2011

Pausal Phonology and Morpheme Realization

John J McCarthy

Pausal Phonology and Morpheme Realization[1]

John J. McCarthy
University of Massachusetts Amherst

1. Introduction

Among her many influential contributions to phonological theory, Lisa Selkirk initiated the study of prosodic domains (Selkirk 1980), and she developed influential ideas about the phonology-morphology interface (e.g., Selkirk 1984:chapter 3). This chapter addresses both of these topics in the context of an analysis of the pausal forms of Classical Arabic.

Words in Classical Arabic,[2] a few modern Arabic dialects (Fischer and Jastrow 1980:111, Fleisch 1968:29), and Biblical Hebrew (Goerwitz 1993, McCarthy 1979, Prince 1975) undergo various morphophonemic alternations when they occur in utterance-final position. Traditionally, the utterance-final context is referred to as *pause*, and the words that appear there are described as *pausal forms* or *in pause*. These terms will be adopted here.

Among the observed alternations between non-pausal contextual forms (marked with subscripted *Cont*) and pausal forms (marked with *Pau*) are the following:

(1) Some Classical Arabic pausal alternations[3]

a. No change		
jaqtul-uː$_{\text{Cont}}$	jaqtul-uː$_{\text{Pau}}$	‘kill (3$^{\text{rd}}$ m. pl. subjn.)’
b. Absence of suffix vowel		
ʔalkitaːb-u$_{\text{Cont}}$	ʔalkitaːb$_{\text{Pau}}$	‘the book (nom.)’
c. Epenthesis of [h] after stem vowel		
ʔiqtadi$_{\text{Cont}}$	ʔiqtadih$_{\text{Pau}}$	‘imitate (m. sg. imptv.)’
d. Metathesis of suffix vowel		
ʔalbakr-u$_{\text{Cont}}$	ʔalbakur$_{\text{Pau}}$	‘the young camel (nom.)’
e. Absence of suffixal [n]		
kitaːb-u-n$_{\text{Cont}}$	kitaːb$_{\text{Pau}}$	‘a book (nom.)’
kitaːb-a-n$_{\text{Cont}}$	kitaːb-aː$_{\text{Pau}}$	‘a book (acc.)’
f. [ah] for suffix [at]		
kaːtib-at-u-n$_{\text{Cont}}$	kaːtib-ah$_{\text{Pau}}$	‘a writer (f. nom.)’

There is an obvious consistency here: pausal forms must end in a heavy syllable. But the various ways of achieving this result — apocope, epenthesis, and metathesis — have to be reconciled. Furthermore, the ancillary phenomena — absence of [n] and debuccalization of [t] — do not seem to fit the pattern. And it is already apparent that any account of these phenomena will need to be sensitive to morphology, phonology, and prosodic domains.

In this chapter I will present an analysis of Classical Arabic pausal phenomena that is couched in terms of a derivational version of Optimality Theory in which morpheme realization interacts freely with the phonology. The key idea is that phonological markedness constraints on pre-pausal syllables — principally, the requirement that these syllables be heavy — affects morpheme realization. These constraints force non-realization of suffixes in (1b) and (1e), epenthesis in (1c), infixation in (1d), and allomorphy in (1f).

This chapter begins (section 2) with an overview of the theoretical background necessary to support the analysis. It then continues by looking at the various aspects of Classical Arabic pause: apocope and epenthesis (section 3), metathesis (section 4), absence of suffixal [n] (section 5), and the replacement of suffixal [at] with [ah] (section 6). Section 7 shows how the analysis in the previous sections interacts with cliticization. Finally, section 8 draws some general conclusions.

2. Theoretical background

It is usually assumed that the mapping from underlying to surface forms happens in a single step in Optimality Theory (Prince and Smolensky 1993/2004). This assumption is questioned in recent work on a derivational version of OT called Harmonic Serialism (HS). HS was briefly considered by Prince and Smolensky, but then set aside. Lately, I and others have begun to reexamine HS, finding that it has a number of attractive properties (see Kimper to appear, McCarthy 2000, 2002, 2007a, b, c, 2008b, c, Pater to appear, Pruitt 2008, Wolf 2008).

HS's differences from 'classic' OT can be described very briefly. In HS, GEN is limited to making one change at a time. Since inputs and outputs may differ in many ways, the output of each pass through GEN and EVAL is submitted as the input to another pass through GEN and EVAL, until no further changes are possible. This is the sense in which HS is a derivational version of OT.

For example, suppose a language maps underlying /pat/ to surface [patʃi] by a combination of [i]-epenthesis and [t]-palatalization. On the first pass through GEN and EVAL, shown in tableau (2a), the competing candidates include [pat], [pati], and [patʃ], among others. Because GEN can make only one change at a time, doubly-changed [patʃi] is not a candidate at this step of the derivation.[4] The grammar selects [pati], which becomes the input to another pass through GEN, shown in tableau (2b). Now the candidate set includes [patʃi], as well as [pati], [pat], and others. EVAL selects [patʃi], which is passed along to GEN. The new candidate set in tableau (2c) includes faithful [patʃi] and singly-unfaithful alternatives like [patʃ], [patʃiʔ], etc. EVAL finds none of the alternatives to be better than [patʃi], so [patʃi] is again the winner. At this point, the GEN-EVAL loop ends, and we say that the grammar has *converged* on its final output. The full derivation can be represented compactly as <pat, pati, patʃi>, or it can be spelled out in detail with the tableaux in (2). (On this tableau format, see Prince (2002) or McCarthy (2008a).)

(2) <pat, pati, patʃi> in detail

a. Step 1

pat	CODA-COND	*ti	DEP	IDENT(anterior)
i. → pati		1	1	
ii. pat	1 W	L	L	
iii. patʃ	1 W	L	L	1 W

b. Step 2

pati	CODA-COND	*ti	DEP	IDENT(anterior)
i. → patʃi				1
ii. pati		1 W		L
iii. pat	1 W			L

c. Step 3 — Convergence

patʃi	CODA-COND	*ti	DEP	IDENT(anterior)
i. → patʃi				
ii. pati		1 W		1 W
iii. patʃ	1 W			

Because EVAL applies repeatedly, each step in the derivation <pat, pati, patʃi> must better satisfy the constraint hierarchy than its predecessor. This property of HS is called *harmonic improvement*. Harmonic improvement is always determined relative to a particular constraint hierarchy that is invariant across all iterations of the GEN → EVAL → GEN … loop.

HS has potential implications not only for phonology proper but also for the phonology-morphology interface. Wolf (2008) has proposed an HS-related theory of this interface called Optimal Interleaving theory (OI). OI's key idea is that morpheme realization is one of the operations that GEN performs, so derivational steps that realize morphemes are interleaved among steps that perform phonological operations. Concomitantly, constraints on morpheme realization are interleaved among phonological constraints in the ranking that EVAL applies.

Realizational theories of morphology, such as OI or Distributed Morphology (Halle and Marantz 1993), assume that the phonological forms of morphemes are the result of processes that spell out morphosyntactic features. Thus, OI's ultimate inputs are feature structure trees — trees whose terminal nodes are abstract morphemes represented by their morphosyntactic features, such as /DOG-PLURAL/. The lexicon consists of phonological forms that may bear these features: $/\text{dɔg}/_{\text{DOG}}$, $/\text{z}/_{\text{PLURAL}}$. OI's GEN includes, in addition to familiar phonological operations like epenthesis, a spell-out operation that inserts the phonological representation of a single root or affix drawn from the lexicon.

Spell-out can occur at any location in the phonological representation, so the constraint hierarchy, rather than GEN, determine whether an affix is prefixed, infixed, or suffixed. Spell-out can also establish correspondence relations between features in the morphosyntactic representation and their counterparts in the phonological representation:

(3) Correspondence relation in OI

N	Morphosyntactic representation
DOG PLURAL	OI correspondence relation
DOG PLURAL dɔg z	Phonological representation

Constraints on this correspondence relation are crucial to OI's account of language typology.

In this chapter, I will often employ a compact representation for HS/OI derivations, such as <DOG-PLURAL, dɔg-PLURAL, dɔgz>. This representation, though convenient, oversimplifies in one important respect: Despite appearances, [dɔg] does not literally replace DOG, nor does [z] replace PLURAL. Rather, the morphosyntactic representation remains separate and unchanged, as in (3), while spell-out and the phonology proper occur in the phonological representation.

OI is, as its name suggests, a theory with interleaving of phonology and spell-out. So much so, that it is possible to get competition between, say, a candidate that has spelled out PLURAL and a candidate that has undergone voicing assimilation. The only limitation on the diversity of the candidate set is the one that is standard in HS: no candidate at step *n* can differ from the input to step *n* by more than the effect of a single operation in GEN.[5]

As usual in HS derivations, spell-out will not occur unless it improves harmony. It is harmonically improving by virtue of OI's constraints on the correspondence relation between features in the morphosyntactic and phonological representations. Among them are these three, all of which will be important later

(4) MAX-M(F)

For every token φ of the feature F, if φ is in the morphosyntactic structure and has no correspondent in the phonological structure, assign a violation mark.

(5) DEP-M(F)

For every token φ of the feature F, if φ is in the phonological structure and has no correspondent in the morphosyntactic structure, assign a violation mark.

(6) UNIFORMITY-M(F_1, F_2) (abbreviated UNIF-M(F_1, F_2))

For every token φ_1 of the feature F_1 and φ_2 of the feature F_2, with output correspondents φ_1' and φ_2' respectively, assign a violation mark if φ_1' and φ_2' are carried by the same phonological element.

