The Mirror Alignment Principle:
Morpheme Ordering at the Morphosyntax-Phonology Interface*

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1 Introduction

Since at least Baker's (1985) proposal of the "Mirror Principle", it has been widely recognized that the linear order of morphemes within a morphologically complex word generally correlates with hierarchical syntactic structure (see also Muysken 1981). In morphologically complex words, morphemes which represent the exponents of morphosyntactic terminals that are lower in the syntactic tree (or, in Baker's terms, earlier in the syntactic derivation) generally surface closer to the root than those morphemes which are exponents of higher morphosyntactic terminals. A question that Baker does not directly explore in his original proposal is by what formal means this ordering relation is implemented in the grammar. Both from a cross-linguistic perspective and a language-internal perspective, it is generally an arbitrary property (in terms of the synchronic grammar) whether a particular morpheme displays prefixal or suffixal behavior. This makes it difficult if not impossible to directly translate proposals regarding syntactic linearization (e.g., Kayne 1994) into the word-level domain.[1] Some other mechanism is needed. This paper proposes such a mechanism: the Mirror Alignment Principle.

This paper outlines a proposal whereby the surface order of morphemes is the result of several steps in a modular, feed-forward grammar with the following characteristics.[2] The syntax generates a hierarchical structure of morphosyntactic terminals (following generally the principles of Chomsky's (1995, *et seq.*) Minimalist Program). This hierarchal structure serves as input to a discrete morphological component (as in Distributed Morphology (DM); Halle & Marantz 1993) which has the ability to perform its own operations on the hierarchical structure (cf. Arregi & Nevins 2012). After vocabulary insertion within the morphological component endows the morphosyntactic terminals with phonological content, an Optimality Theoretic (Prince & Smolensky 1993/2004) grammar generates surface forms through constraint evaluation. The full grammar is schematized in (1), where " ⇩ " indicates that the output of the prior module serves as the input to the next module.

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[1] See Embick (2007) for a proposal that largely attempts to extend the principles of syntactic linearization to the ordering of morphemes within words.

[2] See Embick (2015) for extensive discussion of the nature of a grammar with these properties. This modular architecture is necessary for the current proposal, but alternative conceptions of the individual modules may also be compatible with the proposal.

(1) The modular grammar

Syntactic Component

syntactic operations:
MERGE, MOVE, etc.

⇩

hierarchical structure of morphosyntactic terminals

⇩

Morphological Component

morphological operations:
FISSION, FUSION, DELETION,
FEATURE CHANGE, etc.

⇩

vocabulary insertion

⇩

unordered set of morphemes & **ranking of Alignment constraints**

⇩

Phonological Component

Optimality Theoretic grammar:
GEN, CON, EVAL

The heart of the proposal lies in the relationship between the output of the morphological component and the contents and ranking of the constraint set, CON, in the phonological component. At the output of the morphological component, the hierarchical structure of morphosyntactic terminals over which the syntax and morphology operates is translated into a *ranking of Alignment constraints* in CON. Alignment constraints (McCarthy & Prince 1993, Prince & Smolensky 1993/2004) modulate the relationship between morpheme edges and edges of (higher-order) phonological or morphological constituents. By an algorithm which I call the Mirror Alignment Principle (MAP), whose details are laid out in Section 2, CON receives a ranking in which the Alignment constraint referencing a higher terminal *dominates* the Alignment constraint referencing a lower terminal. In other words, c-command in the morphosyntactic structure translates to ranking domination in the phonological component. By the nature of the Optimality Theoretic grammar, these constraints are violable, and therefore non-satisfaction of the ordering preferences can be compelled by the need to satisfy higher-ranked constraints, be they other Alignment constraints or any other sort of phonological constraint (i.e., markedness or faithfulness).

In this framework, there is no one point in the grammar where the linear order of morphemes is declared, *per se*. There are no operations in the syntactic or morphological components that linearize morphemes within a word, and there are no subcategorization requirements in the morphological or phonological components that dictate how morphemes are concatenated (contra Yu 2007, Paster 2006, 2009, *et seq.*). Instead, the linear order of morphemes is determined only indirectly, and the notions of prefixation and suffixation are epiphenomenal. All possible morpheme orders are produced as candidate outputs by GEN in the phonological component, and the optimal surface order is selected by EVAL, given the ranking in CON transmitted by the Mirror Alignment Principle.

Section 3 discusses the validity of Mirror Principle effects and the need to encode them in the grammar, focusing on the correlation between differences in morpheme order and differences in semantic interpretation in the Bantu languages. It will also countenance the challenge to the Mirror Principle posed by Bantu's so-called "CARP" template, as argued for by Hyman (2003). I will show that the range of challenging orders and their concomitant semantic interpretations can be explained as the result of operations located purely in the morphological component, in such a way that the data is fully compatible with the larger proposal on morpheme ordering.

Section 4 shows how this framework can begin to make headway on a longstanding problem in theoretical linguistics, the Semitic system of nonconcatenative morphology. Following much of the recent literature, I pursue an account whereby the prosodic shapes of different morphological "Forms" in Classical Arabic emerge from the grammar through constraint interaction, rather than prior stipulation, as in the early generative accounts on this topic (McCarthy 1979, 1981). I show that the MAP, coupled with language-specific properties of certain morphemes, accounts in a consistent and principled way for much of the range of Forms which have heretofore eluded such explanation.

Lastly, Section 5 explores a further prediction of the MAP hypothesis. Since morpheme ordering is determined through constraint satisfaction and interaction in the phonological component, it is predicted that phonological constraints can outrank Alignment constraints, and thus cause disruptions in the morpheme order called for by the hierarchical structure. This prediction is borne out in the behavior of the "mobile affixes" in Huave (Noyer 1993, Kim 2008, 2010, 2015). I develop a full account of this behavior, largely following the analysis of Kim (2008, 2010). The fully articulated use of Alignment constraints allows us to account for the data without the ad hoc layered/cyclic approach to affixation required by Kim's analysis. Section 6 concludes.

2 The Mirror Alignment Principle

McCarthy & Prince (1993) develop the theory of Generalized Alignment. They argue for the existence of a species of constraint couched within Optimality Theory which they term the Alignment constraint, which demands the coincidence in the output representation of specified edges of phonological and/or morphological constituents. One application of the theory of Generalized Alignment is in the determination of morpheme order. Since this original proposal, the critique has frequently been leveled that using Generalized Alignment as the primary arbiter of morpheme order massively overgenerates and fails to capture restrictive generalizations (cf. Paster 2009). The proposal outlined in this section takes Generalized Alignment as its starting point, but seeks to significantly constrain its power by placing principled restrictions on the ways Alignment constraints can operate in the phonology. Namely, the relative ranking of Alignment constraints is not free, contrary to the normal conception of free ranking of constraints in OT. Instead, their ranking is fixed, transmitted from the morphological component by means of the

Mirror Alignment Principle. This section defines the Mirror Alignment Principle, and illustrates how it can constrain the operation of Generalized Alignment.

2.1 Generalized Alignment

McCarthy & Prince (1993:2) define *Generalized Alignment* as follows:

(2) Generalized Alignment

> "Align (Cat[egory]1, Edge1, Cat[egory]2, Edge2) $=_{def}$
>
> ∀ Cat1 ∃ Cat2 such that Edge1 of Cat1 and Edge2 of Cat2 coincide.
>
> Where
>
> Cat1, Cat2 ∈ P[rosodic]Cat ∪ G[rammatical]Cat
>
> Edge1, Edge2 ∈ {Right, Left}
>
> …A GA requirement demands that a designated edge of each prosodic or morphological constituent of type Cat1 coincide with a designated edge of some other prosodic or morphological constituent Cat2."

Following the original formulation, violations of Alignment constraints used in this paper will be assigned gradiently (over segments), such that one violation is assigned for each segment which intervenes between the edge of *Cat1* and *Cat2*. McCarthy (2003) argues against the use of gradient constraints, including gradiently-evaluated Alignment constraints, in phonology. McCarthy's argument against gradient Alignment constraints comes from the absence of "hyperinfixation" – an infix moving further into a word to avoid markedness violations which would arise at its usual infixal position – specifically in the case of Tagalog, but also more generally cross-linguistically. He claims that this prediction can be avoided if we employ a small, well-defined set of categorical Alignment constraints. While this may be appropriate for the analysis of Tagalog, Yu (2007) points out that this is not a general cure for the typological problem. The hyperinfixation overgeneration issue thus rests in the use of (non-declarative) Alignment constraints, not in their mode of evaluation. I will not address this overgeneration issue, though I suggest that the mobile affixation pattern in Huave detailed in Section 5 bears striking logical similarity to hyperinfixation (the difference to some extent being whether CONTIGUITY can be violated in the particular case). The account to be presented here crucially relies on gradient Alignment constraints. Therefore, insofar as this account turns out to be valid and useful, it provides an argument in favor of gradient Alignment constraints. Further work will be needed to see if the effects attributed to gradience in this paper can be recapitulated by categorical Alignment constraints in the manner of McCarthy (2003).

Alignment constraints are constraints on the morphology-phonology interface, as they modulate the relationship between morphological categories ("grammatical categories," or, in effect, specific morphemes or classes of morphemes) and prosodic categories.[3] When a single Alignment constraint is active in a phonological derivation, it will appear as though its effect is to place the edge of the relevant morphological category at the edge of a particular prosodic category (or as near to it as possible, subject to higher-ranking phonological considerations). However, a

[3] This paper will not employ Alignment constraints which relate two prosodic categories. Any arguments in favor of the use and/or definition of Alignment constraints made in this paper thus only directly apply to those involving morphological categories.

different picture of Alignment constraints emerges when we consider how they can interact with one another.

Consider the following schematic example. A word contains a Root plus three affixal morphemes: X, Y, and Z. The underlying representation for this word is (by hypothesis) an *unordered* set of the four morphemes /Root, X, Y, Z/ (cf. McCarthy & Prince 1993). Each morpheme is referenced by an Alignment constraint. (I omit discussion of the Alignment of the Root at present.) All three constraints are defined over the same prosodic category – here *prosodic word* (and let's assume that there is only one prosodic word available) – and with reference to the same edges – here *Edge1* and *Edge2* are both *right* for all constraints involved. These constraints are shown in (3).

(3) Alignment constraints for the input /Root, X, Y, Z/

a. ALIGN(X, R; PWD, R)
Assign one violation mark for each segment intervening between the right edge of morpheme X and the right edge of the prosodic word.

b. ALIGN(Y, R; PWD, R)
mutatis mutandis

c. ALIGN(Z, R; PWD, R)
mutatis mutandis

Each Alignment constraint will be maximally satisfied when the morpheme it references is absolute rightmost within the prosodic word. However, in any candidate output, only one morpheme can successfully attain this position (assuming no coalescence).[4] This means that satisfaction of one of these Alignment constraints entails increased violation of the others. These constraints, therefore, will be in *direct competition* for a particular position in the output (here, final position in the prosodic word).

The following table shows the violation profiles for each possible combination of the three morphemes X, Y, and Z (such that each follows the Root). Violations are assigned here treating each morpheme as if it were a single segment, with one violation mark assigned for each morpheme which intervenes between the left edge of the prosodic word and (the left edge of) the morpheme being evaluated.

(4) Violation profiles

/Root, X, Y, Z/	ALIGN(X, R; PWD, R)	ALIGN(Y, R; PWD, R)	ALIGN(Z, R; PWD, R)
a. Root-X-Y-Z	**	*	
b. Root-Y-X-Z	*	**	
c. Root-X-Z-Y	**		*
d. Root-Z-X-Y	*		**
e. Root-Y-Z-X		**	*
f. Root-Z-Y-X		*	**

Each candidate order has a total of three alignment violations (since the morpheme second from the right incurs one Alignment violation, and the morpheme third from the right incurs two), but

[4] If a morpheme fails to have a surface exponent, any Alignment constraints referencing it will be vacuously satisfied.

distributed across the different constraints. The six possible permutations of the three alignment constraints will each correspond to the selection of one of the six candidate orders.

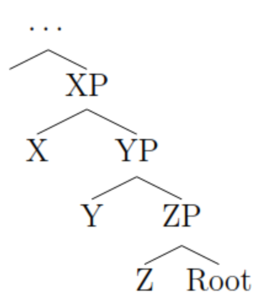
2.2 The Mirror Alignment Principle

Under the principle of free ranking permutation in OT (cf. Prince & Smolensky 1993/2004), we would expect all of these rankings to be permissible. That is to say, if Alignment constraints were solely responsible for determining morpheme order, and if they were subject to free ranking permutation, we would have no prior expectation of which of the six candidate orders the language should display. Put another way, given a full range of languages displaying words comprised of morphemes X, Y, and Z, we should expect each of the six candidate orders to be represented by some language.

Since at least Baker (1985) (see also Muysken 1981, Bybee 1985) it has been recognized that the order in which morphemes appear within a word generally reflects the relative positions that their corresponding morphosyntactic terminals occupy within the hierarchical morphosyntactic structure. Specifically, a morpheme that references a terminal which appears higher in the syntactic structure will be *more external* in the word than a morpheme referencing a lower terminal. Baker terms this generalization the “Mirror Principle”. We will further explore the validity of the proposal in Section 3, but for now let us assume that the Mirror Principle is basically correct.

Given the Mirror Principle, we *do* have prior expectations about the relative order of morphemes in complex words. Taking our schematic example, if we independently (through principles of syntax) have reason to believe that the morphemes X, Y, and Z (or, more properly, the morphosyntactic heads which they expone) stand in the hierarchical syntactic relation shown in (5) below,[5] then the Mirror Principle dictates that Z surface closest to the Root, Y surface next closest, and X surface farthest away, i.e. candidate order (4)f [Root-Z-Y-X].

(5) Syntax of /Root, X, Y, Z/



The ranking of the three Alignment constraints in (3) which will generate candidate order (4)f [Root-Z-Y-X] is the one shown in (6):

[5] In later sections, we will use head movement structures rather than base-generated structures. The difference is not significant here.

