. f.))
12 (rare)	fʕawʕala	jafʕawʕilu
13 (rare)	fʕawwala	jafʕawwilu
14 (rare)	fʕanlala	jafʕanlilu
15 (rare)	fʕanla:	jafʕanli:
Quadriliteral 1, 2	daħraħa, tadaħraħa	judaħriħu, jatadaħraħu
Quadriliteral 3 (rare)	dħanraħa	jadħanriħu
Quadriliteral 4 (rare)	dħarañʔa (*from* /dħarħaħa/—cf. dħarħaħtu (1 c. sg.))	jadħariħʔu (*from* /jadħarħiħu/—cf. jadħarħiħna (3 pl. f.))

(*Sources*: McCarthy 1981; Wright 1971)

Appendix B: The Classical Arabic noun templates

Triliteral: faʔl-u, faʔal-u, fa:ʔal-u, faʔa:l-u, fa:ʔa:l-u
Quadriliteral: daħraħ-u, daħra:ħ-u

Note: The vowel *a* is just a stand-in for any of the three vowels *a*, *i*, and *u*. So /faʔl/, /fiʔl/, and /fuʔl/ are all licit noun stems. Arabic also has non-templatic nouns. Templatic nouns are by far the majority and include not only native words but also many loans. Non-templatic nouns are rare and are nearly all loans. There is an independent criterion for determining whether a noun is templatic: with few exceptions, all and only templatic nouns form their plural by internal change ('broken' plurals—McCarthy and Prince 1990*a*).

(*Sources*: McCarthy and Prince 1990*a*, *b*; Wright 1971)