MAX-M(F) and DEP-M(F) come from Wolf (2008:26). UNIFORMITY-M(F) was suggested by Wolf (p.c.); it follows the obvious parallel with the phonological correspondence constraints in McCarthy and Prince (1995, 1999).

For example, MAX-M(PLURAL) requires the feature PLURAL in the morphosyntactic structure to be spelled out by phonological elements that are lexically marked as PLURAL, such as the suffix [-z] or the root [giːs] 'geese'. DEP-M rules out using, say, PLURAL-marked [giːs] in the singular. UNIFORMITY-M(PLURAL, GENITIVE) is violated by genitive plurals like *dogs'*, where the [-z] suffix does double duty as the exponent of both PLURAL and GENITIVE.

Atypical spell-out effects occur when OI correspondence constraints like MAX-M are dominated by phonological markedness or faithfulness constraints. The English genitive plural is an example, since UNIFORMITY-M(PLURAL, GENITIVE) is dominated by a phonological constraint that disfavors the sequence of [z]s in *[dɔgzz]. I will argue that atypical spell-out is the source of many of the pausal alternations in (1).

3. Non-realization and epenthesis in pause

As we already saw, Arabic words in pause have to end in a heavy syllable. This requirement is codified by the markedness constraint in (7), which prohibits monomoraic syllables utterance-finally.

(7) HEAVYINPAUSE (HIP)

Assign one violation mark for each configuration of the form $[\mu]_\sigma\ ]_{Utt}$ (i.e., an utterance-final light syllable).

The configuration favored by this constraint recalls the well-known utterance-final phonetic effects of lengthening and weakening. But it is clearly not reducible to the phonetics (cf. Barnes 2006, Myers and Hansen 2007), since its diverse effects in Arabic are conditioned by the phonology and morphology.

Words whose contextual forms end in a heavy syllable satisfy HEAVYINPAUSE without further ado, and so in most cases their contextual forms are identical:

(8) Identical contextual and pausal forms with final heavy syllable

qatal-at_{Cont}	qatal-at_{Pau}	'kill (3rd f. sg. perfv.)'
jaqtul-uː_{Cont}	jaqtul-uː_{Pau}	'kill (3rd m. pl. subjn.)'
qatal-aː_{Cont}	qatal-aː_{Pau}	'kill (3rd m. du. perfv.)'
$\text{qatal-at-aː}_{Cont}$	qatal-at-aː_{Pau}	'kill (3rd f. du. perfv.)'

When a word's contextual form ends in a short vowel, however, something has to change. The details of the change depend on morphological and syllabic structure. When the word-final short vowel is a suffix, then it is absent in pause:

(9) Absence of final short suffixal vowels

$\text{ʔalkitaːb-u}_{Cont}$	ʔalkitaːb_{Pau}	'the book (nom.)'
$\text{ʔalkitaːb-i}_{Cont}$	ʔalkitaːb_{Pau}	'the book (gen.)'
$\text{ʔalkitaːb-a}_{Cont}$	ʔalkitaːb_{Pau}	'the book (acc.)'
jaqtul-u_{Cont}	jaqtul_{Pau}	'kill (3rd m. sg. impfv.)'

Although this might look like a phonological apocope process, I will argue below that it is not. OI offers an alternative to apocope: the suffix vowel is absent not because it was deleted but rather because it was never realized in the first place. If HEAVYINPAUSE dominates MAX-M instead of phonological MAX, then the suffix will remain unrealized for phonological reasons: <BOOK-NOM$]_{Utt}$, kitaːb-NOM$]_{Utt}$> is the derivation. (The implicit assumption that the edges of utterances are known in advance of spell-out will be addressed shortly.) The tableaux in (10) show how this derivation is obtained.

(10) <BOOK-NOM]$_{\text{Utt}}$, kitaːb-NOM]$_{\text{Utt}}$>

a. Step 1

BOOK-NOM]$_{\text{Utt}}$	MAX-M(ROOT)	HIP	MAX-M
i. → kitaːb-NOM]$_{\text{Utt}}$			1
ii. BOOK-NOM]$_{\text{Utt}}$	1 W		2 W
iii. BOOK-u]$_{\text{Utt}}$	1 W	1 W	1

b. Step 2: Convergence

Ranking proven: HEAVYINPAUSE >> MAX-M

kitaːb-NOM]$_{\text{Utt}}$	MAX-M(ROOT)	HIP	MAX-M
i. → kitaːb-NOM]$_{\text{Utt}}$			1
ii. kitaːb-u]$_{\text{Utt}}$		1 W	L

Top-ranked MAX-M(ROOT) is an ad hoc expedient to ensure that the root is spelled out first; see Wolf (2008:chapter 3) for the real story and sections 5 and 7 below for related discussion.[6] The interesting action — actually inaction — occurs at step 2. A candidate that leaves NOM unrealized competes against one that realizes it but in doing so violates HEAVYINPAUSE. Since HEAVYINPAUSE is ranked higher, the candidate with incomplete realization of the morphosyntactic feature structure is the winner of this evaluation. It is also the final output of the grammar, since step 2 in (10) is convergent.

Before we continue, two issues must be dealt with. One involves the details of Arabic affixes, and the other involves the availability of information about utterance edges to the word phonology.

The first issue is this: the analysis will produce the desired effect only when an entire affix remains unrealized; partial realization is not an option permitted to GEN. The traditional morpheme segmentation in Classical Arabic looks like a problem, because it posits many CV suffixes and clitics that appear to lose just their final vowel in pause:

(11) CV suffixes and clitics?

jaqtul-uː-na$_{\text{Cont}}$	jaqtul-uː-n$_{\text{Pau}}$	'kill (3$^{\text{rd}}$ m. pl. ind.)'
qatal-tu-ka$_{\text{Cont}}$	qatal-tu-k$_{\text{Pau}}$	'I killed you (m. sg.)'
qatal-tu-ki$_{\text{Cont}}$	qatal-tu-k$_{\text{Pau}}$	'I killed you (f. sg.)'
qatal-naː-hu$_{\text{Cont}}$	qatal-naː-h$_{\text{Pau}}$	'we killed him'

This textbook morpheme segmentation is almost certainly wrong, however. The following is an exhaustive list of multisegmental suffixes and clitics ending in a short vowel:

(12) Apparently multisegmental suffixes and clitics with a final short vowel

a. Indicative mood

-na	‘2nd, 3rd m. pl.’
-ni	‘2nd, 3rd m. & f. du.’

b. Subject agreement

-tu	‘1st sg.’
-ta	‘2nd sg. m.’
-ti	‘2nd sg. f.’
-na	‘2nd, 3rd pl. f.’

c. Clitic

-ka	‘2nd sg. m.’
-ki	‘2nd sg. f.’
-hu	‘3rd sg. m.’ (cf. -haː ‘3rd sg. f.’)
-kunna	‘2nd pl. f.’ (cf. -kum ‘2nd pl. m.’)
-hunna	‘3rd pl. f.’ (cf. -hum ‘3rd pl. m.’)

Although these suffixes and clitics are traditionally analyzed as monomorphemic, the resemblances among them justify a finer morphological analysis (McCarthy 1979:295ff., Trager and Rich 1954). For example, [ta] and [ti] mark second person singular subjects, while [ka] and [ki] mark the corresponding objects. This suggests an analysis where [a] and [i] are separate suffixes with the meaning ‘masculine’ and ‘feminine’, respectively. If this more careful morpheme segmentation is correct, then there is no reason to prefer the apocope analysis to the realizational one.

The second issue is this: information about a word’s location in the utterance must be available at the point of morpheme spell-out. In classic OT, this would come as no surprise, since all aspects of output structure are determined simultaneously. But in a derivational version of OT like HS/OI, one might expect derivations to proceed from the bottom up, as they do in Lexical Phonology (Kiparsky 1982, Mohanan 1982 and many others). One possibility is that Lexical Phonology is simply wrong on this point, as Dresher (1983, 2008) has argued from the evidence of Tiberian Hebrew pausal alternations. Another imaginable approach is precompiled phrasal phonology, but this is clearly not appropriate when pause is the conditioning factor (Hayes 1990:107).[7]

A third option is to recognize the special status of the utterance constituent in the prosodic hierarchy. In an extensive body of research (e.g., Kratzer and Selkirk 2007, Selkirk 1986, 1995), Lisa Selkirk has shown how prosodic constituents like the phonological phrase or intonation phrase are projected from the syntax. The utterance is an exception, however. Utterances have no necessary or even regular relationship with the syntax. An utterance can consist of a single word or several sentences. An utterance can even consist of a part of word: *Q: When you aspirate a stop, do you* ***ab****duct or* ***ad****duct the vocal folds? A: Ab.* All that can be said about an utterance is that it is bounded by pauses and contains no internal pauses. Perhaps this is the reason why the utterance level of the prosodic hierarchy confounds the intuition that structure is built bottom-up.

Back to the main line of analysis and argument. There is a very good reason to prefer an analysis based on morphological realization over one based on phonological apocope: the realizational analysis explains why only affixal vowels disappear in pause. When an utterance-final short vowel belongs to the stem rather an affix, the obligations of HEAVYINPAUSE are met by epenthesizing [h]:

(13) Epenthesis of [h] after final short stem vowels

a. Verbs

ʔiqtadi$_{Cont}$	ʔiqtadih$_{Pau}$	'imitate (m. sg. imptv.)'
ʔirmi$_{Cont}$	ʔirmih$_{Pau}$	'throw (m. sg. imptv.)'
jarmi$_{Cont}$	jarmih$_{Pau}$	'throw (3rd m. sg. juss.)'

b. Other

kajfa$_{Cont}$	kajfah$_{Pau}$	'how?'
θumma$_{Cont}$	θummah$_{Pau}$	'then'

The verbs in (13a) are derived from triconsonantal roots with final [w] or [j], and that is the source of the stem-final vowel. Since the imperative and jussive moods have no suffix, the final vowel could not be affixal. The final vowels in (13b) could not be affixal because these words do not belong to any of the inflectable lexical categories noun, verb, and adjective. Hence, these final vowels are also part of the stem.