(6) Generating the Mirror Principle order

Ranking: ALIGN(X, R; PWD, R) » ALIGN(Y, R; PWD, R) » ALIGN(Z, R; PWD, R)

/Root, X, Y, Z/	ALIGN(X, R; PWD, R)	ALIGN(Y, R; PWD, R)	ALIGN(Z, R; PWD, R)
a. Root-X-Y-Z	*!*	*	
b. Root-Y-X-Z	*!	**	
c. Root-X-Z-Y	*!*		*
d. Root-Z-X-Y	*!		**
e. Root-Y-Z-X		**!	*
f. ☞ Root-Z-Y-X		*	**

What is important here is the relationship between the hierarchical structure in (5) and the ranking in (6). The highest terminal in the syntactic tree is X; the highest ranked constraint in the constraint ranking is ALIGN-X. The next highest terminal in the syntactic tree is Y; the next highest ranked constraint is ALIGN-Y. The lowest terminal in the syntactic tree is Z; the lowest ranked constraint is ALIGN-Z. This shows that mapping hierarchical syntactic relations onto ranking relations among Alignment constraints generates the Mirror Principle-compliant order of morphemes. If we characterize hierarchical relations in the normal way using c-command, this mapping can be defined as in (7).

(7) The Mirror Alignment Principle (The MAP)

In the output of the morphological component,[6] if a terminal node α asymmetrically c-commands a terminal node β, then, in the phonological component, Alignment constraints referencing α must dominate Alignment constraints referencing β.

Shorthand: **If α c-commands β → ALIGN-α » ALIGN-β**

When ALIGN-α and ALIGN-β reference the same edge, this will result in α being closer to the desired edge than β, i.e., the competition will be resolved in favor of α. If, on the other hand, they reference different edges, then satisfaction of the condition will be essentially vacuous. Such would be the case when one morpheme is (descriptively) a prefix and the other is (descriptively) a suffix, i.e., ALIGN-α-Left but ALIGN-β-Right. Since both can be satisfied simultaneously, there is no evidence for competition, and thus there can be no (direct) surface interaction. Whatever relative ranking is transmitted from the morphology can thus be instantiated without problem.

2.3 CONTIGUITY and Generalized Alignment

The Mirror Alignment Principle makes a seemingly nefarious prediction when considered in tandem with the faithfulness constraint CONTIGUITY (Kenstowicz 1994, McCarthy & Prince 1995), which I define as follows:

(8) CONTIGUITY-I(→)O

For two segments in the input x and y with output correspondents x' and y', assign one violation mark * if x and y are adjacent but x' and y' are not adjacent.

[6] This will be justified in Section 3.

CONTIGUITY can, for example, prefer epenthesis to occur at morpheme boundaries rather than morpheme-internally: /patk-sa/ → [patk*i*sa] rather than [pat*i*ksa]. But it is not only epenthetic segments that can intervene to cause CONTIGUITY violations. Other morphemes or pieces of other morphemes also have the potential to trespass inside a morpheme and cause CONTIGUITY violations. Alignment constraints provide a potential trigger for such intrusion.

Consider the following schematic example. We have a word consisting of two morphemes: a morpheme /*x*/ and a morpheme /*abcde*/. (Take each lower-case letter to be a single segment.) Both morphemes have a left-oriented Alignment constraint: ALIGN-/*x*/-L and ALIGN-/*abcde*/-L. ALIGN-/*x*/-L will be perfectly satisfied when *x* is the leftmost segment in the word. Likewise, ALIGN-/*abcde*/-L will be perfectly satisfied when *a* is the leftmost segment in the word. Since Alignment constraints are only concerned with aligning edges, any material in a morpheme which is not at the (designated) edge will be invisible with respect to that morpheme's Alignment constraint. In morphemes that are longer than a single segment, such as /*abcde*/, the invisibility of non-edge segments can become significant.

Let morpheme /*abcde*/ asymmetrically c-command /*x*/ in the morphosyntactic representation, causing the MAP to generate the ranking ALIGN-/*abcde*/-L » ALIGN-/*x*/-L. This ranking demands that the segment *a* surface as the leftmost segment in the word. As long as this condition is upheld, ALIGN-/*abcde*/-L is fully satisfied and the choice between any remaining candidates will be made by lower-ranked constraints. Now let us include CONTIGUITY as one such lower-ranked constraint, and consider candidates that violate it. The relative ranking of CONTIGUITY and the lower-ranked Alignment constraint, ALIGN-/*x*/-L, is crucial in choosing between two candidate outputs: the concatenative/externally-affixing output [*abcde*-*x*], and the *non*concatenative/infixing output [*a*-*x*-*bcde*]. This is demonstrated by the tableaux in (9).

(9) External affixation vs. infixation

(i) High-ranked CONTIGUITY → *external affixation*

/*abcde*, *x*/	ALIGN(*abcde*, L; PWD, L)	CONTIGUITY	ALIGN(*x*, L; PWD, L)
a. ☞ *abcde-x*			*****
b. *a-x-bcde*		*!	*
c. *x-abcde*	*!		

(ii) Low-ranked CONTIGUITY → *infixation*

/*abcde*, *x*/	ALIGN(*abcde*, L; PWD, L)	ALIGN(*x*, L; PWD, L)	CONTIGUITY
a. *abcde-x*		**!***	
b. ☞ *a-x-bcde*		*	*
c. *x-abcde*	*!		

When CONTIGUITY is ranked higher, as in (9)(i), the morpheme referenced by the lower-ranked Alignment constraint (/*x*/) can get no closer to the left edge than the end of the first morpheme, because it is more important to retain the contiguity relationships of all segments belonging to that first morpheme than to optimally align the second morpheme.[7] However, when the lower-ranked Alignment constraint ranks *over* CONTIGUITY, as in (9)(ii), the second morpheme can and does intrude on the first in order to optimize its alignment. This results descriptively in a nonconcatenative pattern, here plainly infixation.

Given that external affixation is the much more frequent pattern cross-linguistically, we might assume that there is a default ranking of CONTIGUITY over Alignment. Insofar as we ever see cases of alignment-driven infixation (perhaps distinct from phonotactically-driven infixation),[8] it must be the case that the lower ranking of CONTIGUITY is posited by a learner only under the weight of evidence for such a ranking. In Section 4, I will suggest that Classical Arabic represents such a system, where there would be no way to avoid positing low-ranked CONTIGUITY, due to idiosyncrasies of the segmental composition of morphemes. While it is perhaps misleading to talk of the Arabic system as infixing, this is a more general recipe for generating nonconcatenative morphology.

2.4 Local summary

This section has demonstrated that the Mirror Principle can be implemented in a framework that handles morpheme ordering in the phonological component using Alignment constraints if there is a principle which links hierarchical structure to the ranking of Alignment constraints. This proposal is here termed the Mirror Alignment Principle (MAP). The MAP limits the overgeneration problem typically associated with a Generalized Alignment approach to morpheme ordering, crucially because it eliminates the possibility of free ranking of Alignment constraints, in contradistinction to other phonological constraints. In a strong sense, this proposal does not attribute the *decision* on morpheme ordering to the phonology, but rather only the *implementation* of morpheme ordering, which is determined elsewhere (i.e. by the syntax and morphology). There is no obvious way in which this proposal could be translated into an account of morpheme ordering which relies on declarative subcategorization frames (a la Yu 2007, Paster 2006, 2009).

The following section will show how the MAP applies to a real example of Mirror Principle-determined orderings in the Bantu languages. Sections 4 and 5 consider how this framework can be useful in explaining difficult empirical and theoretical questions regarding nonconcatenative morphology in Classical Arabic and mobile affixation in Huave, respectively.

3 Bantu and the Mirror Principle

3.1 Mirror-image morpheme orders in Chichewa

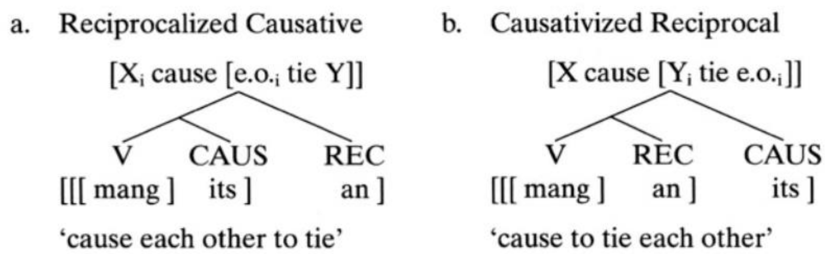
Baker (1985) demonstrates that, in certain Bantu languages, given two meaningful elements in verbal derivation, such as Causative and Reciprocal, a reversal in interpretation correlates with a

[7] It is crucial in this conception that precedence relations are not established between segments belonging to distinct morphemes. If, for example, the segment /*x*/ was adjacent to the right-edge segment of /*abcde*/, i.e. /*e*/, candidate (a) would incur a CONTIGUITY violation, because the *x*↔*e* pair is no longer adjacent in the output. With this violation recorded, candidates (a) and (b) are equivalent with respect to CONTIGUITY, and the lower-ranked ALIGN-/*x*/-L would decide the evaluation in favor of the infixing candidate (b). The view that there are no precedence relations between distinct morphemes in the input follows from the view that the input consists of an unordered set of morphemes. Their relative order is not fixed until the output, as determined by the constraint set transmitted in part by the MAP.

[8] See Yu (2007) for a comprehensive survey of infixation, and a quite different proposal on how to analyze it.

reversal in the linear order of the morphemes which expone those meanings. While there is a great deal more to say that will be taken up in Section 3.2 (based primarily on Hyman 2003), the basic generalization can be seen with the following contrast from Chichewa.

(10) Orders of Causative and Reciprocal in Chichewa (Hyman 2003:247, ex.2)



When the Reciprocal meaning "scopes" over that of the Causative as in (10)a, the Reciprocal morpheme *-an-* is more external in the linear ordering of morphemes than the Causative morpheme *-iʦ-*. On the other hand, when the Causative meaning scopes over the Reciprocal meaning in (10)b, that order is reversed and Causative *-iʦ-* is most external. While Hyman (2003) is cautious not to assert that these hierarchical structures are truly the *syntactic* structures associated with these derivations, I propose that we should indeed interpret them as such. Given that these derivational morphemes are suffixal in Chichewa (and the other Bantu languages), when these structures are fed into the mechanism of the Mirror Alignment Principle, the following rankings are generated for the two distinct structures:[9]

(11) Mirror Alignment Principle Rankings for the structures in (10)

a. Reciprocalized Causative: ALIGN-REC-R » ALIGN-CAUS-R
b. Causativized Reciprocal: ALIGN-CAUS-R » ALIGN-REC-R

When these rankings are submitted to EVAL in the phonological component, they will generate mirror-image orders. In the input, the morphemes are unordered; therefore, the order in which they are listed graphically is purely arbitrary and bears no significance. Each morpheme is notated with the morphosyntactic category it is exponing.

(12) Phonological derivations

a. Reciprocalized Causative: ALIGN-REC-R » ALIGN-CAUS-R

/maŋ$_{\text{ROOT}}$, iʦ$_{\text{CAUS}}$, an$_{\text{REC}}$/	ALIGN-REC-R	ALIGN-CAUS-R
a. ☞ maŋ-iʦ-an		** (an)
b. maŋ-an-iʦ	*!* (iʦ)	
c. iʦ-maŋ-an		***!** (an, maŋ)
d. an-maŋ-iʦ	*!**** (iʦ, maŋ)	

[9] I omit here discussion of the Root's alignment. The question of how Root-alignment can interact with other elements will be taken up in the discussion of Classical Arabic in Section 4.

b. Causativized Reciprocal: ALIGN-CAUS-R » ALIGN-REC-R

/maŋ$_{ROOT}$, iʦ$_{CAUS}$, an$_{REC}$/	ALIGN-CAUS-R	ALIGN-REC-R
a. maŋ-iʦ-an	*!* (an)	
b. ☞ maŋ-an-iʦ		** (iʦ)
c. iʦ-maŋ-an	*!**** (an, maŋ)	
d. an-maŋ-iʦ		***!** (iʦ, maŋ)

This demonstrates for a very basic case that Alignment constraints can place morphemes in the correct order in the phonological component without the application of any specific, declarative operations at any point within the grammar. All that is required is that hierarchical relations in the syntax/morphology are transmitted to the phonology as a set of pairwise ordered rankings, via the Mirror Alignment Principle.

Before proceeding, a brief digression here is required. We can see from this example that the ranking between these Alignment constraints differs across different syntactic derivations. This is somewhat unusual from the perspective of Optimality Theory, in which the constraint ranking is generally taken to be internally consistent within a language. But note that these are not purely phonological constraints; they crucially depend on morphosyntactic information. Therefore, it seems appropriate that higher-level morphosyntactic differences could alter their ranking. This would not be the case for purely phonological constraints, which are not sensitive to differences in morphosyntactic structure, so we should not expect their ranking to change in this way (though compare the operation of lexically-indexed constraints (e.g., Pater 2009), or cophonology theory (cf. Inkelas & Zoll 2007)).

3.2 The CARP template in Bantu

While certain Bantu languages do indeed display the behavior outlined in the above section for Chichewa, the full picture is a great deal more complicated. As shown by Hyman (2003), there are at least two major problems for assuming that the Mirror Principle operates without exception in Bantu (pp. 247-8). First, not all Bantu languages permit the sorts of reversals illustrated above for Chichewa – for example, Chimwiini shows none of this behavior (Hyman 2003:258); and those that do, including Chichewa, tend to permit them only with certain pairs of suffixes rather than as a whole throughout the language – for example, Chichewa does not show mirror-image orders for Causative and Applicative (Hyman 2003:248). Second, there is an interpretive asymmetry: in languages which do permit mirror-image orderings, one type of ordering permits both scopal interpretations while the other permits only the one correlated with the surface order.

Both of these problems point to the existence of the “CARP template.” Across the Bantu languages, in verbal formations involving multiple affixes from the set of Causative (C), Applicative (A), Reciprocal (R), and Passive (P), it is always permissible to have those affixes surface in that linear order, i.e. Causative before Applicative before Reciprocal before Passive, regardless of the relative scopal interpretation of those affixes. Chichewa’s Causativized Reciprocal in (10)b, with the order Root-Rec-Caus, is marked within the family. Many Bantu languages do not permit this surface order, and instead express the semantic equivalent using the CARP-obeying order Root-Caus-Rec. The interpretation of this form is thus ambiguous, since it can also be used to express the Reciprocalized Causative, as expected. Even in languages where both orders are permitted, the CARP-obeying order has the potential to express both meanings.

Yet, the CARP-violating orders have only one possible interpretation, the one which is properly correlated with the surface morpheme order via the Mirror Principle. This state of affairs, focusing specifically on Chichewa, is summarized in table (13).

(13) Orders and Interpretations in Chichewa

		Surface Morpheme Order	
		CARP-obeying	*CARP-violating*
		ROOT-CAUS-REC	ROOT-REC-CAUS
Semantic Interpretation	[[[ROOT] CAUS] REC]	a. ✓ (*MP-obeying*)	b. ✗ (*MP-violating*)
	[[[ROOT] REC] CAUS]	c. ✓ (*MP-violating*)	d. ✓ (*MP-obeying*)

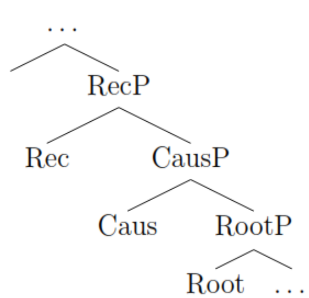
In a language like Chichewa which permits CARP-violating orders, the Mirror Principle-obeying interpretation is available for all forms (indicated by a "✓" in table (13) in the "MP-obeying" cells (13)a and (13)d). That is to say, any verbal form can be interpreted as having the outer affix take semantic scope over the inner affix. However, only the CARP-obeying order *additionally* permits the reverse, Mirror Principle-violating interpretation ((13)c); the CARP-violating order only permits the Mirror Principle-obeying interpretation (i.e., the interpretation in (13)d is possible but the interpretation in (13)b is not).

All of these facts can be accommodated within the present proposal if we assume that the CARP template is in some way real, and its effects are located *in the morphological component*. The range of cases can all be generated if we assume the following distribution of events within the full grammatical derivation. In the following discussion, I will use Chimwiini to refer to cases where CARP must be obeyed at all costs, and I will use Chichewa to refer to cases where CARP-violation is possible.

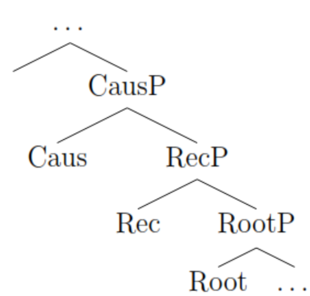
- The syntax can generate all semantic scopal orders, and does so with distinct hierarchical structures, such that a (morpho)semantic/syntactic terminal with wider scope is generated higher in the syntactic tree than those with narrower scope. That is to say, the syntactic component of any Bantu language, regardless of its morphological properties, can generate both of the syntactic structures in (10), reproduced here schematically:

(14) Structures generated in the syntax

a. Reciprocal scopes over Causative



b. Causative scopes over Reciprocal



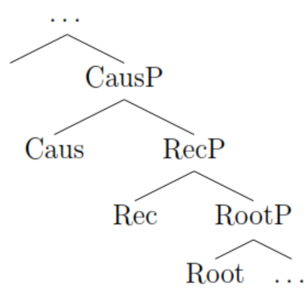
- This structure generated by the syntactic component (possibly having already undergone head movement) is submitted both to the morphological component (i.e., the first step in the PF branch) and to the semantic component (i.e., LF), where it is interpreted without further adjustment (other than whatever operations are typically attributed to the semantic component).
    i. If the hierarchical structure happens to be CARP-obeying, as in (14)a, then nothing further needs to be said. It passes through the morphological component without any adjustments. The Mirror Alignment Principle is thus calculated over the original syntactic structure, and generates, in the phonology, a CARP-obeying morpheme order Root-Caus-Rec. Semantic interpretation will therefore perfectly match the surface order of morphemes, satisfying the Mirror Principle. This is represented in table (13) by cell (13)a. This is the state of affairs in all Bantu languages, including both Chimwiini and Chichewa.
    ii. The action happens if the hierarchical structure happens to be *CARP-violating*, as in (14)b. Just in this case, the morphological component *may* perform an operation on it.

- When the morphological component receives a syntactic structure that violates CARP (e.g., (14)b where Caus c-commands Rec), the morphological component *has the ability to* (though may not ultimately decide to) alter this structure, such that these problematic structural relations no longer hold. While there are a number of ways in which this might be executed (see Appendix A for discussion), the result of this operation is a reorganized hierarchical structure in which "CARP is satisfied". One possibility is that this operation creates a flat structure where no asymmetric c-command relations hold between any two CARP elements.[10] Another possibility is that the operation creates a new hierarchical structure, such that Passive c-commands Reciprocal/Applicative/Causative, Reciprocal c-commands Applicative/ Causative, and Applicative c-commands Causative. For simplicity's sake, I will here assume the latter, illustrated as follows:

[10] If this is the correct approach, the output of this operation would yield a flat structure with no asymmetric c-command relations. Therefore, the MAP would not assert any rankings between these elements' Alignment constraints. We would then need to posit a list of ordering statements on the relative ranking of the CARP elements' Alignment constraints, located at the same point in the grammar where the MAP is located (i.e., the morphology-phonology interface). These ordering statements would be default rankings that kick in only in the absence of MAP-prescribed rankings. A similar statement will be proposed for Arabic in Section 4, whereby, in the absence of a MAP-prescribed ranking, ALIGN-ROOT dominates all other Alignment constraints.

(15) The results of the morphological CARP operation

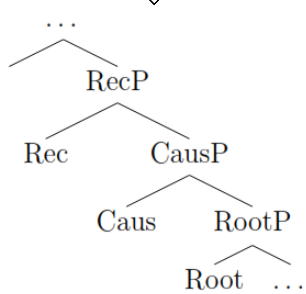
a. *Input to the morphological component (syntactic structure (14)b)*



⇩

Morphological CARP operation applies

⇩



b. *Output of the morphological component (hierarchical structure identical to (14)a)*

However, since the syntactic structure was submitted to LF prior to this operation, this operation has no effect on semantic interpretation. That is to say, the syntactically-CARP-violating structure (14)b can be, and in fact must be, interpreted *as is*, even if its surface morphemic representation will ultimately not reflect that hierarchy.

To derive the Bantu micro-typology, this operation, whatever its details, must apply in one of the following two ways:

i. *The operation applies obligatorily (CARP violation never permitted)*
Any time the morphological component receives a syntactically-CARP-violating structure ((14)b/(15)a), it alters that structure such that it satisfies CARP (resulting in the structure in (15)b). This CARP-satisfying structure is submitted to the Mirror Alignment Principle, and the phonology generates the surface morpheme order Root-Caus-Rec, which follows the CARP template. This will be homophonous with the Mirror Principle-obeying derivation based on the syntactic structure in (14)a, but bear a different interpretation, since it was underlyingly based on a different syntactic structure. It will therefore violate the Mirror Principle. This derivation is represented in table (13) by cell (13)c. This obligatory application of this operation is instantiated by languages like Chimwiini, where the CARP template is strictly adhered to. These languages have derivations corresponding to (13)c, but no derivations corresponding to (13)d, where the Mirror Principle is obeyed at the expense of the CARP template.

ii. *The operation applies optionally (CARP violation permitted)*
For any given on-line production, when the morphological component receives a syntactically-CARP-violating structure ((14)b/(15)a), it *has the option* to apply the CARP operation.
   a. If the grammar *does* apply the operation, the derivation proceeds as just described, and (13)c is instantiated.
   b. If the grammar *does not* apply the operation, the syntactically-CARP-violating structure ((14)b/(15)a) is passed through the morphological component unchanged, and the Mirror Alignment Principle is calculated over the original syntactic structure. The phonology thus generates a CARP-violating surface order Root-Rec-Caus, which adheres to the Mirror Principle. This derivation is represented in table (13) by cell (13)d.

This optional application of the CARP operation is exemplified by Chichewa, where the non-CARP-obeying interpretation (Caus scopes over Rec) is available for both morpheme orders.

In this system, there is no way to generate (13)b, a structure which violates the CARP template and simultaneously does not comply with the Mirror Principle (i.e., has an interpretation that does not match the surface order of morphemes). This is because semantic interpretation is fixed prior to any operations which take place in the morphological component, and the only (relevant) operation which can affect morpheme ordering is the one which creates the CARP hierarchy. That is to say, there is nothing which will transform a syntactically-CARP-obeying structure into a morphologically-CARP-violating one. Thus, if we can properly define an operation (or set of operations) in the morphological component that can create the CARP hierarchy, we perfectly capture the interaction between possible morpheme orders and possible interpretations across the Bantu languages.

4 Nonconcatenative Morphology in Classical Arabic

The nonconcatenative morphological system of the Semitic language family has long been a problem in generative linguistics, and has been an object of study from the very outset of the discipline (Harris 1941, Chomsky 1951).[11] Unlike most languages, morphological derivation of complex forms in Semitic does not straightforwardly consist of sequential affixation to a fixed base of derivation. While individual morphemes marking various morphological categories can be segmented and identified (with varying degrees of clarity and ease), they are often interspersed within other morphemes, and their addition often significantly alters the segmental order and/or larger prosodic organization relative to the corresponding less derived morphological form. These complex alternations are demonstrated most clearly in the verbal system of Classical Arabic, illustrated below with the 3SG.MASC inflected forms of the root *ktb* ‘write’:

[11] See McCarthy & Prince (1986/1996:52) for a list of pre-OT works on Semitic and Afro-Asiatic nonconcatenative morphology. See Tucker (2011) for an excellent introduction to the current state of the literature.

(16) The Classical Arabic verbal system (adapted from McCarthy 1981:385)[12]

	Perfective		Imperfective	
Form	Active	Passive	Active	Passive
I	kataba	kutiba	yaktubu	yuktabu
II	kattaba	kuttiba	yukattibu	yukattabu
III	kaataba	kuutiba	yukaatibu	yukaatabu
IV	ʔaktaba	ʔuktiba	yuʔaktibu	yuʔaktabu
V	takattaba	tukuttiba	yatakattabu	yutakattabu
VI	takaataba	tukuutiba	yatakaatabu	yutakaatabu
VII	(ʔi)nkataba	(ʔu)nkutiba	yankatibu	yunkatabu
VIII	(ʔi)ktataba	(ʔu)ktutiba	yaktatibu	yuktatabu
IX	(ʔi)ktababa		yaktabibu	
X	(ʔi)staktaba	(ʔu)stuktiba	yastaktibu	yustaktabu
XI	(ʔi)ktaababa		yaktaabibu	
XII	(ʔi)ktawtaba		yaktawtibu	
XIII	(ʔi)ktawwaba		yaktawwibu	
XIV	(ʔi)ktanbaba		yaktanbibu	
XV	(ʔi)ktanbaya		yaktanbiyu	

Early generative accounts attempted to explain the various patterns using prosodic templates (McCarthy 1979, 1981). Recent work (Bat-el 2003, 2011, Ussishkin 2000a, 2000b, 2003, 2005, Tucker 2010, 2011, Wallace 2013) has generally rejected this approach, arguing, among other things, that the prosodic template stipulates generalizations about phonotactics and syllable structure which should fall out independently from the grammar. For this reason, many recent accounts (e.g., Tucker 2010, 2011, Wallace 2013) seek to explain the patterns through the interaction of phonotactics and Alignment constraints.

These accounts reveal something strange about the Alignment behavior of the Reflexive marker *t* which is found in Forms V, VI, VIII, and X,[13] extracted and highlighted in (17).

(17) Reflexives (perfective active forms)

a. Form V *reflexive of the intensive* **t**akattaba

b. Form VI *reflexive of the reciprocal* **t**akaataba

c. Form X *causative of the reflexive* (*ʔi*)s**t**aktaba

vs.

d. Form VIII *simple reflexive* (*ʔi*)k**t**ataba

In Forms V, VI, and X, the *t* affix surfaces farther to the left than the first root consonant (the *k* in these examples). This is similar to the behavior of the *n* affix of Form VII and the *ʔ* affix of Form IV. However, in Form VIII, the reverse is true: the root-initial *k* is farther left than the reflexive *t*.

[12] The final [a] of the perfective and the final [u] of the imperfective are agreement suffixes. The initial [y] of the imperfective is an agreement prefix. The parenthesized [ʔi] / [ʔu] represent epenthetic segments that surface when the word is not in connected context.

[13] Tucker (2010:58 fn.28) raises doubt about the unity of the *t* affix across these forms. However, parsimony dictates that unity should be preferred if a straightforward analysis of these forms can be constructed.

One way to account for this behavior could be to posit that there are different classes of morphemes whose Alignment constraints are ranked differently with respect to the Root's Alignment constraint. This is exactly the approach pursued by Tucker (2010). For Tucker, the *t* of Forms V & VI (and X, though he does not decompose the *stV-* string into separate morphemes) belong to the "Prefix 1" class together with the *n* of Form VII,[14] while the *t* of Form VIII comprises its own separate class "Prefix 2". He generates the distinct orders with the ranking ALIGN-PREFIX1-L » ALIGN-ROOT-L » ALIGN-PREFIX2-L.

Such an approach begs the questions, why are there distinct Alignment rankings, and why does *t* pattern differently in different forms? The Mirror Alignment Principle provides a potential answer. In this section, I will show that the distinct Alignment behaviors in these Forms correlates with differences in syntactic structure. Furthermore, similar considerations can be used to explain other broader patterns within the verbal formations laid out in (16).

4.1 The verbal derivational morphemes and edge-precedence

In this subsection, we will consider the range of attested Forms in Classical Arabic and attempt to identify which morphosyntactic terminals each Form includes. Once we have identified the morphemes involved and their relative "edge-precedence", we will have in hand a diagnostic of the Mirror Alignment Principle, which we can subsequently use as our point of comparison with the phonological analysis.