When words like those in (13) occur in pause, non-realization of a suffix is not an option, since there is no suffix. In that case, [h]-epenthesis takes over the job of satisfying HEAVYINPAUSE. The derivation in (14) shows the ranking that produces this result.

(14) [h]-epenthesis

a. Step 1

Ranking proven: MAX-M(ROOT) >> HIP

HOW]$_{Utt}$	MAX-M(ROOT)	HIP	DEP	MAX-M
i. → kajfa]$_{Utt}$		1		
ii. HOW]$_{Utt}$	1 W	L		1 W

b. Step 2 (converges at step 3)

Ranking proven: HEAVYINPAUSE >> DEP

kajfa]$_{Utt}$	MAX-M(ROOT)	HIP	DEP	MAX-M
i. → kajfah]$_{Utt}$			1	
ii. kajfa]$_{Utt}$		1 W	L	

Tableau (14a) shows that MAX-M(ROOT) must dominate HEAVYINPAUSE, since spelling out the root can introduce an utterance-final light syllable. Tableau (14b) establishes that HEAVYINPAUSE dominates DEP, so it can compel epenthesis.

To ensure the internal consistency of the analysis, we need to check that the introduction of dominated DEP does not affect the account of affix non-realization in (10). It does not because there is no point in (10) where non-realization competes against a viable epenthetic alternative. That is, the intended winner [kitaːb-NOM] never competes against [kitaːbuh], which realizes the nominative suffix as [u] and satisfies HEAVYINPAUSE by epenthesizing [h]. They do not compete because they come from different GEN "generations". The ultimate input is [BOOK-NOM], and [kitaːb-NOM] is one step away from that. But [kitaːbuh] is three steps away — spell-out of BOOK, spell-out of NOM, and epenthesis.

In sum, the OI analysis presented here explains two properties of the Arabic pausal system. It explains why affix vowels are absent in pause but stem vowels are not — non-realization is an option only for the former. It also explains why affix vowels never undergo [h]-epenthesis — non-realization wins before epenthesis is a viable option. Both explanations rely on OI's eponymous ability to interleave phonological and morphological operations and constraints.

A conventional OT analysis of these data might seem to be possible with root faithfulness constraints (McCarthy and Prince 1995, 1999). MAX_{root} prevents stem vowels from deleting. If it dominates DEP, which itself dominates unadorned MAX, then the right results are obtained:

(15) Classic OT analysis with MAX_{root}

a. Deletion of suffix vowel

kitaːb-u	MAX_{root}	HIP	DEP	MAX
i. → kitaːb$]_{\text{Utt}}$				1
ii. kitaːbu$]_{\text{Utt}}$		1 W		L
iii. kitaːbuh$]_{\text{Utt}}$			1 W	L

b. Epenthesis after stem vowel

kajfa	MAX_{root}	HIP	DEP	MAX
i. → kajfah$]_{\text{Utt}}$			1	
ii. kajfa$]_{\text{Utt}}$		1 W	L	
iii. kajf$]_{\text{Utt}}$	1 W		L	1 W

The problem with this analysis is that it requires rankings that are contradicted elsewhere in the language. Phonotactic requirements prohibit word-initial consonant clusters. With MAX_{root} dominating DEP dominating plain MAX, we would expect clusters composed of root consonants to undergo epenthesis, while clusters with an affixal consonant would simplify by deletion. This is false; clusters of both types have epenthesis of prothetic [ʔi] or [ʔu]: /ktub/ → [ʔuktub] 'write!'; /sta-ktab-a/ → [ʔistaktaba], *[taktaba] 'he asked someone to write'. Therefore, Max must dominate Dep, contradicting (15).

4. Infixation in pause

When a noun whose stem ends in a consonant cluster appears in the nominative or genitive case in pause, the suffix vowel appears to be metathesized into the cluster (16). This does not occur in the accusative case, however.

(16) Apparent metathesis in pause

ʔalbakr-u$_{\text{Cont}}$	ʔalbakur$_{\text{Pau}}$	'the young camel (nom.)'
ʔadalw-u$_{\text{Cont}}$	ʔadaluw$_{\text{Pau}}$	'the leather bucket (nom.)'
ʔalbakr-i$_{\text{Cont}}$	ʔalbakir$_{\text{Pau}}$	'the young camel (gen.)'
but		
ʔalbakr-a$_{\text{Cont}}$	ʔalbakr$_{\text{Pau}}$	'the young camel (acc.)'

OI offers an alternative to metathesis. The idea is that the nominative suffix [-u] is not *moved* into the preceding cluster; rather, the morphosyntactic feature NOM is *realized* in that position. This suffix is, in short, infixed for phonological reasons.

Consider the fate of utterance-final [CAMEL-NOM] (ignoring the definite article). At the second step of the derivation, the root has already been spelled out and the input to GEN is [bakr-NOM]. One option for spelling out NOM is [bakur], with NOM realized internally to the stem. This is a violation of the OI constraint MIRROR, which says (approximately) that the phonological exponent of NOM has to follow the phonological exponent of CAMEL, mirroring in phonological structure the relation between these morphemes in morphosyntactic structure. Wolf (2008:81) defines MIRROR so it assesses violations gradiently by counting segments. Therefore, [bakur] receives one mark from this constraint.

Infixation of the suffix occurs with cluster-final stems like [bakr], but not with stems ending in a single consonant, such as [kitaːb], [ʤabal] 'hill', or [θaʕlab] 'fox'. In pause, these latter nouns opt for non-realization of NOM, as we have already seen. The explanation for this difference is that infixation avoids the final consonant cluster of *[bakr-NOM]. On this view, *COMPLEXCODA (*CMP) dominates MIRROR, thereby compelling infixation in cluster-final stems like the one in tableau (17). *COMPLEXCODA is irrelevant in non-cluster-final stems, as tableau (18) shows.

(17) Step 2 of <CAMEL-NOM]$_{\text{Utt}}$, bakr-NOM]$_{\text{Utt}}$, bakur]$_{\text{Utt}}$>
Ranking proven: HEAVYINPAUSE, *COMPLEXCODA, DEP >> MIRROR

	bakr-NOM]$_{\text{Utt}}$	HIP	*CMP	DEP	MIR	MAX-M
a. →	bakur]$_{\text{Utt}}$				1	
b.	bakr-NOM]$_{\text{Utt}}$		1 W		L	1 W
c.	bakir-NOM]$_{\text{Utt}}$			1 W	L	1 W
d.	bakru]$_{\text{Utt}}$	1 W			L	

(18) Step 2 of <FOX-NOM]$_{\text{Utt}}$, θaʕlab-NOM]$_{\text{Utt}}$> — Convergence
Ranking proven: MIRROR >> MAX-M

	θaʕlab-NOM]$_{\text{Utt}}$	HIP	*CMP	DEP	MIR	MAX-M
a. →	θaʕlab-NOM]$_{\text{Utt}}$					1
b.	θaʕlabu]$_{\text{Utt}}$	1 W				L
c.	θaʕulab]$_{\text{Utt}}$				3 W	L

These two tableaux merit close study. From previous discussion we know that HEAVYINPAUSE dominates DEP and MAX-M. These tableaux introduce two more constraints, *COMPLEXCODA and MIRROR. Tableau (17) shows that MIRROR has to be dominated by three constraints: *COMPLEXCODA, to rule out non-realization with cluster-final stems; DEP, to prevent *COMPLEXCODA from being satisfied by ordinary vowel epenthesis; and, as usual, HEAVYINPAUSE. But MIRROR must itself dominate MAX-M, as shown in (18), so that infixation does not become a more generally applicable alternative to non-realization.[8]

Interestingly, it is not possible in OI to construct an actual metathesis analysis of these data that is consistent with the results of the previous section. To get to the output by way of metathesis, the derivation would have to proceed as <CAMEL-NOM]$_{\text{Utt}}$, bakr-NOM]$_{\text{Utt}}$, bakru]$_{\text{Utt}}$, bakur]$_{\text{Utt}}$>. At step 2, NOM is realized at the expense of violating HEAVYINPAUSE — an impossibility because the previous section established that MAX-M is ranked below HEAVYINPAUSE. In OI, as in HS generally, there is no look-ahead, so the prospect of fixing [bakru]'s HEAVYINPAUSE violation is not in sight. Derivations must steadily improve harmony, and violating undominated HEAVYINPAUSE is not the way to do that.

The analysis so far is crucially incomplete in one respect: it does not account for the contextual ~ pausal alternation in accusative nouns like [ʔalbakr-a]$_{\text{Cont}}$ ~ [ʔalbakr]$_{\text{Pau}}$. Evidently the accusative suffix resists infixation. It is by no means unusual for similar-looking affixes to differ in infixability within a language. For example, Prince and Smolensky's (1993/2004) analysis of the Tagalog infix [um] 'actor focus' relies on the fact that it starts with a vowel and ends in a consonant. But [ipag] 'benefactive focus' is also vowel-initial and consonant-final, yet it does not infix. Facts like this show that MIRROR, like the affixal alignment constraints it replaces, is morpheme-specific. Tagalog assigns a different ranking to MIRROR(ACTOR FOCUS) and MIRROR(BENEFACTIVE FOCUS), violating the former but not the latter. In Arabic, MIRROR(ACC) is unviolated, but MIRROR(NOM) and MIRROR(GEN) are ranked lower.