To begin, let us consider again the data from table (16) above, reproduced below in (18) with additional material. The likely underlying forms of the portmanteau morphemes that mark the *aspect* + *voice* categories are displayed across the top, and the likely underlying representations of the Form markers (i.e., verbal derivational morphemes) are listed down the left side. The suggested derivational meanings of each Form are based on my reading of Wright (1896:29-46) and Schramm (1962:361-2) (see immediately below for discussion). Additionally, the pieces of each individual form which are due to the Form marker are shown in boldface. Each form is the third singular masculine for the root /ktb/ 'write'.[15]

[14] Presumably the ʔ of Form IV would also belong to this class, but this Form is absent from the dialect he is analyzing (Iraqi Arabic).

[15] Forms XI-XV are omitted due to their rarity and non-productivity. Note that they do seem to have certain behaviors that do not immediately follow from the account to be developed below.

(18) The Classical Arabic verbal system

Form	Derivational morphemes: morphosemantics and phonological content	**Perfective**		**Imperfective**	
		Active /a/	**Passive** /ui/	**Active** /uai/?	**Passive** /ua/
I	--	katab-a	kutib-a	y-aktub-u	y-uktab-u
II	*intensive*: /C/	ka**tt**ab-a	ku**tt**ib-a	y-uka**tt**ib-u	y-uka**tt**ab-u
III	*reciprocal*: /V/	k**aa**tab-a	k**uu**tib-a	y-uk**aa**tib-u	y-uk**aa**tab-u
IV	*causative*: /ʔ/	**ʔ**aktab-a	**ʔ**uktib-a	y-u(**ʔ**a)ktib-u	y-u(**ʔ**a)ktab-u
V	*reflexive*: /t/ of the *intensive*: /C/ (II)	**t**aka**tt**ab-a	**t**uku**tt**ib-a	y-a**t**aka**tt**ab-u	y-u**t**aka**tt**ab-u
VI	*reflexive*: /t/ of the *reciprocal*: /V/ (III)	**t**ak**aa**tab-a	**t**uk**uu**tib-a	y-a**t**ak**aa**tab-u	y-u**t**ak**aa**tab-u
VII	*resultative*: /n/	(*ʔi*)**n**katab-a	(*ʔu*)**n**kutib-a	y-a**n**katib-u	y-u**n**katab-u
VIII	*reflexive*: /t/	(*ʔi*)k**t**atab-a	(*ʔu*)k**t**utib-a	y-ak**t**atib-u	y-uk**t**atab-u
IX	*denominative*(?): /C/	(*ʔi*)kta**b**a**b**-a		y-akta**b**i**b**-u	
X	*causative*: /s/ + *reflexive*: /t/	(*ʔi*)**st**aktab-a	(*ʔu*)**st**uktib-a	y-a**st**aktib-u	y-u**st**aktab-u

Within a given Form category, there is often a significant degree of variation in the attested semantic interpretations observable for different roots which attest the formation. One category which is particularly difficult to pin down is Form II. Wright (1896:31-2) remarks that the basic meaning is "intensive," but that various forms may also be interpreted as "extensive," "iterative/ frequentative," "causative," "factitive," or "estimative". The plurality of semantic types within certain Form categories has been a factor in support of the notion of Form *cum* template as independent formal objects. However, given the locality of the morphosyntactic heads involved, and their location within the syntax, it is not unreasonable to assume that the combination of the Roots with these heads should be able to yield idiosyncratic, "idiomatic" meanings that obscure the unity of the category. I will thus assume that each Form represents a single morphosyntactic structure, and that this structure is independent of interpretation. The names given to these morphemes are only placeholders, and will be revised below.

The table in (19) shows Forms II-VII & X of the active perfective (omitting Agreement suffixes and phonotactically-motivated word-initial epenthetic segments). Of interest in this table is what I will refer to as "edge-precedence". I use this term to refer to the linear ordering of morphemes relative to a word edge – in this case, the left edge. A morpheme whose exponent's leftmost segment is farther to the left than a second morpheme's leftmost segment is said to *edge-precede* that second morpheme, indicated by " > " in the rightmost column. Boxes are placed around the exponents of the verbal derivational morphemes. Edge-precedence is determined by comparing the position of the boxes to the position of the *k* which represents the leftmost segment of the root, and to each other.

(19) Edge-precedence

	Form	Shape	Edge-precedence
a.	II	ka$\boxed{\text{tt}}$ab	*root* > *intensive*
b.	III	k$\boxed{\text{aa}}$tab	*root* > *reciprocal*
c.	IV	$\boxed{\text{ʔ}}$aktab	*causative* > *root*
d.	V	$\boxed{\text{t}}$aka$\boxed{\text{tt}}$ab	*reflexive* > *root* > *intensive*
e.	VI	$\boxed{\text{t}}$ak$\boxed{\text{aa}}$tab	*reflexive* > *root* > *reciprocal*
f.	VII	$\boxed{\text{n}}$katab	*resultative* > *root*
g.	VIII	k$\boxed{\text{t}}$atab	*root* > *reflexive*
h.	X	$\boxed{\text{s}}\boxed{\text{t}}$aktab	*causative* > *reflexive* > *root*

From this table, we can make several generalizations.

(20) Generalizations about edge-precedence

a. The *root* may edge-precede one verbal derivational morpheme, but never more than one.

b. *Reflexive* displays two distinct behaviors (as mentioned earlier):

   i. When *reflexive* co-occurs with another verbal derivational morpheme, it edge-precedes the *root* (V, VI, X).

   ii. When *reflexive* occurs by itself, it is edge-preceded by the *root* (VIII).

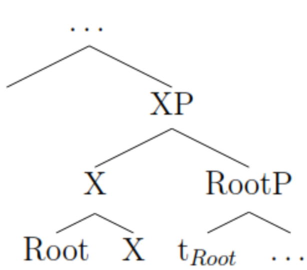
c. All other morphemes have consistent edge-precedence with respect to the *root*:

   i. *Causative* (IV & X) and *resultative* (VII) always edge-precede the *root*.

   ii. *Intensive* (II & V) and *reciprocal* (III & VI) are always edge-preceded by the *root*.

These generalizations will follow from the operation of the Mirror Alignment Principle, when coupled with one additional assumption: there is a *default preference* for Root-alignment to out rank all other Alignment constraints. The force of this assumption exerts itself only when the MAP does not impose a ranking of Alignment constraints. This will occur only in cases where, after head movement, the Root and another terminal node stand in a relation of *symmetric* c-command.[16] Within a complex head-movement structure, the only place where such a relationship will exist is between the lowest head (i.e., the Root) and the next highest head (to which the Root moves first).

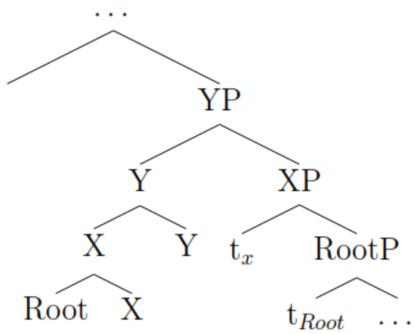
(21) Result of first head movement



[16] This will also occur if Root and another terminal node bear no c-command relation with one another. See Appendix A for discussion of one such possible case.

At all successive steps up the tree, the higher head will asymmetrically c-command the terminals that comprise the complex head which has head-moved to it (i.e., Root and X).[17]

(22) Result of further head movement



In this schematic structure, Y c-commands X and Root. Now consider again the definition of the MAP, repeated here:

(23) The Mirror Alignment Principle (repeated from (7) above)

> In the output of the morphological component, if a terminal node α asymmetrically c-commands a terminal node β, then, in the phonological component, the Alignment constraint referencing α must dominate the Alignment constraint referencing β.

Shorthand: **If α c-commands β → ALIGN-α » ALIGN-β**

For the structure in (22), because Y c-commands X and Root, the MAP dictates that ALIGN-Y dominates ALIGN-X and ALIGN-ROOT. However, since X and Root *symmetrically* c-command one another, the MAP asserts no ranking between their Alignment constraints, ALIGN-X and ALIGN-ROOT. In the absence of a MAP-prescribed ranking, the default preference for the higher ranking of ALIGN-ROOT kicks in, yielding the ranking ALIGN-ROOT » ALIGN-X. Transitivity thus gives the total ranking ALIGN-Y » ALIGN-ROOT » ALIGN-X. The MAP coupled with the default preference for high ranking Root-alignment thus captures generalization (20)a that the Root may only edge-precede at most one morpheme. This is indeed a general recipe in this language for the treatment of Root and the first two functional heads above it: ALIGN-ROOT will always dominate the Alignment constraint on the first functional head, and always be dominated by the Alignment constraint on the second functional head.

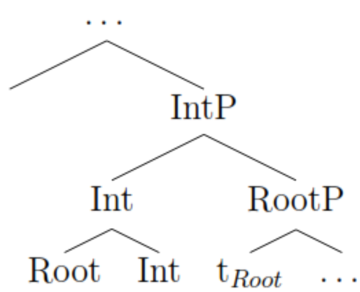
With this in mind, we have at hand a way to distinguish the syntactic structures underlying the two possible edge-precedence relations between a morpheme and the Root. When a morpheme *is edge-preceded by* the root (as in II, III, VIII, and the lower morphemes in V & VI), that morpheme is the first functional head above the root, i.e., head X in (21) and (22). When a morpheme *edge-precedes* the root (as in IV, VII, X, and the *reflexive* morpheme in V & VI), there is (at least) one functional head intervening between that morpheme and the root, i.e., it is head Y

[17] I assume that the calculation of c-command is restricted to only the lowest segments of terminal nodes, i.e., those heads in the structure which do not dominate any head.

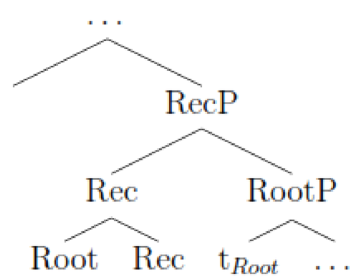
in (22).[18] As shown in the trees in (24), this requires positing an additional, silent head immediately above Root in three cases: Form IV, Form VII, and Form X. The most obvious candidate for the identity of this head is the default verbal categorizing head $v_{default}$ (perhaps $v_{agentive}$[19]). All of the morphemes under discussion could indeed be identified as some flavor of little *v*: v_{caus}, v_{refl}, etc. If this $v_{default}$ has a consistently null exponent, it would affect the hierarchical structure in the way required to generate the proper MAP ranking yet not have any direct surface reflex.

(24) Structures of Forms II-VII, X

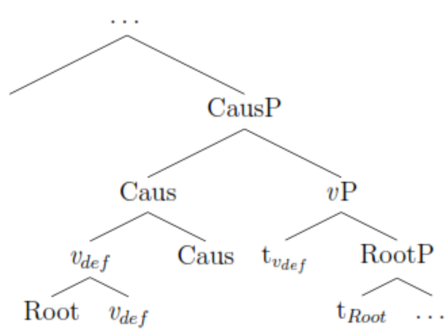
a. **Form II:** *intensive*



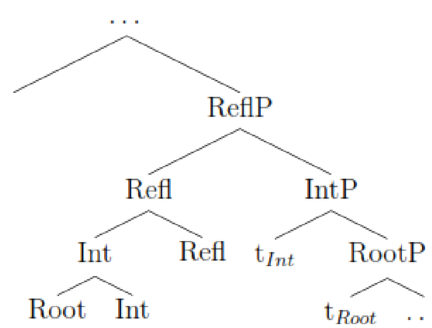
b. **Form III:** *reciprocal*



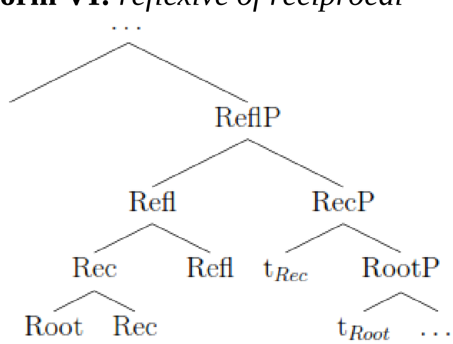
c. **Form IV:** *causative*



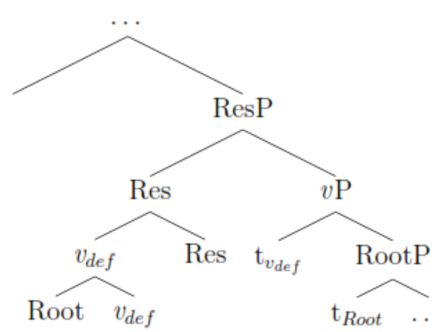
d. **Form V:** *reflexive of intensive*



e. **Form VI:** *reflexive of reciprocal*



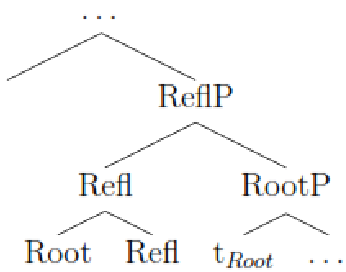
f. **Form VII**: *resultative*



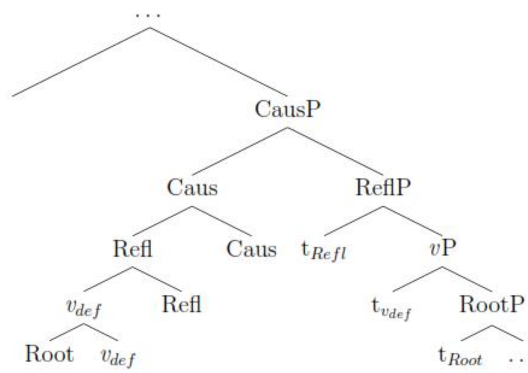
[18] We could entertain alternatives whereby, in cases where the Root scopes over another head, that head actually merges below Root, and the MAP is calculated over the pre-head movement structure. This may alleviate the need for positing the default ranking, but likely introduces additional complications.