Tableau (19) illustrates this effect of MIRROR(ACC):

(19) Step 2 of <CAMEL-ACC]$_{\text{Utt}}$, bakr-ACC]$_{\text{Utt}}$> — Convergence
Ranking proven: HEAVYINPAUSE, MIRROR(ACC) >> *COMPLEXCODA

bakr-ACC]$_{\text{Utt}}$	HIP	MIR(ACC)	*CMP	DEP	MIR(NOM/GEN)	MAX-M
a. → bakr-ACC]$_{\text{Utt}}$			1			1
b. bakar]$_{\text{Utt}}$		1 W	L			L
c. bakra]$_{\text{Utt}}$	1 W		L			L

Splitting MIRROR in this way has no effect on previous results; for example, substituting MIRROR(NOM/GEN) for undifferentiated MIRROR does not change the outcome in tableau (17).

A final point about this analysis. When the final short vowel is not affixal, it is not "metathesized" into the preceding cluster. This is exemplified by [ʔirmi]$_{\text{Cont}}$ ~ [ʔirmih]$_{\text{Pau}}$ and several other words in (13). The pausal form *[ʔirim]$_{\text{Pau}}$ is impossible because there is no actual metathesis — no violation of the faithfulness constraint LINEARITY. The final vowel of [ʔirmi]$_{\mathrm{Cont}}$ is not affixal, so there is no possibility of treating it as an infix. Thus, although DEP has to dominate MIRROR(NOM/GEN) (see (17)), *[ʔirim]$_{\mathrm{Pau}}$ is not a successful challenger to [ʔirmih]$_{\mathrm{Pau}}$.

I will now compare this OI account with the alternative OT analyses that are available if OI is not assumed. There are two: infixation in the style of Prince and Smolensky (1993/2004) and McCarthy and Prince (1993), which I will refer to alignment-based infixation (ABI); and infixation by phonological metathesis, as proposed by Horwood (2002, 2004).

The main premise of ABI is that morphemes are unordered in the input and affix placement is determined by the ranking of affix-specific alignment constraints, such as ALIGN-L(*um*, stem) in Tagalog.[9] In Arabic, ranking ALIGN-R(u_{NOM}, stem) below *COMPLEX-CODA and HEAVYINPAUSE will favor infixation of this suffix. In contrast, ALIGN-R(a_{ACC}, stem) is ranked above these two constraints. The form *[ʔirim]$_{\mathrm{Pau}}$ is a non-starter because it has no affix to infix.

Although ABI can supply a working analysis of these Arabic data, it has bigger problems. Horwood's (2002, 2004) critique of ABI is that independent ranking of affix-specific alignment constraints cannot capture generalizations subsumed by Baker's (1985) Mirror Principle.[10] For example, it is an accident of ranking that the case suffixes follow the feminine plural suffix [aːt]. The Mirror Principle and the cognate OI constraint MIRROR relate this observation about the phonological representation to properties of the morphosyntactic representation

Earlier, I argued that metathesis is not a viable approach to these facts in OI, but perhaps it would work in classic OT. The idea is that /bakr-u/ becomes [bakur] in pause because LINEARITY is dominated by *COMPLEX-CODA and HEAVYINPAUSE:

(20) Fragment of metathesis analysis

bakr-u	*CMP	HIP	LINEARITY
a. → bakur]$_{\mathrm{Utt}}$			1
b. bakru]$_{\mathrm{Utt}}$		W 1	L
c. bakr]$_{\mathrm{Utt}}$	W 1		L

If LINEARITY dominates MAX, then this analysis will also account for why /θaʕlab-u/ becomes [θaʕlab] and not *[θaʕulab] in pause.

This classic OT analysis also has to deal with the pausal forms where metathesis fails to occur, accusatives like [bakr]$_{\mathrm{Pau}}$ and [h]-epenthesis cases like [ʔirmih]$_{\mathrm{Pau}}$. The obvious move in the case of the accusative is to recruit a high-ranking morpheme-specific faithfulness constraint LINEARITY$_{\mathrm{ACC}}$, which is violated by the mapping /bakr-a/ → *[bakar]$_{\mathrm{Pau}}$. As for the [h]-epenthesis cases, the root faithfulness constraint LINEARITY$_{\mathrm{root}}$ (McCarthy and Prince 1995, 1999) could rule out the mapping /ʔirmi/ → *[ʔirim]$_{\mathrm{Pau}}$.

Though superficially plausible, these applications of morpheme- or root-specific faithfulness do not actually work. The problem centers on identifying the *locus of* *exceptionality* in the sense of Pater (2006). For example, suppose MAX is indexed to a particular morpheme or class of morphemes. The scope of this indexed constraint is limited to segments that are exponents of that morpheme or morpheme class. Other segments that happen to occur in the same word as one of these morphemes are not protected by indexed MAX. Therefore, the locus of exceptionality is the segment whose deletion would violate MAX.

What is the locus of exceptionality for LINEARITY? Unlike MAX, LINEARITY refers to a pair of segments. If LINEARITY is morphologically indexed, do both segments have to meet the morphological condition, or is it enough that one of them does? Is the locus of exceptionality two segments or one? I do not know the answer to this question, but I do know that $\text{LINEARITY}_{\text{ACC}}$ and $\text{LINEARITY}_{\text{root}}$, if they are to have the desired effect in Arabic, must be inconsistent in exactly this respect. To prevent the mapping /bakr-a/ → *$[\text{bakar}]_{\text{Pau}}$, $\text{LINEARITY}_{\text{ACC}}$ has to be active when only one of the segments involved, the [a], is an exponent of ACC. But to prevent the mapping /ʔirmi/ → *$[\text{ʔirim}]_{\text{Pau}}$ while still allowing the mapping /bakr-u/ → *$[\text{bakur}]_{\text{Pau}}$, $\text{LINEARITY}_{\text{root}}$ has to be active only when both of the segments involved, the [m] and the [i], are exponents of a root. It would, of course, be possible to solve this problem by stipulating for each indexed LINEARITY constraint how its locus of exceptionality will be reckoned, but then the *reductio* would be well advanced on the road to the *absurdum*.

To sum up the analysis so far, I have argued that Wolf's (2008) Optimal Interleaving theory provides the framework for an analysis of the absence of final short vowels in pause that is superior to a more conventional OT approach. The central claim of the analysis is that the effects of the markedness constraint HEAVYINPAUSE are both morphological — blocking realization of affixes as final short vowels — and phonological — triggering epenthesis.

For convenience, I provide a list of all the ranking results and where they are established:

(21) Ranking so far

MAX-M(ROOT) >> HIP	(14a)
HEAVYINPAUSE >> MAX-M	(10b)
HEAVYINPAUSE >> DEP	(14b)
HEAVYINPAUSE >> MIRROR(NOM/GEN)	(17)
HEAVYINPAUSE >> *COMPLEXCODA	(19)
MIRROR(ACC) >> *COMPLEXCODA	(19)
*COMPLEXCODA >> MIRROR(NOM/GEN)	(17)
DEP >> MIRROR(NOM/GEN)	(17)
MIRROR(NOM/GEN)>> MAX-M	(18)

As evidence that the analysis is internally consistent, note that HEAVYINPAUSE dominates MIRROR(NOM/GEN) by direct argument and by two arguments from transitivity of domination, one via DEP and the other via *COMPLEX-CODA. Likewise, the ranking of HEAVYINPAUSE above MAX-M is shown by direct argument and by transitivity through MIRROR(NOM/GEN). This is an indication that the analysis is on the right track.

In the next section, we will see how this analysis extends to other pausal phenomena.

5. Consequences of sequential spell-out

In HS, GEN is limited to making one change at a time. In OI, this means that spell-out can insert only one morpheme at a time. For example, in the derivation of [ROOT-F1-F2], after ROOT has been spelled-out, it is not possible to spell out both F1 and F2, unless the lexicon happens to supply a single morpheme that matches both of these features. This sequential spell-out requirement, which follows from basic HS/OI assumptions, has consequences for the phonology of pause in Classical Arabic.

Under certain circumstances, indefinite nouns are marked by a suffix [n], called "nunation", that follows the case desinence. In pausal forms of indefinite nominatives and genitives, the desinence and the [n] are both absent (22a). In pausal forms of indefinite accusatives, the desinence and [n] are replaced by [aː] (22b).

(22) Nunation disappears in pause

a. Nominative and genitive

kitaːb-u-n_{Cont}	kitaːb_{Pau}	'a book (nom.)'
bakr-u-n_{Cont}	bakur_{Pau}	'a young camel (nom.)'
kitaːb-i-n_{Cont}	kitaːb_{Pau}	'a book (gen.)'
bakr-i-n_{Cont}	bakir_{Pau}	'a young camel (gen.)'

b. Accusative

kitaːb-a-n_{Cont}	kitaːb-aː$_{\text{Pau}}$	'a book (acc.)'
bakr-a-n_{Cont}	bakr-aː$_{\text{Pau}}$	'a young camel (acc.)'

From the perspective of a classic OT or rule-based analysis, the forms in (22a) are puzzling. Since [kitaːbun]$_{\text{Cont}}$ ends in a heavy syllable, the contextual and pausal forms should be identical (cf. (8)). Furthermore, the data in (23) show that there is no general [n]-deletion process in pause. In fact, the absence of suffix vowels in pause can actually expose [n]s to utterance-final position, where they remain intact.

(23) [n] otherwise preserved in pause

a. Root [n]

ʔaddiːn-i_{Cont}	ʔaddiːn_{Pau}	'the judgment (gen.)'
ħiːn-in_{Cont}	ħiːn_{Pau}	'time (gen.)'

b. Suffixal [n]

ʔalʕaːlam-iːn-a_{Cont}	ʔalʕaːlam-iːn_{Pau}	'the worlds (gen.)'

It is clear that the absence of nunation in pause is not the result of some conventional phonological process.

In fact, the absence of nunation in pause follows from the OI analysis already proposed, without any additional stipulations. Tableau (24) addresses the situation that obtains after root spell-out, when there is a choice between realizing the case suffix or failing to realize it. HEAVYINPAUSE and *COMPLEX-CODA dominate MAX-M, and these candidates violate no other constraints under discussion. Hence, the candidate that fails to spell out NOM or INDEF is the winner. And since this candidate is identical with the latest input to GEN, the derivation converges.

(24) Convergence at step 2 of <BOOK-NOM-INDEF]$_{Utt}$, kitaːb-NOM-INDEF]$_{Utt}$>

kitaːb-NOM-INDEF]$_{Utt}$	HIP	*Cmp	Max-M
a. → kitaːb-NOM-INDEF]$_{Utt}$			2
b. kitaːb-u-INDEF]$_{Utt}$	1 W		1 L

As I noted earlier, HS/OI has no capacity to look ahead to what might be possible at later steps of the derivation. For that reason, [kitaːb-u-INDEF] enjoys no advantage, even though spell-out of INDEF as [n] at the next step would provide the sought-for heavy syllable while spelling out all of the morphosyntactic features.

Because of sequential spell-out, tableau (24) does not include the candidate [kitaːb-u-n]. HS/OI's Gen cannot draw two morphemes from the lexicon in a single step, so input [kitaːb-NOM-INDEF] cannot yield this candidate. This fact is crucial, because [kitaːb-u-n] would otherwise win, as it satisfies both HeavyInPause and Max-M. Furthermore, under the assumption that spell-out proceeds from the root outward (see Wolf (2008:chapter 3) as well as sections 3 above and 7 below), it is impossible to spell out INDEF before NOM, so [kitaːb-NOM-n] is non-viable. Succinctly, nunation is absent in the pausal forms of indefinite nominative and genitive singular nouns because the case suffix is absent, and the case suffix is absent because nunation is absent. This explanation crucially relies on HS/OI's serial character.

The pausal form of the indefinite accusative also lacks nunation, but it satisfies HeavyInPause in a different way: [kitaːb-aː]$_{Pau}$.[11] The [aː] suffix, I propose, is a portmanteau morpheme. That is, it realizes two morphosyntactic features that the language usually spells out with separate morphemes. In the derivation <BOOK-ACC-INDEF]$_{Utt}$, kitaːb-ACC-INDEF]$_{Utt}$, kitaːb-aː]$_{Utt}$>, suffixation of [aː] at the final step spells out both ACC and INDEF without running afoul of HeavyInPause:

(25) The portmanteau suffix [aː]

kitaːb-ACC-INDEF]$_{Utt}$	HIP	*Cmp	Max-M
a. → kitaːb-aː]$_{Utt}$			
b. kitaːb-a-INDEF]$_{Utt}$	1 W		1 W

As tableau (25) shows, no changes in the grammar are necessary to account for why [aː] appears in the pausal indefinite accusative. Because a portmanteau morpheme spells out two or more morphosyntactic features at once, it is always favored by Max-M over spelling out the features one at a time (Wolf 2008:191 ff.).[12]

In fact, the attractiveness of the portmanteau is such that we must take care to explain why [kitaːb-a-n]$_{Cont}$, rather than *[kitaːb-aː]$_{Cont}$, is the contextual form of the indefinite accusative. Specifically, we need the intermediate form [kitaːb-a-INDEF]$_{Cont}$ to beat [kitaːb-aː]$_{Cont}$. Since Max-M(INDEF) favors the latter, it has to be dominated by a constraint that the portmanteau violates. That constraint is Uniformity-M in (6). Tableau (26) shows how this works, and tableau (27) establishes that this move does not affect the analysis of the pausal form if UNIFORMITY-M is dominated by HEAVYINPAUSE and MAX-M(ACC).

(26) No portmanteau [aː] in contextual indefinite accusative[13]

	kitaːb-ACC-INDEF]$_{Cont}$	HIP	MAX-M(ACC)	UNIF-M	MAX-M(INDEF)
a. →	kitaːb-a-INDEF]$_{Cont}$				1
b.	kitaːb-aː]$_{Cont}$			1 W	L
c.	kitaːb-ACC-INDEF]$_{Cont}$		1 W		

(27) Portmanteau [aː] in pausal indefinite accusative (expanding (25))

	kitaːb-ACC-INDEF]$_{Pau}$	HIP	MAX-M(ACC)	UNIF-M	MAX-M(INDEF)
a. →	kitaːb-aː]$_{Pau}$			1	
b.	kitaːb-a-INDEF]$_{Pau}$	1 W		L	1 W
c.	kitaːb-ACC-INDEF]$_{Pau}$		1 W	L	1 W

6. Allomorphy

To introduce the now standard approach to allomorphy in OT, I will begin with an example. In Korean, the nominative suffix has two alternants, [i] and [ka]. There is no reasonable way of deriving them from a single underlying representation, but their distribution is determined phonologically: [i] follows consonant-final stems and [ka] (voiced intervocalically to [ɡa]) follows vowel-final stems:

(28) Korean nominative suffix allomorphy

cib-i	'house (nom.)'
c^ha-ɡa	'car (nom.)'

The standard approach to allomorphy in OT is based on the following premises (e.g., Burzio 1994, Hargus 1995, Hargus and Tuttle 1997, Mascaró 1996, 2007, Mester 1994, Perlmutter 1998, Tranel 1996a, b, 1998):

(i) The allomorphs of a morpheme are listed together in the underlying representation: /cip-{i, ka}/, /c^ha-{i, ka}/ (Hudson 1974).

(ii) GEN creates candidates that include all possible choices of an allomorph: [cib-i], [cip-ka], [c^ha-i], [c^ha-ɡa].

(iii) Faithfulness constraints like MAX and DEP treat all allomorph choices equally.

(iv) So markedness constraints determine which allomorph is most harmonic. In Korean, the markedness constraints ONSET and NO-CODA correctly favor [cib-i] and [c^ha-ɡa] over [cip-ka] and [c^ha-i], respectively. Because no faithfulness violation is involved in allomorph selection, the markedness constraints that make the choice can be emergent in the sense of McCarthy and Prince (1994).

The following tableaux illustrate:

(29) Allomorph selection in Korean

a.

/cip-{i, ka}/	ONSET	NO-CODA
i. → cibi		
ii. cipka		1 W

b.

/cʰa-{i, ka}/	ONSET	NO-CODA
i. → cʰaɡa		
ii. cʰa.i	1 W	

NO-CODA is an emergent constraint in Korean — it is unable to compel faithfulness violation, since the language permits syllables with codas

OI's theory of allomorphy is similar, except for one not unexpected difference: allomorphs compete at the point of spell-out, not at surface structure (Wolf 2008:chapters 2 & 3). Thus, [cʰaɡa] and *[cʰa.i] compete as different ways of continuing the derivation that begins with <CAR-NOM, cʰa-NOM, …>. This difference is important when we apply OI to the problem of allomorphy in the feminine singular suffix of Classical Arabic.

The feminine singular suffix is normally [at], but it takes the form [ah] when it occurs utterance-finally:

(30) Feminine singular suffix [at] in pause

kaːtib-at-un$_{\text{Cont}}$	kaːtib-ah$_{\text{Pau}}$	'a writer (f. nom.)'
ħamz-at-a$_{\text{Cont}}$	ħamz-ah$_{\text{Pau}}$	'Hamza (masc. name) (acc.)'

When [t] comes from any other source, such as the root, the feminine plural suffix [aːt], or the homophonous third person feminine singular subject agreement suffix [at], it does not alternate with [h] (Hoberman 1995:168):

(31) Other [t]s in pause

mustanbat-un$_{\text{Cont}}$	mustanbat$_{\text{Pau}}$	'cultivated (nom.)'
kaːtib-aːt-un$_{\text{Cont}}$	kaːtib-aːt$_{\text{Pau}}$	'writers (f. nom)'
katab-at$_{\text{Cont}}$	katab-at$_{\text{Pau}}$	'write (3rd f. sg. perfv.)'

As in Korean, the [t]~[h] alternation is phonologically conditioned, but no general phonological process is involved. This too is an example of allomorphy, as Hoberman (1995) argues.

It follows that the feminine singular suffix has two synonymous allomorphs, [at] and [ah]. They compete at the point of spell-out of FEM, and phonological constraints determine which is more harmonic. These constraints must favor, e.g., [kaːtib-*at*-NOM-INDEF]$_{\text{Cont}}$ over *[kaːtib-*ah*-NOM-INDEF]$_{\text{Cont}}$, but they must also favor [kaːtib-*ah*-NOM-INDEF]$_{\text{Pau}}$ over *[kaːtib-*at*-NOM-INDEF]$_{\text{Pau}}$. In short, they must favor [h] over [t] utterance-finally and [t] over [h] elsewhere. The effects of these constraints are emergent in allomorph selection but not in unfaithful mappings, since the language otherwise allows utterance-final [t] (as in (31)) and non-utterance-final [h] (as in [ʔahlaka] 'ruin (3rd m. sg. perfv.)').