[19] It does not appear that these morphological alternations reliably correlate with alternations in argument structure (see Tucker 2011:196-7, and references therein).

g. **Form VIII:** *reflexive*



h. **Form X:** *causative of reflexive*



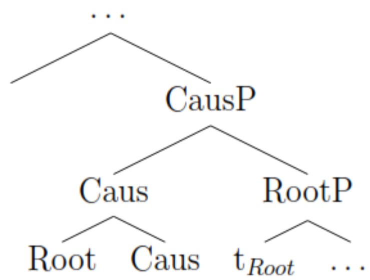
With the structures in (24) in hand, we can now address the asymmetry in the behavior of the reflexive *t*, as outlined in generalization (20)b. The Forms in which the reflexive *t* edge-precedes the Root (Forms V, VI, X) are exactly those which have a functional head intervening between Reflexive and Root.[20] This predicts the ranking ALIGN-REFL » ALIGN-ROOT (» ALIGN-$v_{default}$) via the MAP. The Form where the reflexive *t* is edge-preceded by the Root (Form VIII) has no intervening functional heads. This means that Refl and Root stand in symmetric c-command in the head-moved structure, and thus the MAP asserts no ranking. The default preference for Root-alignment imposes the ranking ALIGN-ROOT » ALIGN-REFL. Therefore, we have derived Tucker's stipulation of distinct prefix Alignment categories.

The morphosyntactic structures in (24) may also be able to help us reduce the overall complexity of the morphological system in another way. Recall generalization (20)c: unlike *reflexive*, all of the other derivational morphemes can show only a single edge-precedence behavior relative to the Root. Viewed in terms of their hierarchical structure, we can reframe this generalization in the following way: *causative* and *resultative* only occur (relatively) high, and *intensive* and *reciprocal* only occur (relatively) low. As mentioned above, the semantics of many of the Forms are fairly difficult to pin down. Yet, we can observe a general similarity in meaning between Form II (*intensive*) and Form IV (*causative*) – Form II can in fact sometimes have a causative interpretation (see Wright 1896:31-4). Additionally, we can observe that Intensive and Causative are in a structurally complementary distribution in the trees in (24): Intensive always surfaces as sister to Root (Form II (24)a & Form V (24)d); Causative never surfaces as sister to Root (Form IV (24)c & Form X (24)h). Taken together, these observations suggest that Intensive and Causative might actually represent the same morphosyntactic terminal, which I will call Causative. Under this proposal, the unitary Causative head would yield different interpretations, and also different allomorphs (see immediately below), depending on whether it is merged high or low. The structures that result if we conflate Intensive and Causative are shown in (25).

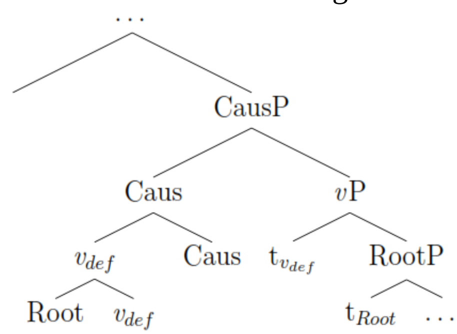
[20] The logic regarding Form X is circular because we have to posit a null functional head based purely on the operation of the MAP; but the logic of the other Forms does not suffer in this way.

(25) Conflating Intensive and Causative

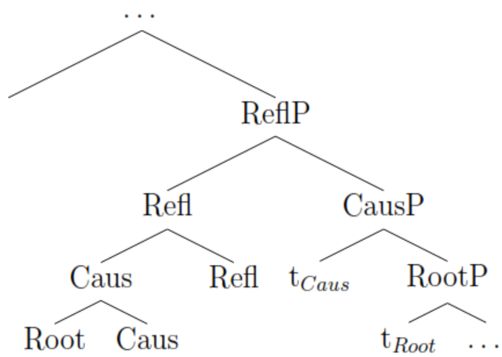
a. **Form II**: intensive → low causative



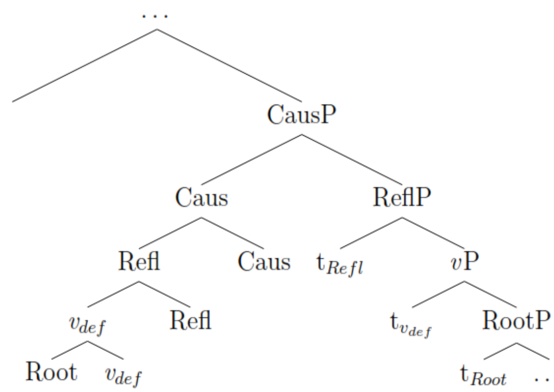
b. **Form IV**: causative → high causative



c. **Form V**: reflexive of intensive →
reflexive of causative [low]



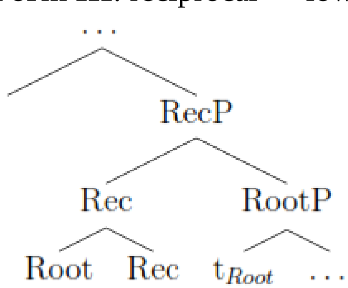
d. **Form X**: causative of reflexive →
causative [high] of reflexive



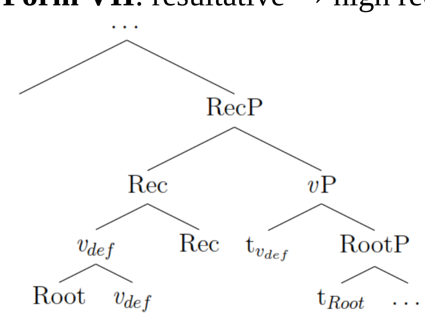
The same logic can be applied to *reciprocal* (Form III) and *resultative* (Form VII) – these Forms have broadly similar meanings and are in structurally complementary distribution. I will call this unitary head Reciprocal. The structures involving this head are shown in (26).

(26) Conflating Resultative and Reciprocal

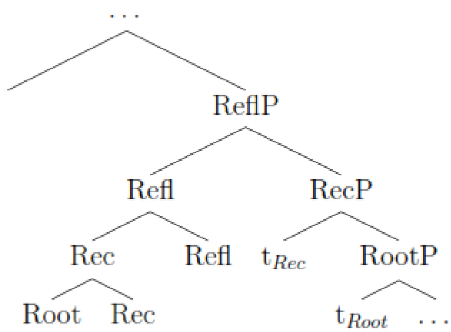
a. **Form III**: reciprocal → low reciprocal



b. **Form VII**: resultative → high reciprocal



c. **Form VI**: reflexive of reciprocal → reflexive of low reciprocal



Both of these new unitary heads display different allomorphs depending on their structural position. The allomorphy in both cases can be locally conditioned:

(27) Vocabulary entries

a. RECIPROCAL ↔ *vocalic timing slot* / sister to ROOT
b. RECIPROCAL ↔ n
c. CAUSATIVE ↔ *consonantal timing slot* / sister to ROOT
d. CAUSATIVE ↔ ʔ ~ s [21]

When we conflate the morphemes in this way, we end up with an almost fully crossed combination of possible little *v*'s:

(28) Combinations of terminals

		LOWER HEAD			
		CAUSATIVE *v*	RECIPROCAL *v*	REFLEXIVE *v*	*default v*
HIGHER HEAD	CAUSATIVE *v*	--	*not attested*	X	IV
	RECIPROCAL *v*	*not attested*	--	*not attested*	VII
	REFLEXIVE *v*	V	VI	--	X
	none (*default v*?)	II	III	VIII	I

While some logically possible combinations appear to still be lacking, most combinations are attested. This picture of the Arabic *v* domain comes to look a bit like what is shown by Bantu languages like Chichewa that allow mirror-image orders; heads can be merged in different orders by the syntax/semantics, and this is reflected in the surface order of those morphemes. Since we accounted for the differences in morpheme ordering in the Bantu case with the Mirror Alignment Principle, it would be ideal if we could do the same for Arabic. The remainder of this section demonstrates that this is indeed possible to a large extent, and can correctly generate much of the diversity seen in the various Forms.

[21] In Form X (*reflexive* + *causative*), the *causative* morpheme is exponed by /s/. There is comparative evidence indicating that the glottal stop [ʔ] that expones *causative* in Form IV derives historically from /s/ (Yushmanov 1961:49), the same form which is preserved in Form X. While it's unlikely that this diachrony would be precisely recapitulated in the minds of speakers, we could entertain the idea that the [ʔ] and [s] are still in a certain sense exponents of the same vocabulary insertion rule, distinct from that which yields gemination. The alternation between [s] and [ʔ] could be phonologically conditioned: [s] surfaces before consonants and [ʔ] surfaces before vowels.

The Mirror Alignment Principle provides us with expectations regarding the rankings of different Alignment constraints in different Forms. Assuming the syntactic representations presented in this section, the predicted rankings are shown in (29). We will see in the next section that these are exactly the rankings needed to capture the phonological facts, thus furnishing support for the Mirror Alignment Principle hypothesis.

(29) Rankings predicted by the MAP + Root-alignment preference (cf. (19))[22]

	Form		**Ranking**
a.	II	ka$\boxed{\text{tt}}$ab	Align-Root » Align-Caus
b.	III	k$\boxed{\text{aa}}$tab	Align-Root » Align-Rec
c.	IV	$\boxed{\text{ʔ}}$aktab	Align-Caus » Align-Root [» Align-v_{def}]
d.	V	$\boxed{\text{t}}$aka$\boxed{\text{tt}}$ab	Align-Refl » Align-Root » Align-Caus
e.	VI	$\boxed{\text{t}}$ak$\boxed{\text{aa}}$tab	Align-Refl » Align-Root » Align-Rec
f.	VII	$\boxed{\text{n}}$katab	Align-Rec » Align-Root [» Align-v_{def}]
g.	VIII	k$\boxed{\text{t}}$atab	Align-Root » Align-Refl
h.	X	$\boxed{\text{s}}\boxed{\text{t}}$aktab	Align-Caus » Align-Refl » Align-Root [» Align-v_{def}]

With this series of Alignment rankings generated by the Mirror Alignment Principle (with the default preference for high-ranking Root-alignment), we can begin to untangle the phonological complexities of the nonconcatenative morphological system of Classical Arabic (or at least its verbal system).

4.2 Phonological preliminaries

Before proceeding to the analysis, I will briefly discuss a few preliminary issues of syllable structure and Alignment.

4.2.1 Syllable Structure in Classical Arabic

Classical Arabic has a relatively restrictive syllable structure. It bans onsetless syllables. This is instantiated in the grammar by undominated Onset (Prince & Smolensky 1993/2004). It also restricts the distribution of consonants. It never permits three-consonant clusters, nor word-initial two-consonant clusters. Two-consonant clusters are permitted word-finally, but usually (or perhaps exclusively) resulting from suffixation of a singleton-consonant affix (e.g., /t/). These cluster distributions can be generalized as a requirement that all (non-word-final) consonants be adjacent to a vowel (since the first consonant in a word-initial cluster and the middle consonant in a three-consonant cluster are not adjacent to a vowel). We can represent this in the grammar by a constraint C//V, defined as "assign one violation mark for each non-word-final consonant which is not adjacent to a vowel." In the tableaux to be presented, only candidates which satisfy Onset and C//V will be considered (other than in the first tableau in (36), which retains maximal candidates for the sake of completeness). Many of the candidates ruled out by these constraints would have been suboptimal anyway given the ranking of Alignment constraints.

[22] Since v_{def} has a null exponent, its Alignment constraint Align-v_{def} is always vacuously satisfied and will have no impact in the phonology. Its predicted position is included for completeness.

4.2.2 The domain(s) of Alignment in Classical Arabic

It will become important in the analysis that there are two distinct domains/categories over which Alignment constraints can be defined in Classical Arabic. One is the MORPHOLOGICAL WORD (MWD), the other is the PROSODIC WORD (PWD):

(30) Two different types of words / Alignment domains

a. Definition of MORPHOLOGICAL WORD (MWD)
The string bounded by the leftmost segment with an underlying correspondent and the rightmost segment with an underlying correspondent.

b. Definition of PROSODIC WORD (PWD)
The string bounded by the leftmost segment and the rightmost segment (regardless of morphological affiliation).

This distinction is necessary due to the interaction between epenthesis and Alignment, specifically relating to the possibility of consonant clusters at the left edge. We will see that certain Forms in the perfective create a cluster at the left edge of the word, which is resolved by preposed epenthesis. This option is never tolerated in the imperfective, even in the Forms involving the same morphemes. This can be attributed to distinct properties of the imperfective subject agreement morphemes, which (in part) surface as prefixes. As will be shown below, if they are aligned with respect to the prosodic word, and all other left-oriented Alignment constraints operate over the morphological word, this distinction falls out. Furthermore, the calculation of alignment with respect to the epenthetic segments in the clustering Forms requires this distinction as well.

4.2.3 Edge Alignment

In Section 2.1, we reviewed the definition of Generalized Alignment, and subsequently showed how it could be responsible for aspects of morpheme ordering. In the standard definition of Alignment constraints, evaluation is conducted with respect to a particular edge of the two constituents, either Left or Right.[23] In the analysis of Classical Arabic presented below, I will propose a slight addition to this inventory. In addition to Left-alignment and Right-alignment constraints, I propose that there can exist *Both Edge*-alignment constraints (henceforth Edge-alignment or E-alignment). The informal schematic definition of these constraints is shown in (31).

(31) ALIGN (CATEGORY1, E; CATEGORY2, E)

Assign one violation mark for each segment that intervenes between the left edge of CATEGORY1 and the left edge of CATEGORY2, **and** assign one violation mark for each segment that intervenes between the right edge of CATEGORY1 and the right edge of CATEGORY2.

[23] It is a common assumption that Alignment constraints align their two constituents with respect to the same edge, as articulated by Kager (2007:119): "although it is not logically necessary that alignment constraints relate pairs of *identical* edges (that is, both left, or both right) for both categories, such matching is implicitly assumed by most researchers." However, this is not universally true in the literature. Going back to the original proposal by McCarthy & Prince (1993), there are analyses which employ opposite edge alignment between morphemes, which effectively results in adjoining those morphemes. This type of constraint is prevalent in subcategorization approaches, as in Yu (2007) and Paster (2006, 2009). The framework being developed in this paper requires same-edge alignment (within a particular constraint, not necessarily across different constraints), or else the effect of competition would be nullified.

In effect, these constraints are the conjunction of the Left- and Right-alignment constraints relating the same two categories. An alternative which would yield identical results is to have the Left- and Right-alignment constraints individually present in the ranking, ranked identically with respect to all other constraints, but not ranked with respect to one another. In the general case, the same result will also obtain if one is critically ranked above the other, since the complementary Alignment constraints will tend not to interact with one another. However, this has not been exhaustively confirmed for the proposed rankings, so I will not at present claim that there is no potential difference. Therefore, if one rejects the notion of E-alignment as a primitive, consider it instead a shorthand for either dual presence of complementary Alignment constraints or a conjunction of complementary Alignment constraints.

The analysis presented below will claim that both the Root and the Aspect+Voice morphemes have the property of E-alignment. This will account for much of the typologically unusual behavior displayed in Arabic word formation.[24]

4.3 Basics of the Phonological Analysis

Form I is the most basic verbal category, from the perspective of both the morphology and the semantics – it is the Form which contains no verbal derivational morphemes (only the default verbal categorizing head $v_{default}$). In this subsection, I will provide a brief overview of how the proposed system handles segmental ordering via Alignment interaction in this general case. This will provide the background for assessing the predictions of the MAP in the more morphologically complex forms, as laid out in Section 4.1.

4.3.1 The perfective passive of Form I

The third person masculine singular perfective passive of Form I for the root which means ‘write’ is *kutiba*. This word (and indeed any Form I perfective) consists of three morphemes:

(32) Morphemes in *kutiba*

a.	The root:	/ktb/	‘write’
b.	The Aspect+Voice morpheme:	/ui/	PERFECTIVE.PASSIVE
c.	The subject agreement morpheme:	/a/	3SG.MASC.PERFECTIVE

The Alignment constraints which reference these morphemes are defined in (33).

(33) Alignment constraints

a. ALIGN (ROOT, E; MORPHOLOGICALWORD, E) [ALIGN-ROOT-E-MWD]
Assign one violation mark for each segment that intervenes between an edge of the Root morpheme and the corresponding edge of the morphological word.

b. ALIGN (ASPECT+VOICE, E; MORPHOLOGICALWORD, E) [ALIGN-AV-E-MWD]
Assign one violation mark for each segment that intervenes between an edge of the *aspect+voice* morpheme and the corresponding edge of the morphological word.

[24] A more transparent application of E-alignment would be with circumfixes. It is possible that the imperfective agreement morphemes have this type of behavior, but I will not pursue this here.

c. ALIGN (AGREEMENT, R; PROSODICWORD, R) [ALIGN-AGR-R-PWD]
Assign one violation mark for each segment that intervenes between the right edge of the *perfective* morpheme and the right edge of the prosodic word.[25]

When these constraints are ranked as in (34), the desired output is selected.[26]

(34) Ranking: ALIGN-AGR-R-PWD » ALIGN-ROOT-E-MWD » ALIGN-AV-E-MWD

The OT derivation for the perfective of Form I is shown in (36) below; but, given the nature of Alignment constraints, we can also conceptualize the derivation in operational terms. The step-wise construction of *kutiba* is shown in (35), and described immediately below.

(35) Constructing the word

i. #…**a**#
ii. #**k**…t…**b**a#
iii. #k**u**…t…**i**ba#
iv. #ku**t**iba#

- Step (i): maximally satisfy ALIGN-AGR-R-PWD
  - *This places (the rightmost segment of) the Agreement affix ([a]) as close to the right-edge word boundary as possible. Since it is the top-ranked constraint, it can be satisfied fully. No subsequent material can intervene between the [a] and the word boundary.*
- Step (ii): maximally satisfy ALIGN-ROOT-E-MWD
  - *This places the leftmost segment of the Root ([k]) as close to the left-edge word boundary as possible. Since no previous material was aligned to the left, the [k] successfully reaches the left edge.*
  - *This also places the rightmost segment of the Root ([b]) as close to the right-edge word boundary as possible. Since the Agreement affix's [a] has already claimed rightmost position, the [b] must settle for attaching to the left of [a].*
  - *Nothing is asserted about the position of the Root-medial [t], other than that it comes between the [k] and the [b].*
- Step (iii): maximally satisfy ALIGN-AV-E-MWD
  - *This places the leftmost segment of the AV morpheme ([u]) as close to the left-edge word boundary as possible. Since the Root's [k] has already claimed leftmost position, the [u] must settle for attaching to the right of [k].*
  - *This also places the rightmost segment of the AV morpheme ([i]) as close to the right-edge word boundary as possible. Since the Agreement affix's [a] and the Root's [b] have already been placed at the right edge, the [i] must settle for attaching to the left of [b].*

[25] Aligning this morpheme to the prosodic word rather than the morphological word is not strictly necessary; but since it will be necessary to align the imperfective prefix to the left edge of the prosodic word, this makes all inflectional morphemes' alignment essentially parallel.
[26] The ranking ALIGN-ROOT » ALIGN-AV may pose a problem for the MAP, since the Aspect and Voice heads would be expected to appear higher in the syntactic structure than Root. However, it seems likely that the morphological operation which fuses Aspect and Voice disrupts this structure in a way that does indeed make this ranking MAP-compliant. See the Appendix A for discussion.

- Step (iv): resolve the placement of any remaining segments
  - *The only unplaced segment is the Root-medial [t]. It cannot be placed anywhere to the left of the AV morpheme's [u], since that would disrupt the order established by preceding constraints/operations; likewise, it cannot be placed anywhere to the right of the AV morpheme's [i]. Therefore, its position is fixed between [u] and [i].*[27]

This derivation, not in these operationalized terms, is demonstrated in tableau (36) below. In the following tableaux, {…} indicates the boundaries of the prosodic word and […] indicates the boundaries of the morphological word. *Italics* identify a segment as epenthetic. In addition to standard " * " violation marks, I notate Alignment violation cells with the segments which are causing the violations. In the segmental violation notations of E-alignment constraints, violations associated with the left edge are indicated to the left of the vertical bar " | ", while violations associated with the right edge are indicated to its right.

(36) Perfective passive of Form I: 3SG.MASC *kutiba*

/ktb, ui, a/	ALIGN-AGR-R-PWD	ALIGN-ROOT-E-MWD	ALIGN-AV-E-MWD
a. ☞ {[kutiba]}		* (| a)	*** (k | b,a)
b. {[ku.itba]}		* (| a)	****! (k | t!,b,a)
c. {[uktiba]}		**! (u! | a)	** (| b,a)
d. {[kutbi.a]}		**! (| i!,a)	** (k | a)
e. {[ktubi.a]}		**! (| i!,a)	*** (k,t | a)
f. {[ktbu.i.a]}		**!* (| u!,i, a)	**** (k,t,b | a)
g. {[kuti.ab]}	*! (b!)		*** (k | a,b)
h. {[ku.itab]}	*! (b!)		**** (k | t,a,b)
i. {[u.iktab]}	*! (b!)	** (u,i |)	**** (| k,t,a,b)
j. {[ukitab]}	*! (b!)	* (u |)	*** (| t,a,b)
k. {[akutib]}	*!**** (k!,u!,t!,i!,b!)	* (a |)	*** (a,k | b)

Making use of the rankings proposed above, we select the desired candidate (a). Undominated ALIGN-AGR-R-PWD rules out candidates (g-k), since they have maximally right-aligned the Root at the expense of the perfective agreement morpheme. The next highest-ranked Alignment constraint, ALIGN-ROOT-E-MWD, rules out candidates (c-f), as they each have at least one AV morpheme vowel more external than one of the Root's edge consonants. ALIGN-AV-E-MWD decides between the remaining two candidates, (a) and (b), in favor of (a), because the AV morpheme's [i] is closer to the right.

But this tableau does not include the syllabic well-formedness constraints C//V and Onset, which, based on the rules of general syllable structure in the language discussed above, must be undominated. The following tableau shows that, when we include these constraints, we get the same outcome, but nevertheless still need the ranking of the Alignment constraints presented thus far. (I omit candidates where the perfective agreement morpheme is misaligned.) This tableau also

[27] The placement of segments which are neither leftmost nor rightmost within any morpheme's underlying representation will never be directly modulated by an Alignment constraint. If there were multiple remaining medial segments (from distinct morphemes), their relative placement would be determined by other constraints, namely phonotactics. It appears, though, that, for Classical Arabic, this situation will rarely if ever come about.

shows candidates which repair these phonotactic violations through epenthesis, which is an attested repair under certain circumstances. These candidates are likewise ruled out by Alignment.

(37) Perfective passive of Form I: 3SG.MASC *kutiba*

/ktb, ui, a/	C//V	ONSET	ALIGN-ROOT-E-MWD		ALIGN-AV-E-MWD	
a. ☞ {[kutiba]}			*	(| a)	***	(k | b,a)
b. {[ku.itba]}		*!	*	(| a)	****	(k | t,b,a)
c. {[kuʔitba]}			*	(| a)	****!	(k | t!,b,a)
d. {[uktiba]}		*!	**	(u | a)	**	(| b,a)
e. {ʔ[uktiba]}			**!	(u! | a)	**	(| b,a)
f. {[kutbi.a]}		*!	**	(| i,a)	**	(k | a)
g. {[kutbiʔa]}			**!*	(| i!,ʔ!,a)	**	(k | ʔ,a)
h. {[ktubi.a]}	*!	*!	**	(| i,a)	***	(k,t | a)
i. {ʔ*u*[ktubiʔa]}			**!*	(| i!,ʔ!,a)	****	(k,t | ʔ,a)

The syllable well-formedness constraints immediately rule out many of the permutations (b,d,f,h). But since epenthesis (at least morphological-word externally) is a viable repair strategy in the language (see below for further discussion), the candidates that employ epenthesis to improve the syllable structure resulting from these Alignment permutations (c,e,g,i) must still be considered. These candidates are again ruled out by the Alignment constraints. If we zoom in on the most viable candidates (a,c,e), we can clearly see the evidence for the ranking of ALIGN-ROOT-E-MWD » ALIGN-AV-E-MWD:

(38) Perfective passive of Form I: 3SG.MASC *kutiba*

/ktb, ui, a/	ALIGN-ROOT-E-MWD		ALIGN-AV-E-MWD	
a. ☞ {[kutiba]}	*	(| a)	***	(k | b,a)
c. {[kuʔitba]}	*	(| a)	****!	(k | t!,b,a)
e. {ʔ[uktiba]}	**!	(u! | a)	**	(| b,a)

The tradeoff is now clear. Candidate (e) is ruled out precisely because it has optimally aligned an AV vowel at the expense of a root consonant. Candidate (c) is ruled out because it has aligned the root-medial *t* too far to the right at the expense of the AV vowel *i*. Therefore, even with the syllable well-formedness constraints, we still require Alignment constraints to properly derive the full segmental order.

4.3.2 CONTIGUITY (or lack thereof) in Classical Arabic

In Section 2.3, I suggested that Classical Arabic was a language where the faithfulness constraint CONTIGUITY, whose definition is repeated here, could not help but be violated in the course of word formation.

(39) CONTIGUITY-I(→)O (repeated from (8) above)

For two segments in the input *x* and *y* with output correspondents *x′* and *y′*, assign one violation mark * if *x* and *y* are adjacent but *x′* and *y′* are not adjacent.

We are now equipped to see why this is the case. This fact stems from the unusual distribution of segments in underlying representations.

Roots are comprised of a string of consonants (such as *ktb*), and the Aspect+Voice morphemes are comprised of a string of vowels (such as *ui*). Since the language imposes restrictions both on sequences of consonants (C//V) and sequences of vowels (ONSET), there is no way that these two morphemes could surface as a phonotactically licit string without violating CONTIGUITY.

Besides deletion, which is not a repair generally employed in this language, there are two ways that the string could be made phonotactically licit. One is epenthesis. At the expense of DEP violations, epenthesis would allow for a concatenative structure: /ktb, ui/ → [k*i*tb-u*ʔ*i], [*ʔi*kt*i*b-u*ʔ*i], etc. However, this sort of epenthesis itself creates a CONTIGUITY violation, as it separates segments which were adjacent in underlying representation ([k*i*tb-u*ʔ*i] would have violations for the pair *k*↔*t* and the pair *u*↔*i*). The other way to repair the phonotactics is what we might call intrusion. Given the idiosyncratic underlying structure of the morphemes, having the AV morpheme intrude on the Root provides vowels to avoid C//V violations for the Root, and consonants to avoid ONSET violations for the AV morpheme: /ktb, ui/ → [k-u-t-i-b]. This results in three CONTIGUITY violations (*k*↔*t*, *t*↔*b*, and *u*↔*i*), but it manages to avoid having to violate any other faithfulness constraints, namely DEP.

Since CONTIGUITY must be multiply violated under either strategy, learners would be led to rank it very low in their grammar. Since extra violation of the low-ranked CONTIGUITY constraint allows avoidance of DEP violations altogether, the intrusion strategy would be preferred, and we are left with the nonconcatenative system we observe for Classical Arabic.

4.3.3 The imperfective passive of Form I

In the perfective, all Agreement markers surface at the right edge (i.e., are inherently suffixal). This is not the case in the imperfective, where an Agreement morpheme always surfaces at the left edge, as well as at the right edge. The presence of a left-edge morpheme affects the Root's ability to attain its position at the left edge, thus introducing a new complication.

The imperfective form otherwise equivalent to *kutiba* is *yuktabu*.

(40) Morphemes in *yuktabu*

a.	The root:	/ktb/	'write'
b.	The Aspect+Voice morpheme:	/ua/	IMPERFECTIVE.PASSIVE
c.	The subject agreement morpheme(s):	/y…u/	3SG.MASC.IMPERFECTIVE

For simplicity's sake, I will treat the prefixal and suffixal parts of the imperfective agreement as distinct entities[28] – the prefixal part controlled by a Left-alignment constraint, the suffixal part

[28] How exactly to analyze the composition of the imperfective subject agreement markers (and, to a lesser extent, the perfective ones) is quite a complicated issue. Tucker (2011:181-3) attempts to lay out a Distributed Morphology analysis of the vocabulary entries necessary to generate the system, but does not focus on the relationship between prefixal and suffixal exponents in the imperfective (see also Schramm 1962:363-4 for a basic overview of the system).

controlled by a Right-alignment constraint. Both constraints dominate all other Alignment constraints.