I will now elucidate these constraints. One piece of the analysis comes from the observation that some languages limit codas to the laryngeals [h] and [ʔ] (Kaneko and Kawahara 2002, Lombardi 1995/2001, Parker 2001). This follows if laryngeals are placeless and the constraint CODACOND bans place from codas (1990:123--8, Ito 1989). Another key piece of the analysis comes from Flack's (2007, 2009) proposal that conditions on the onsets or codas of syllables are paralleled by conditions on the 'onsets' or 'codas' of words, phrases, or utterances. Thus, we expect to find a constraint $\text{CODACOND}_{\text{Utt}}$ that is violated by non-laryngeal consonants utterance-finally. It is this constraint that favors [kaːtib-*ah*-NOM-INDEF]$_{\text{Pau}}$ over *[kaːtib-*at*-NOM-INDEF]$_{\text{Pau}}$. Its effect is limited to allomorph selection because it is ranked below faithfulness, so it does not cause, say, [mustanbat]$_{\text{Pau}}$ to become [mustanbah]$_{\text{Pau}}$.

There is independent support for $\text{CODACOND}_{\text{Utt}}$ in Classic Arabic. It explains why [h] and not some other consonant is epenthesized in the pausal forms in (13), since all other consonants except [ʔ] violate it. This too is an emergent effect. Furthermore, $\text{CODACOND}_{\text{Utt}}$ is plausibly implicated in insertion of final [h] in phrases beginning with the so-called [waː] of lamentation (Wright 1971:vol. i, 295): [waː ʔamiːra lmuʔminiːnaː**h**] 'alas for the Prince of Believers'. $\text{CODACOND}_{\text{Utt}}$ is also supported by Sanskrit *visarga*, a process that replaces /s/ and /r/ with [h] utterance-finally (Selkirk 1980:118, Whitney 1889:58).

Another emergent constraint disfavors the [ah] allomorph in non-pausal contexts. This constraint, HAVE-PLACE, is violated by the laryngeals [h] and [ʔ] because of their placelessness (Padgett 1995, Parker 2001, Smith 2002). With $\text{CODACOND}_{\text{Utt}}$ ranked above HAVE-PLACE, the correct allomorph is selected in both contexts:

(32) Pausal allomorph selected

	kaːtib-FEM-NOM-INDEF]$_{\text{Pau}}$	$\text{CODACOND}_{\text{Utt}}$	HAVE-PLACE
a. →	kaːtib-ah-NOM-INDEF]$_{\text{Pau}}$		1
b.	kaːtib-at-NOM-INDEF]$_{\text{Pau}}$	1 W	L

(33) Non-pausal allomorph selected

	kaːtib-FEM-NOM-INDEF]$_{\text{Cont}}$	$\text{CODACOND}_{\text{Utt}}$	HAVE-PLACE
a. →	kaːtib-at-NOM-INDEF]$_{\text{Cont}}$		
b.	kaːtib-ah-NOM-INDEF]$_{\text{Cont}}$		1 W

After the step in (33), the derivation continues with spell-out of NOM and INDEF, in that order. The derivation in (32) converges at the next step, however, for reasons discussed previously.

7. Interaction with cliticization

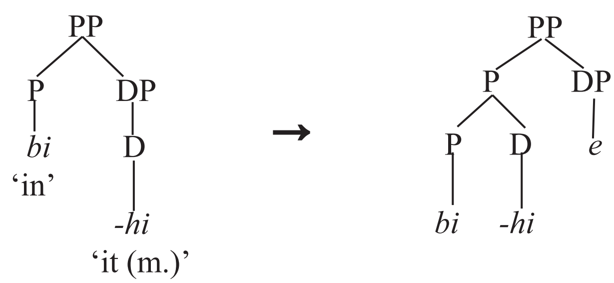
When a noun or verb is followed by a possessive or object clitic, the pausal alternation occurs on the clitic, with the preceding noun or verb in its contextual form. Several examples of this type appeared in (11) and are repeated in (34); some additional examples have been included as well.

(34) Words with clitics

qatal-tu-ka$_{\mathrm{Cont}}$	qatal-tu-k$_{\mathrm{Pau}}$	'I killed you (m. sg.)'
qatal-tu-ki$_{\mathrm{Cont}}$	qatal-tu-k$_{\mathrm{Pau}}$	'I killed you (f. sg.)'
kitaːb-a-ka$_{\mathrm{Cont}}$	kitaːb-a-k$_{\mathrm{Pau}}$	'your (m. sg.) book (acc.)'
kaːtib-at-u-ki$_{\mathrm{Cont}}$	kaːtib-at-u-k$_{\mathrm{Pau}}$	'your (f. sg.) writer (f. nom.)'

A fairly standard view of Arabic clitics is that they are adjoined to their hosts (Broselow 1976) by incorporation (Fassi Fehri 1993).[14]

(35) Cliticization as incorporation (Fassi Fehri 1993:102)



The host of cliticization is the nearest c-commanding head (Fassi Fehri 1993:98ff., Shlonsky 1997:178--9), which can be a noun, verb, adjective, preposition, quantifier, or complementizer. Incorporation is blocked under various conditions, such as when the pronoun is in a coordinate structure (Fassi Fehri 1993:103--6). In that case, the pronoun is instead cliticized to the dummy noun [ʔijjaː]: [raʔajtu ʔijjaː-ka wazajdan] 'I saw *ʔijjaː*-you (m. sg.) and Zeyd'.

It follows, then, that clitics and inflections have different morphosyntactic representations. Clitics are adjoined to the root's Xº, but inflections are in it: [[WRITER-FEM-NOM]$_{\mathrm{N}}$ [2$^{\mathrm{ND}}$-SG-FEM]$_{\mathrm{D}}$]$_{\mathrm{N}}$ (=last example in (34)). As we saw in (10) and (32), when [WRITER-FEM-NOM]$_{\mathrm{N}}$ occurs uncliticized and in pause, phonological constraints force FEM to be spelled out as [ah] rather than [at], and they block spell-out of NOM entirely. But when [WRITER-FEM-NOM]$_{\mathrm{N}}$ bears a clitic, it is not the rightmost Xº in the utterance; instead, the clitic is. In words with clitics, then, the clitic's Xº is the locus of the pausal alternation.

The explanation for why the pausal alternation affects only the clitic's Xº has to do with how spell-out works. Spell-out within an Xº goes from the bottom up, root first followed by the lowest/least peripheral affix, and so on (see Wolf (2008:chapter 3) as well as sections 3 and 5 above). But this says nothing about the order of spell-out of the adjoined Xºs in cliticized forms. The most reasonable hypothesis is that they are spelled out simultaneously, in parallel with one other. This is by no means a new idea, since it is exactly how generative phonology has always dealt with cyclic rule application in Xº compounds like *language requirement* (Chomsky and Halle 1968:21, Liberman and Prince 1977).

On this view, the explanation for why $[\text{ka:tib-at-u-k}]_{\text{Pau}}$ has a host in its contextual form and a clitic in its pausal form can be seen in the following partial derivation:

(36) Derivation of $[\text{ka:tib-at-u-k}]_{\text{Pau}}$

Morphosyntactic representation	$[[\text{WRITER-FEM-NOM}]_N\ [2^{\text{ND}}\text{-SG-FEM}]_D]_N$
Step 1	$[[\text{ka:tib-FEM-NOM}]_N\ [\text{k-FEM}]_D]_N$
Step 2	$[[\text{ka:tib-at-NOM}]_N\ [\text{k-FEM}]_D]_N$
Step 3	$[[\text{ka:tib-at-u}]_N\ [\text{k-FEM}]_D]_N$

At step 1, spell-out proceeds bottom-up in both $[\text{WRITER-FEM-NOM}]_N$ and $[2^{\text{ND}}\text{-SG-FEM}]_D$, simultaneously. At step 2, FEM in the host noun is spelled out as contextual [at] rather than pausal [ah] because the [ah]-favoring phonological constraint $\text{CODACOND}_{\text{Utt}}$ is applicable only to utterance-final consonants and the [k] of the clitic is utterance-final. In the clitic's D^o, spell-out of FEM as [i] is blocked by HEAVYINPAUSE. Finally, at step 3 the nominative suffix [u] is spelled out, since it too is protected from the effects of pause by the following [k].[15]

8. Conclusion

This chapter has examined the phonology of utterance-final words in Classical Arabic. Although well-motivated markedness constraints determine the properties of utterance-final syllables, the satisfaction of these markedness constraints is deeply entangled with the morphology. Wolf's (2008) Optimal Interleaving theory, I have argued, offers the best account of how phonology and morphology interact in these phenomena.

OI's principal contribution to the understanding of Arabic pausal forms is that it establishes a formal connection among four seemingly disparate phenomena: missing suffixes, infixation, portmanteau morphology, and allomorphy. The connection is that all are types of (non-)realization. Suffixes remain unrealized or are infixed for phonological reasons; a portmanteau morpheme appears under phonological conditions; and phonological constraints choose between allomorphs. OI also accommodates the one purely phonological consequence of pause, epenthetic [h].

It is clear from these results that OI offers a new and valuable perspective on phonology-morphology interaction.

Personal remark

I first met Lisa Selkirk in 1976 at NELS VII. She was a dashing figure who wore an École Polytechnique cape and gave a talk in which she boldly laid out a novel theory of syntax-phonology relations. She impressed me more, however, because she took a genuine interest in my work even though I was just a second-year graduate student at another school.

I later learned that Lisa's intellectual boldness at NELS was not unusual. When she engages with a topic, she does not hesitate to set out all the premises of her approach. This might seem dangerous, but experience shows that more often than not she is on the right track.

Having Lisa as a colleague was one of the most important reasons why I came to UMass in 1985. She has been a good friend and a continuing inspiration. I am excited to see how her work develops in the future.

Notes

[1] This research was supported by grant BCS-0813829 from the National Science Foundation to the University of Massachusetts Amherst. I am grateful to Matt Wolf, Shigeto Kawahara, and two anonymous reviewers for extensive comments.