(41) Alignment constraints

a. ALIGN (IMPERFECTIVEPREFIX, L; PROSODICWD, L) [ALIGN-AGR$_{\text{IPFP}}$-L-PRWD]
Assign one violation mark for each segment that intervenes between the left edge of the imperfective prefixal agreement marker and the left edge of the prosodic word.

b. ALIGN (IMPERFECTIVESUFFIX, R; PROSODICWD, R) [ALIGN- AGR$_{\text{IPFS}}$-R-PRWD]
Assign one violation mark for each segment that intervenes between the right edge of the imperfective suffixal agreement marker and the right edge of the prosodic word.

The following tableau demonstrates that, when these constraints are ranked above the Root-alignment constraint, we generate the correct imperfective of Form I. Furthermore, this tableau shows why it is necessary that these Alignment constraints (at least ALIGN-AGR$_{\text{IPFP}}$-L) are defined over the prosodic word, and not the morphological word.

(42) Imperfective passive of Form I: 3SG.MASC *yuktabu*[29]

/y, ktb, ua, u/	C//V	ALIGN-AGR$_{\text{IPFP}}$-L-PWD	ALIGN-AGR$_{\text{IPFS}}$-R-PWD	ALIGN-ROOT-E-MWD	ALIGN-AV-E-MWD
a. ☞ {[yuktabu]}				*** (y,u | u)	*** (y|b,u)
b. {[yukatbu]}				*** (y,u | u)	****! (y|t!,b,u)
c. {[ykutabu]}	*!			** (y | u)	**** (y,k|b,u)
d. {*ʔu*[ykutabu]}		*!* (ʔ!,u!)		** (y | u)	**** (y,k|b,u)
e. {[kuytabu]}		*!* (k!,u!)		* (| u)	*** (k|b,u)
f. {[yukatub]}			*! (b!)	*** (y,u | u)	**** (y|t,u,b)

Ranking the imperfective affixes' Alignment constraints high rules out a candidate like (e), which optimally left-aligns the Root at the expense of the imperfective prefix, and candidate (f), which optimally right-aligns the Root at the expense of the imperfective suffix.[30] Candidate (c) shows what would be the optimal segmental makeup purely in terms of the Alignment constraints. However, since this ends up creating a word-initial cluster (C//V violation), it is not allowed to surface.

We will see below in Section 4.4 that, when this situation (optimal alignment resulting in left-edge C//V violation) comes about through Alignment interaction between the Root and a

[29] It is probably safe to ignore any potential complications that arise from phonotactic restrictions on the segment [y]; other imperfective prefixes, such as /n/, a consonant with unrestricted distributions, behave in the identical way. Though, perhaps some paradigmatic uniformity condition could be at work based on positional restrictions of [y]. Such an account may be able derive the same effect that is here basically stipulated through reference to prosodic word rather than morphological word.

[30] We actually do not have evidence for critical ranking of ALIGN-AGR$_{\text{IPFS}}$-R-PWD here, since candidate (e) is harmonically bounded by (a) and (b). I believe that evidence for the high ranking of this constraint could be gleaned from more complex forms, but I will not revisit this issue.

verbal derivational morpheme, the syllable well-formedness problem is repaired through epenthesis. This is the sort of candidate illustrated by (42)d. But this is not the optimal candidate in this imperfective derivation. The reason why this does not occur should be traced to a difference in the domain of alignment between the imperfective agreement prefix and the verbal derivational morphemes; namely, it must be the case that the domain of alignment for ALIGN-AGR$_{\text{IPFP}}$-L is the prosodic word rather than the morphological word. Candidate (d) has a configuration where the imperfective prefix is leftmost in the morphological word, and the Root-initial consonant immediately follows; the C//V violation is avoided by epenthesis *outside* the morphological word. If ALIGN-AGR$_{\text{IPFP}}$-L were evaluated with respect to the morphological word, no violation would be recorded for the epenthetic segments *ʔ* and *u*. If these violations were thusly removed from candidate (d), it would be more optimal than desired candidate (a), since it incurs fewer violations of ALIGN-ROOT-E-MWD. Therefore, we must retain the definition in (41)a whereby the constraint is evaluated over the prosodic word.

Since clustering at the left edge is prohibited by ALIGN-AGR$_{\text{IPFP}}$-L-PWD, a vowel must immediately follow the agreement prefix *y-*. Since the AV morpheme has a vowel, it is recruited into second position, in service of the combined force of ALIGN-AGR$_{\text{IPFP}}$-L-PWD and C//V. A by-product of this interaction is increased satisfaction of ALIGN-AV-E-MWD, but this is only incidental; desire for increased satisfaction of this constraint plays no role in determining the shape of the word.[31]

This leaves only candidates (a) and (b). The difference between these candidates comes down to the relative position of the Root-medial consonant *t* and the second AV vowel *a*. Since the Alignment constraint on the Root references only the edges of the Root (left edge = *k*, right edge = *b*), the position of the middle radical is irrelevant for Root-alignment. However, as we see here, its placement can make a crucial difference for AV-alignment. In (b), the middle radical *t* follows the second AV vowel. This does not improve Root-alignment, but it does actually worsen AV-alignment, as now both the *t* and the *b* (plus the suffix *u*) will intervene between the AV morpheme and the right edge. This is opposed to (a), where the *t* precedes the second AV vowel. This configuration does not adversely affect AV-alignment, yielding only the requisite two right-side violations of ALIGN-AV-E-MWD. Therefore, ALIGN-AV-E-MWD selects candidate (a) over (b).

4.3.4 Local summary

This subsection has demonstrated that Alignment constraints can be directly responsible for determining segmental order in the basic verbal forms. Syllable well-formedness plays some role, but Alignment constraints do most of the heavy lifting. With this background in place, we can now examine how Alignment operates in the Forms which have verbal derivational morphemes. Since the MAP makes strong predictions on this point, this will serve as a testing ground for the MAP.

4.4 Phonological Analysis of Forms involving Reciprocal

As discussed at the beginning of Section 4, previous analyses of these facts which have employed Alignment constraints (namely Tucker 2010) have been forced to stipulate different alignment behavior of different verbal derivational prefixes, sometimes inconsistent even for a single

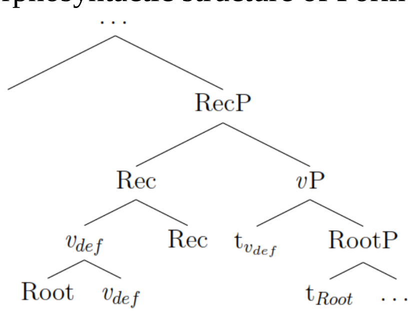
[31] It does actually play a role in preferring the use of this vowel over an epenthetic vowel; see Appendix B further discussion.

morpheme. This subsection, which focuses on Forms with the Reciprocal morpheme, and the next subsection, which focuses on Forms with the Reflexive morpheme, use the phonological framework just illustrated for the basic verbal forms (Form I) to determine the ranking of Alignment constraints which are necessary to generate the data. These rankings will be compared to the predictions of the MAP made in Section 4.1, and it will be shown that these rankings are completely consistent with those predictions.

4.4.1 The perfective passive of Form VII (“resultative” = high RECIPROCAL)

The verbal derivational morpheme which displays the most unambiguous prefixal behavior is the *n* morpheme found in Form VII. This is the morpheme which was originally identified as the marker of the “resultative” (cf. (18)), but subsequently reanalyzed as the exponent of the Reciprocal morpheme when it is merged relatively high in the syntactic structure (cf. (26)). Under this reanalysis, the morphosyntactic structure associated with Form VII is the following:

(43) Morphosyntactic structure of Form VII (repeated from (26)b)



The phonological form of Form VII in the perfective passive is (in isolation) *ʔunkutiba*. The initial *ʔu* sequence is epenthetic, arising from the presence of a morphological-word-initial cluster. These segments’ epenthetic status is confirmed by the fact that they are absent when preceded by a vowel-final word within a phonological phrase.[32] The exponent of the Reciprocal morpheme in this Form is the *n*. This *n* surfaces before the first Root consonant in all categories. Therefore, it must have a left-oriented Alignment constraint, defined in (44), and this constraint must dominate the Root’s Alignment constraint, as shown in the ranking in (45).

(44) ALIGN (RECIPROCAL, L; MORPHWD, L) [ALIGN-REC-L-MWD]

> Assign one violation mark for each segment that intervenes between the left edge of the Reciprocal morpheme and the left edge of the morphological word.
> *Reciprocal is underlyingly /n/ when not syntactically adjacent to the Root (Form VII); it is underlyingly a vocalic timing slot when syntactically adjacent to the root (Forms III & VI).*

[32] The normal epenthetic vowel which is inserted to support a word-initial cluster is [i]. This is what we see in the corresponding active forms, e.g., *ʔinkataba*. [u] shows up here for phonotactic reasons: Classical Arabic displays a prohibition (or at least strong dispreference) for *iCu* sequences (REFERENCE). Therefore, the presence of the [u] vowel from the passive morpheme triggers epenthesis of a non-default vowel [u] instead of the default [i]. This can be captured with the ranking **iCu* » DEP(u) » DEP(i).

(45) Ranking (Form VII):[33] ALIGN-REC-L-MWD » ALIGN-ROOT-E-MWD

With these constraints and rankings in place, we derive the segmental composition of Form VII:

(46) Perfective passive of Form VII: 3SG.MASC *ʔunkutiba*

/n, ktb, ui, a/	C//V	ALIGN-REC-L-MWD	ALIGN-ROOT-E-MWD	ALIGN-AV-E-MWD
a. {[nuktiba]}			***! (n,u! | a)	*** (n | b,a)
b. {[kuntiba]}		*!* (k!,u!)	* (| a)	*** (k | b,a)
c. {ʔ[uknitba]}		*!* (u!,k!)	** (u | a)	*** (| t, b,a)
d. {[nkutiba]}	*!		** (n | a)	**** (n,k | b,a)
e. ☞ {*ʔu*[nkutiba]}			** (n | a)	**** (n,k | b,a)
f. {*ʔu*[knutiba]}		*! (k!)	* (| a)	**** (k,n | b,a)

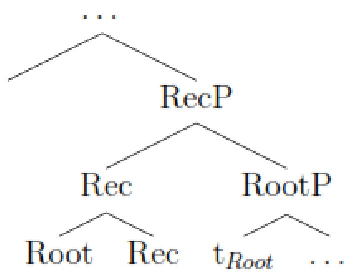
Unlike what we previously saw in the imperfective, this "prefix" allows (and in fact requires – at least when in isolation) epenthesis before it. These sorts of forms are what motivates identifying this epenthesis as external to the morphological word. If we treated it as internal to the morphological word, the desired string in candidate (d) would have the phonological representation {[*ʔu*nkutiba]}. This would add two violations to ALIGN-REC-L-MWD. These violations would be fatal, and candidate (a) would be selected instead. In fact, since this would also add two violations to ALIGN-ROOT-E-MWD, this candidate would be harmonically bounded by candidate (a). Therefore, identifying *ʔu*-/*ʔi*-epenthesis as internal to the domain of Alignment is incompatible with the analysis.

4.4.2 *Perfective passive of Form III* (reciprocal = low reciprocal)

The structurally complementary version of Reciprocal is Form III. The structure of this Form was identified above as follows:

[33] All Alignment rankings involving the verbal derivational morphemes are notated with the specific Form to which it applies. This is because, based on the Mirror Alignment Principle, we expect this ranking to correlate with a particular syntactic structure. The syntactic structure changes with each Form, and therefore the ranking of Alignment constraints will not necessarily be consistent across Forms. (The relative positioning of Root, AV, and Agr does not change depending on the presence/absence of a verbal derivational morpheme, so those rankings are indeed fixed across Forms.) While the MAP does not make any explicit predictions about the relative ranking of a given Alignment constraint with a particular markedness constraint across different syntactic structures, we might assume that their relative ranking should be fixed. But if we allow this to not be the case, then it may provide a semi-principled way to account for some instances of lexical constraint indexation without that formal apparatus. This proposal says nothing regarding whether relative re-ranking of non-Alignment constraints based on differences in syntactic structure should be possible.

(47) Form III (repeated from (26)a)



The marker of Form III is a lengthening of the vowel which immediately follows the first root consonant: in the perfective, this is the first AV vowel; in the imperfective, it is the second AV vowel.

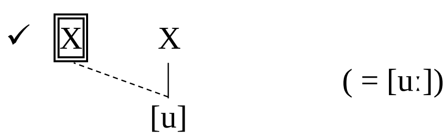
(48) Form III forms

	Perfective		Imperfective	
	Active	Passive	Active	Passive
Form III	kaataba	kuutiba	yukaatibu	yukaatabu
cf. Form I	kataba	kutiba	yaktubu	yuktabu

While a number of other analyses are possible, I will pursue an analysis of this pattern that identifies the underlying representation of the Reciprocal morpheme (in this structural configuration) in the following way: it is a featurally-unspecified timing slot that must surface adjacent to a fully-specified vowel, from which it acquires its features by spreading. For reasons which will be made clear below, this spreading must be extremely local, and not be possible across even an intervening consonant.[34] The permissible type of spreading, where melodic specification spreads from an adjacent vowel, is illustrated in (49)a. The configuration where spreading is blocked by an intervening consonant is shown in (49)b. The configuration where spreading is prohibited, when it is only adjacent to consonantal segments, is shown in (49)c. (This restriction is an underlying property of the morpheme.)

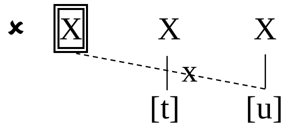
(49) Spreading to the Reciprocal (timing slot belonging to Reciprocal enclosed in double box)

a. Permissible local spreading



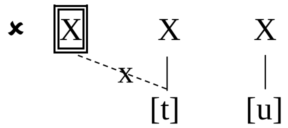
[34] This runs very much counter to the tier-separation approach used by McCarthy (1979, 1981, 1986). However, what he analyzes as spreading I analyze as a sort of phonological copying (which violates INTEGRITY), which is not spreading, *per se*. See Appendix B for further discussion.

b. Blocked by intervening segment



(≠ [utu])

c. Can only link to vocalic segments



(≠ [tːu])

With these assumptions about spreading, if we assume that the Reciprocal's timing slot counts as a distinct unit in the calculation of Alignment violations, then these forms can be generated by the ranking in (50). (The timing slot associated with the Reciprocal morpheme /X_V/ is marked by a subscript v.)