[2] The principal Western references on Classical Arabic pausal forms are Birkeland (1940), Fleisch (1968:28--30), Hoberman (1995), Howell (1986:772--929), Schaade (1911:55--63), and Wright (1971:vol. II, 368--73). For evidence that the pausal forms were productive in Classical Arabic, see Hoberman (1995:162--4).

[3] Abbreviations used in glosses in this chapter: *1st*, *2nd*, *3rd* first, second, third person subject; *acc.* accusative; *du.* dual; *f.* feminine; *gen.* genitive; *impfv.* imperfective; *imptv.* imperative; *juss.* jussive; *m.* masculine; *nom.* nominative; *perfv.* perfective; *pl.* plural; *subjn.* subjunctive.

[4] Because [paʧi] is not in the candidate set at Step 1, CODA-COND and *ti are in conflict. Hence, CODA-COND must dominate *ti for the derivation to proceed any further, though these constraints would be unrankable in classic OT. To ensure that intermediate candidates win on the way to the ultimate surface form, HS often imposes additional ranking requirements like this. This difference from classic OT forms the basis of many of HS's typological predictions (e.g., McCarthy 2007b, 2008b)

[5] An exception may be needed for syllabification; see McCarthy (2010).

[6] Throughout this chapter, unmodified *root* refers to what is usually called the *stem* in analyses of Arabic. It does not refer to the consonantal root.

[7] Precompilation theory treats sandhi forms as a kind of morphology. It is therefore limited to sandhi alternations that are conditioned by the syntax. Pause is clearly not syntactic, so the Arabic pausal alternations cannot be analyzed with precompilation.

[8] In (18) I use a noun with a medial cluster, [θaʕlab], rather than [kitaːb] or [ʤabal], because *[kitaː.ub] or *[ʤabu.al] are independently ruled out by ONSET.

[9] ALIGN-L(*um*, stem) is violated once for each segment intervening between the left edge of the stem and the infix [um]. It therefore favors placing this affix as close to the beginning of the stem as possible.

[10] The Mirror Principle says that affix order reflects the order of syntactic operations.

[11] The [aː] indefinite accusative suffix must also bear the feature MASCULINE, since it is limited to nouns that are formally masculine.

[12] An anonymous reviewer points out that the two anomalous properties of the accusative suffix — resistance to infixation and pausal indefinite [aː] — receive different explanations in (19) and (27), respectively. Although it might seem that a generalization has been missed, in reality these two anomalies have a very different

status. The indigenous grammatical tradition describes the accusative suffix's resistance to infixation as variable or inconsistent, but the use of pausal indefinite [aː] is quite regular.

[13] At the next step of this derivation, $[\text{kitaːb-a-INDEF}]_{\text{Cont}}$ becomes $[\text{kitaːb-a-n}]_{\text{Cont}}$, after which the derivation converges.

[14] See Borer (1984) and Shlonsky (1997) for other views.

[15] An anonymous reviewer has drawn my attention to Kenstowicz's (2005:162) remark that the Arabic [at]~[ah] alternation is a counterexample to the claim that phonologically-conditioned allomorph selection never "looks ahead" to higher/later morphology (Carstairs[-McCarthy] 1987, 1990, Kiparsky 1994, Paster 2006, to appear), a claim that follows from the assumptions made here about sequential spell-out (see section 5). This counterexample is only apparent, however; it disappears once clitics are analyzed as they are in (36).

References

Baker, Mark (1985) The Mirror Principle and morphosyntactic explanation. *Linguistic Inquiry* 16: 373--415.

Barnes, Jonathan (2006) *Strength and Weakness at the Interface: Positional Neutralization in Phonetics and Phonology*. Berlin and New York: Mouton de Gruyter.

Birkeland, Harris (1940) *Altarabische Pausalformen*. Oslo: Jacob Dybwad.

Borer, Hagit (1984) *Parametric Syntax: Case Studies in Semitic and Romance Languages*. Dordrecht: Foris Publications.

Broselow, Ellen (1976) *The Phonology of Egyptian Arabic*. Doctoral dissertation, University of Massachusetts Amherst, Amherst, MA.

Burzio, Luigi (1994) Metrical consistency. In Eric Sven Ristad (ed.), *Language Computations*, 93--125. Providence, RI: American Mathematical Society.

Carstairs[-McCarthy], Andrew (1987) *Allomorphy in Inflexion*. London: Croom Helm.

Carstairs[-McCarthy], Andrew (1990) Phonologically conditioned suppletion. In Wolfgang U. Dressler, Hans C. Luschützky, Oscar E. Pfeiffer and John R. Rennison (eds.), *Contemporary Morphology*, 17--23. Berlin: Mouton de Gruyter.

Chomsky, Noam & Morris Halle (1968) *The Sound Pattern of English*. New York: Harper & Row.

Dresher, B. Elan (1983) Postlexical phonology in Tiberian Hebrew. In M. Barlow, D. Flickinger and M. Wescoat (eds.), *The Proceedings of the West Coast Conference on Formal Linguistics 2*, 67--78. Stanford: Stanford Linguistic Association.

Dresher, B. Elan (2008) The word in Tiberian Hebrew. In Kristin Hanson and Sharon Inkelas (eds.), *The Nature of the Word: Essays in Honor of Paul Kiparsky*, 95--111. Cambridge, MA: MIT Press.

Fassi Fehri, Abdelkader (1993) *Issues in the Structure of Arabic Clauses and Words*. Dordrecht and Boston: Kluwer Academic.

Fischer, Wolfdietrich & Otto Jastrow (eds.). 1980. *Handbuch der Arabischen Dialekte*. Wiesbaden: Otto Harrassowitz.

Flack, Kathryn (2007) *The Sources of Phonological Markedness*. Doctoral dissertation, University of Massachusetts Amherst, Amherst, MA.

Flack, Kathryn (2009) Constraints on onsets and codas of words and phrases. *Phonology* 26: 269--302.
Fleisch, Henri (1968) *L'Arabe Classique*. Beirut: Dar Al Machreq.
Goerwitz, Richard (1993) *Tiberian Hebrew Pausal Forms*. Doctoral dissertation, University of Chicago, Chicago. Available at http://www.goerwitz.com/papers/dissertation/.
Goldsmith, John (1990) *Autosegmental and Metrical Phonology*. Oxford and Cambridge, MA: Blackwell.
Halle, Morris & Alec Marantz (1993) Distributed Morphology and the pieces of inflection. In Kenneth Hale and Samuel Jay Keyser (eds.), *The View from Building 20*, 111--76. Cambridge, MA: MIT Press.
Hargus, Sharon. (1995) The first person plural prefix in Babine-Witsuwit'en. Unpublished paper, University of Washington, Seattle. Available on Rutgers Optimality Archive, ROA-108.
Hargus, Sharon & Siri G. Tuttle (1997) Augmentation as affixation in Athabaskan languages. *Phonology* 14: 177--220. Available on Rutgers Optimality Archive, ROA-191.
Hayes, Bruce (1990) Precompiled phrasal phonology. In Sharon Inkelas and Draga Zec (eds.), *The Phonology-Syntax Connection*, 85--108. Chicago: University of Chicago Press.
Hoberman, Robert (1995) Subtractive morphology and morpheme identity in Arabic pausal forms. *Yearbook of Morphology 1995*: 161--74.
Horwood, Graham (2002) Precedence faithfulness governs morpheme position. In Line Mikkelsen and Christopher Potts (eds.), *Proceedings of the 21st West Coast Conference on Formal Linguistics*, 166--79. Cambridge, MA: Cascadilla Press. Available on Rutgers Optimality Archive, ROA-527.
Horwood, Graham (2004) *Order without Chaos: Relational Faithfulness and Position of Exponence in Optimality Theory* Doctoral dissertation, Rutgers University, New Brunswick, NJ.
Howell, Mortimer Sloper (1986) *A Grammar of the Classical Arabic Language Translated and Compiled from the Works of the Most Approved Native or Naturalized Authors*. Delhi, India: Gian Publishing House.
Hudson, Grover (1974) The representation of non-productive alternation. In John Anderson and Charles Jones (eds.), *Historical Linguistics*, 203--29. Amsterdam: North Holland.
Ito, Junko (1989) A prosodic theory of epenthesis. *Natural Language & Linguistic Theory* 7: 217--59.
Kaneko, Ikuyo & Shigeto Kawahara (2002) Positional faithfulness theory and the emergence of the unmarked: The case of Kagoshima Japanese. *ICU English Studies* 5: 18--36.
Kenstowicz, Michael (2005) Paradigmatic uniformity and contrast. In Laura J. Downing, T. Alan Hall and Renate Raffelsiefen (eds.), *Paradigms in Phonological Theory*, 145--69. Oxford: Oxford University Press.
Kimper, Wendell (to appear) Local optionality and harmonic serialism. *Natural Language & Linguistic Theory*. Available on Rutgers Optimality Archive, ROA-988.
Kiparsky, Paul (1982) Lexical phonology and morphology. In I. S. Yang (ed.), *Linguistics in the Morning Calm*, 3--91. Seoul: Hanshin.
Kiparsky, Paul (1994) Allomorphy or morphophonology. In Rajendra Singh and Richard Desroches (eds.), *Trubetzkoy's Orphan: Proceedings of the Montréal Roundtable "Morphonology: Contemporary Responses"*, 13--31.

Amsterdam: John Benjamins.
Kratzer, Angelika & Elisabeth Selkirk (2007) Phase theory and prosodic spellout: The case of verbs. *The Linguistic Review* 24: 93--135.
Liberman, Mark & Alan Prince (1977) On stress and linguistic rhythm. *Linguistic Inquiry* 8: 249--336.
Lombardi, Linda (1995/2001) Why Place and Voice are different: Constraint-specific alternations in Optimality Theory. In Linda Lombardi (ed.), *Segmental Phonology in Optimality Theory: Constraints and Representations*, 13--45. Cambridge: Cambridge University Press. Originally circulated in 1995. Available on Rutgers Optimality Archive, ROA-105.
Mascaró, Joan (1996) External allomorphy as emergence of the unmarked. In Jacques Durand and Bernard Laks (eds.), *Current Trends in Phonology: Models and Methods*, 473--83. Salford, Manchester: European Studies Research Institute, University of Salford.
Mascaró, Joan (2007) External Allomorphy and Lexical Representation. *Linguistic Inquiry* 38: 715--35.
McCarthy, John J. (1979) *Formal Problems in Semitic Phonology and Morphology*. Doctoral dissertation, MIT, Cambridge, MA.
McCarthy, John J. (2000) Harmonic serialism and parallelism. In Masako Hirotani (ed.), *Proceedings of the North East Linguistics Society 30*, 501--24. Amherst, MA: GLSA Publications. Available on Rutgers Optimality Archive, ROA-357.
McCarthy, John J. (2002) *A Thematic Guide to Optimality Theory*. Cambridge: Cambridge University Press.
McCarthy, John J. (2007a) *Hidden Generalizations: Phonological Opacity in Optimality Theory*. London: Equinox Publishing.
McCarthy, John J. (2007b) Restraint of analysis. In Sylvia Blaho, Patrik Bye and Martin Krämer (eds.), *Freedom of Analysis*, 203--31. Berlin and New York: Mouton de Gruyter. Available on Rutgers Optimality Archive, ROA-844.
McCarthy, John J. (2007c) Slouching towards optimality: Coda reduction in OT-CC. In Phonological Society of Japan (ed.), *Phonological Studies 10*, 89--104. Tokyo: Kaitakusha. Available on Rutgers Optimality Archive, ROA-878.
McCarthy, John J. (2008a) *Doing Optimality Theory*. Malden, MA, and Oxford, UK: Blackwell.
McCarthy, John J. (2008b) The gradual path to cluster simplification. *Phonology* 25: 271--319. doi:10.1017/S0952675708001486.
McCarthy, John J. (2008c) The serial interaction of stress and syncope. *Natural Language & Linguistic Theory* 26: 499--546.
McCarthy, John J. (2010) Studying Gen. *Journal of the Phonetic Society of Japan* 13: 3--12.
McCarthy, John J. & Alan Prince (1993) Generalized Alignment. In Geert Booij and Jaap van Marle (eds.), *Yearbook of Morphology*, 79--153. Dordrecht: Kluwer. Available on Rutgers Optimality Archive, ROA-7.
McCarthy, John J. & Alan Prince (1994) The emergence of the unmarked: Optimality in prosodic morphology. In Mercè Gonzàlez (ed.), *Proceedings of the North East Linguistic Society 24*, 333--79. Amherst, MA: GLSA Publications. Available on Rutgers Optimality Archive, ROA-13.
McCarthy, John J. & Alan Prince (1995) Faithfulness and reduplicative identity. In Jill Beckman, Laura Walsh Dickey and Suzanne Urbanczyk (eds.), *University of Massachusetts Occasional Papers in Linguistics 18*, 249--384. Amherst, MA: GLSA Publications. Available on Rutgers Optimality

Archive, ROA-103.
McCarthy, John J. & Alan Prince (1999) Faithfulness and identity in Prosodic Morphology. In René Kager, Harry van der Hulst and Wim Zonneveld (eds.), *The Prosody-Morphology Interface*, 218--309. Cambridge: Cambridge University Press.
Mester, Armin (1994) The quantitative trochee in Latin. *Natural Language & Linguistic Theory* 12: 1--61.
Mohanan, K. P. (1982) *Lexical Phonology*. Doctoral dissertation, MIT, Cambridge, MA. Distributed by Indiana University Linguistics Club Publications.
Myers, Scott & Benjamin B. Hansen (2007) The origin of vowel length neutralization in final position: Evidence from Finnish speakers. *Natural Language & Linguistic Theory* 25: 157--93.
Padgett, Jaye (1995) Partial class behavior and nasal place assimilation. In Keiichiro Suzuki and Dirk Elzinga (eds.), *Proceedings of the 1995 Southwestern Workshop on Optimality Theory (SWOT)*, 145--83. Tucson, AZ: Department of Linguistics, University of Arizona. Available on Rutgers Optimality Archive, ROA-113.
Parker, Steve (2001) Non-optimal onsets in Chamicuro: An inventory maximized in coda position. *Phonology* 18: 361--86.
Paster, Mary (2006) *Phonological Conditions on Affixation*. Doctoral dissertation, University of California, Berkeley, CA.
Paster, Mary (to appear) Phonologically conditioned suppletive allomorphy: Cross-linguistic results and theoretical consequences. In Bernard Tranel (ed.), *Understanding Allomorphy: Perspectives from OT*. London: Equinox Publishing.
Pater, Joe (2006) The locus of exceptionality: Morpheme-specific phonology as constraint indexation. In Leah Bateman, Adam Werle, Michael O'Keefe and Ehren Reilly (eds.), *University of Massachusetts Occasional Papers in Linguistics 32: Papers in Optimality Theory III*. Amherst, MA: GLSA. Available on Rutgers Optimality Archive, ROA-866.
Pater, Joe (to appear) Serial Harmonic Grammar and Berber syllabification. In Toni Borowsky, Shigeto Kawahara, Takahito Shinya and Mariko Sugahara (eds.), *Prosody Matters: Essays in Honor of Lisa Selkirk*. London: Equinox Publishing.
Perlmutter, David (1998) Interfaces: Explanation of allomorphy and the architecture of grammars. In Steven G. Lapointe, Diane K. Brentari and Patrick M. Farrell (eds.), *Morphology and its Relation to Phonology and Syntax*, 307--38. Stanford, CA: CSLI Publications.
Prince, Alan (1975) *The Phonology and Morphology of Tiberian Hebrew*. Doctoral dissertation, MIT, Cambridge, MA.
Prince, Alan (2002) Arguing optimality. In Angela Carpenter, Andries Coetzee and Paul de Lacy (eds.), *University of Massachusetts Occasional Papers in Linguistics 26: Papers in Optimality Theory II*, 269--304. Amherst, MA: GLSA. Available on Rutgers Optimality Archive, ROA-562.
Prince, Alan & Paul Smolensky (1993/2004) *Optimality Theory: Constraint Interaction in Generative Grammar*. Malden, MA, and Oxford, UK: Blackwell.
Pruitt, Kathryn. (2008) Iterative foot optimization and locality in stress systems. Unpublished paper, University of Massachusetts Amherst, Amherst, MA. Available on Rutgers Optimality Archive, ROA-999.
Schaade, A. (1911) *Sibawaihi's Lautlehre*. Leiden: E. J. Brill.

Selkirk, Elisabeth (1980) Prosodic domains in phonology: Sanskrit revisited. In Mark Aronoff and Mary-Louise Kean (eds.), *Juncture*, 107--29. Saratoga, CA: Anma Libri.
Selkirk, Elisabeth (1984) *Phonology and Syntax: The Relation between Sound and Structure*. Cambridge, MA: MIT Press.
Selkirk, Elisabeth (1986) On derived domains in sentence phonology. *Phonology* 3: 371--405.
Selkirk, Elisabeth (1995) The prosodic structure of function words. In Jill Beckman, Laura Walsh Dickey and Suzanne Urbanczyk (eds.), *University of Massachusetts Occasional Papers in Linguistics 18: Papers in Optimality Theory*, 439--70. Amherst, MA: GLSA Publications.
Shlonsky, Ur (1997) *Clause Structure and Word Order in Hebrew and Arabic: An Essay in Comparative Semitic Syntax*. New York: Oxford University Press.
Smith, Jennifer L. (2002) *Phonological Augmentation in Prominent Positions*. Doctoral dissertation, University of Massachusetts Amherst, Amherst, MA.
Trager, George L. & Frank A. Rich (1954) The personal-pronoun system of Classical Arabic. *Language* 30: 224--9.
Tranel, Bernard (1996a) Exceptionality in Optimality Theory and final consonants in French. In Karen Zagona (ed.), *Grammatical Theory and Romance Languages*, 275--91. Amsterdam: John Benjamins. Available on Rutgers Optimality Archive, ROA-61.
Tranel, Bernard (1996b) French liaison and elision revisited: A unified account within Optimality Theory. In Claudia Parodi, Carlos Quicoli, Mario Saltarelli and Maria Luisa Zubizarreta (eds.), *Aspects of Romance Linguistics*, 433--55. Washington, DC: Georgetown University Press. Available on Rutgers Optimality Archive, ROA-15.
Tranel, Bernard (1998) Suppletion and OT: On the issue of the syntax/phonology interaction. In E. Curtis, J. Lyle and G. Webster (eds.), *The Proceedings of the West Coast Conference on Formal Linguistics 16*, 415--29. Stanford, CA: CSLI Publications.
Whitney, W. D. (1889) *Sanskrit Grammar*. Cambridge, MA: Harvard University Press.
Wolf, Matthew (2008) *Optimal Interleaving: Serial Phonology-Morphology Interaction in a Constraint-Based Model*. Doctoral dissertation, University of Massachusetts Amherst, Amherst, MA. Available on Rutgers Optimality Archive, ROA-996.
Wright, W. (1971) *A Grammar of the Arabic Language*. Cambridge: Cambridge University Press.