(50) Ranking (Form III): ALIGN-ROOT-E-MWD » ALIGN-REC-L-MWD » ALIGN-AV-E-MWD

(51) Perfective passive of Form III: 3SG.MASC *kuutiba*

/ktb, ui, X_V, a/	ALIGN-ROOT-E-MWD	ALIGN-REC-L-MWD	ALIGN-AV-E-MWD
a. ☞ {[ku$_V$utiba]}	* (| a)	* (k)	*** (k,u$_V$ | b,a)
b. {[kuu$_V$tiba]}	* (| a)	**! (k,u!)	** (k | b,a)
c. {[kuti$_V$iba]}	* (| a)	**!* (k,u!,t!)	** (k | b,a)
d. {ʔ[u$_V$uktiba]}	***! (u$_V$!,u! | a)		*** (u$_V$ | b,a)
e. {ʔ[uu$_V$ktiba]}	***! (u!,u$_V$! | a)		** (| b,a)

By assuming that spreading must be local and from a vowel, any realization of the Reciprocal will include a long vowel. Since Reciprocal has a Left-alignment constraint, this long vowel will strive to be towards the left edge. In candidates (d) and (e), the long vowel consisting of the Reciprocal's timing slot and the first AV vowel /u/ is initial within the morphological-word. This is ruled out because ALIGN-ROOT » ALIGN-REC in this ranking, as dictated by the morphosyntactic structure. Associating Reciprocal with the second AV vowel /i/ in candidate (c) displaces it unnecessarily far from the left edge, and is ruled out by ALIGN-REC. This leaves only candidates (a) and (b) where the long vowel follows the Root-initial consonant. By hypothesis, ALIGN-REC selects candidate (a), where the Reciprocal's timing slot is the first of the long vowel; but the two candidates are surface identical, so this is not crucial.

In the perfective, nothing hinges on the assumptions made earlier regarding what is or is not a licit spreading candidate, and whether Alignment constraints are assessed over timing slots or segments. However, each of these will be significant in the imperfective, because it independently requires a vowel after the Agreement prefix. Allowing non-local spreading from a vowel (candidate (52)e) or feature filling through epenthesis (candidate (52)d) would yield problematic candidates in the imperfective. (52)d could be ruled out independently if DEP dominates ALIGN-REC; but (52)e presumably would only violate INTEGRITY, which, as demonstrated in Appendix B, must be ranked below the active Alignment constraints. Therefore, the only way to prevent candidate (52)e from being selected is to assume it is not produced by GEN, or that there is some high-ranked spreading constraint, perhaps NOCROSSINGLINES.

(52) Imperfective passive of Form III: 3SG.MASC *yukaatabu*

<table>
<tr><th>/y, ktb, ua, X_V, u/</th><th>ALIGN-ROOT-E-MWD</th><th>ALIGN-REC-L-MWD</th><th>ALIGN-AV-E-MWD</th></tr>
<tr><td>a. {[yu$_V$uktabu]}</td><td>****! (y,u$_V$,u | u)</td><td>* (y)</td><td>**** (y,u$_V$ | b,u)</td></tr>
<tr><td>b. {[yuka$_V$atbu]}</td><td>*** (y,u | u)</td><td>*** (y,u,k)</td><td>****! (y | t!,b,u)</td></tr>
<tr><td>c. ☞ {[yuka$_V$atabu]}</td><td>*** (y,u | u)</td><td>*** (y,u,k)</td><td>*** (y | b,u)</td></tr>
<tr><td>d. ✖ {[yi$_V$kutabu]}</td><td>*** (y,i$_V$ | u)</td><td>* (y)</td><td>**** (y,i$_V$ | b,u)</td></tr>
<tr><td>e. ✖ {[yu$_V$kutabu]}</td><td>*** (y,u$_V$ | u)</td><td>* (y)</td><td>**** (y,u$_V$ | b,u)</td></tr>
</table>

Once the problematic candidates are excluded, either by constraint ranking or by GEN, the Alignment constraints select the correct output, (52)c.[35]

4.4.3 Alignment Rankings and the MAP

We have now considered two cases which I have argued to involve the morphosyntactic head Reciprocal. In the case where it merges directly with the Root (Form III), we require the ranking ALIGN-ROOT » ALIGN-REC ((45)). In the case where there is (by hypothesis) an intervening head ($v_{default}$) (Form VII), we require the reverse ranking, ALIGN-REC » ALIGN-ROOT ((50)). These are exactly the rankings predicted by the MAP when coupled with a default preference for Root-alignment ((29)). This set of Forms might not be viewed as conclusive proof for the operation of the MAP, as they require several pieces of potentially circular logic (positing $v_{default}$ in Form VII, restrictions on spreading in Form III, and, to begin with, the conflation of the morphemes into a unitary functional head). However, when considered in tandem with the more robust evidence of the Reflexive, it should be taken as positive evidence in favor of the MAP.

4.5 Phonological Analysis of Forms involving Reflexive

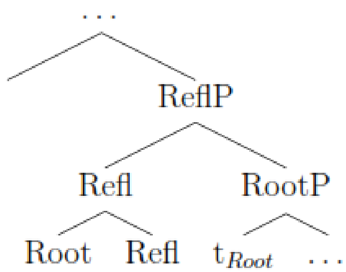
The Reflexive /t/ shows up transparently in several different forms. However, the behavior of this /t/ differs significantly across the different categories. This behavior is predicted by the MAP.

4.5.1 Form VIII: the low reflexive

In Form VIII, the only verbal derivational morpheme is Reflexive.

[35] The choice of which vowel gets multiple exponents is determined based on phonological properties of the vowels involved. See Appendix B for discussion.

(53) Syntactic structure of Form VIII (repeated from (24)g)



In this category, the Reflexive *t* always appears immediately after the Root-initial consonant. For example, in the perfect passive, Root *ktb* surfaces as [*ʔu*ktutiba]. We know that the *t* exponing Reflexive is the post-root-initial *t* by comparing other roots which do not have a medial *t*, e.g. /drs/ → [*ʔu*dduriba] (where the Reflexive *t* has assimilated in voicing). Since it appears to be left-oriented, we can define Reflexive's Alignment constraint as follows:

(54) ALIGN (REFLEXIVE, L; MORPHWD, L) [ALIGN-REFL-L-MWD]
    Assign one violation mark for each segment that intervenes between the left edge of the Reflexive morpheme and the left edge of the morphological word.
    Reflexive is underlyingly /t/ in all cases (Forms V,VI,VIII,X).

We can generate the post-root-initial behavior with the ranking in (55), as illustrated in (56). (I represent the Reflexive marker as *T* to avoid confusion with the Root-medial consonant *t*.)

(55) Ranking (Form VIII): ALIGN-ROOT-E-MWD » ALIGN-REFL-L-MWD » ALIGN-AV-E-MWD

(56) Perfective passive of Form VIII: 3SG.MASC *ʔuktutiba*

<table>
<tr><th>/T, ktb, ui, a/</th><th>ALIGN-ROOT-E-MWD</th><th>ALIGN-REFL-L-MWD</th><th>ALIGN-AV-E-MWD</th></tr>
<tr><td>a. {[Tuktiba]}</td><td>**!* (T!,u! | a)</td><td></td><td>*** (T | b,a)</td></tr>
<tr><td>b. {[kuTtiba]}</td><td>* (| a)</td><td>**! (k,u!)</td><td>*** (k | b,a)</td></tr>
<tr><td>c. ☞ {ʔu[kTutiba]}</td><td>* (| a)</td><td>* (k)</td><td>**** (k,T | b,a)</td></tr>
<tr><td>d. {ʔu[Tkutiba]}</td><td>**! (T! | a)</td><td></td><td>**** (T,k | b,a)</td></tr>
</table>

4.5.2 Form VI: the reflexive of the reciprocal

When examining the (high) Reciprocal of Form VI in Section 4.4.1, the prefixal behavior of the Reciprocal *n* was generated by the ranking ALIGN-REC over ALIGN-ROOT. This ranking follows from the MAP, but only under the assumption of an additional functional head below Reciprocal, which was not externally motivated. Form VI, which is the Reflexive of the (low) Reciprocal, gives us a chance to see the behavior of two functional heads which both have overt realizations. Therefore, conclusions about the necessary Alignment rankings will be directly comparable to syntactic structure which is independently motivated.

In Form VI, the Reflexive *t* surfaces word-initially, and the vowel-lengthening attributed to the low Reciprocal, as discussed in Section 4.4.2, surfaces after the Root-initial consonant: the

Form VI perfective passive of the Root *ktb* is thus *tukuutiba*. With one additional complication to be addressed immediately, this form will fall out from the Alignment ranking which is predicted by the MAP if Reflexive is the higher head and Reciprocal is the lower head:

(57) Ranking (Form VI): ALIGN-REFL-L-MWD » ALIGN-ROOT-E-MWD » ALIGN-REC-L-MWD

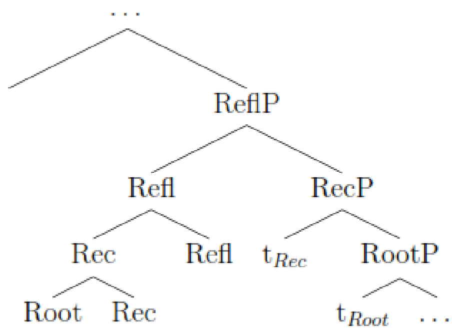
The complication is that, if the Alignment constraint on the Reflexive is aligned over the morphological word, as all other verbal derivational morphemes appear to be, this ranking predicts that we should get clustering of the Reflexive *t* and the Root-initial consonant, just as with the *n* of Form VII. One approach would be to say that Reflexive is actually aligned to the prosodic word, but there is no independent reason for this. The more viable approach is to turn to phonotactics. In certain morphological contexts, coronals display place assimilation in coda position (cf. Fischer 2002:26-28). If Form VI were to show clustering, then the Reflexive /t/ would surface in coda position, and thus be subject to place assimilation. Whether directly or indirectly, it thus appears that the lack of clustering could be a way to avoid changing the place of the Reflexive morpheme. This makes sense from a realizational and/or processing perspective, as place assimilation would make the result of affixing the Reflexive basically homophonous with the result of affixing the (low) Causative (Form II), both of which would surface as geminates (since there is also voicing assimilation in obstruent clusters). Fully exploring the details of these interactions is beyond the scope of this paper, so, for simplicity's sake, I will use a constraint *tC, which will penalize all outputs where the Reflexive /t/ surfaces as a coda. (A precisely parallel constraint, with parallel motivation, can be employed to account for the non-clustering behavior of the (high) Causative in Form IV – see Appendix B.) This generalization is surface true, as all Forms with the Reflexive (V,VI,VIII,X) position the *t* before a vowel. As long as *tC outranks ALIGN-ROOT, we now derive the correct output.

(58) Perfective passive of Form VI (reflexive of reciprocal): 3SG.MASC *tukuutiba*

/T, ktb, X$_v$, ui, a/	*tC	ALIGN-REFL-L-MWD	ALIGN-ROOT-E-MWD	ALIGN-REC-L-MWD
a. {*ʔu*[Tku$_v$utiba]}	*!		** (T | a)	** (T,k)
b. {*ʔu*[kTu$_v$utiba]}		*! (k)	* (| a)	** (k,T)
c. ☞ {[Tuku$_v$utiba]}			*** (T,u | a)	*** (T,u,k)
d. {[Tu$_v$ukutiba]}			****! (T,u$_v$,u | a)	* (T)

This ranking matches perfectly what is predicted by the MAP, given the proposed syntactic structure:

(59) Syntactic structure of Form VI (repeated from (26)c)



4.5.3 Alignment Rankings and the MAP

The comparison between Form VIII, the simple Reflexive, and Form VI, the Reflexive of the Reciprocal, directly confirms the predictions of the MAP. When Reflexive is the only verbal derivational morpheme in the structure, it merges directly with Root. Upon head movement, there is no asymmetric c-command between the two elements, clearing the way for the default preference for Root-alignment and the ranking ALIGN-ROOT » ALIGN-REFL. In Form VI, it is overtly true that Reflexive is not the only functional head in the structure. With Reciprocal merging first and Reflexive merging above it, this creates the necessary conditions for asymmetric c-command between Reflexive and Root (and also Reflexive and Reciprocal). Therefore, the MAP prescribes the ranking of ALIGN-REFL » ALIGN-ROOT. This is exactly the ranking needed to generate the phonological shape of this Form.

If divorced from the MAP or some other similar proposal which relates syntactic structure to alignment, the phonological facts of the Reflexive would be troubling, since we require what would seem to be a ranking paradox between (55) and (57). However, the Mirror Alignment Principle demands that the grammar operate in this way, and it is exactly the ranking which was predicted by the Mirror Alignment Principle in (29) above. Therefore, while the details of additional Forms and additional root types (biliteral roots, quadriliteral roots, roots containing glides) remain to be worked out in order to achieve a full account of the Classical Arabic system, the evidence presented above supports a causal relationship between the Mirror Alignment Principle and the phonological properties of Classical Arabic verbal forms.

5 Mobile affixation in Huave

This section explores a further prediction of the Mirror Alignment Principle. If the surface order of morphemes is determined in the phonological component through the interaction of ranked, competing Alignment constraints, then it follows from the notion of constraint interaction and constraint conflict that purely phonological constraints should be able to disrupt/alter the morpheme order transmitted from the morphology via the MAP. Much recent work has challenged the notion that morphological information of this sort should be handled in the phonology, namely Yu (2007) on infixation and Paster (2006, 2009) primarily with respect to phonologically-conditioned suppletive allomorphy. I will not at present undertake the task of countering these arguments,[36] but instead will focus on demonstrating the positive analytical results which can be gained by taking the opposite position. One such gain comes in the analysis of "mobile affixes," most prominently illustrated by Huave (Noyer 1993, Kim 2008, 2010, 2015).

Mobile affixes are affixal morphemes which sometimes surface towards the left edge of the stem (i.e., as "prefixes") and at other times towards the right edge of the stem (i.e., as "suffixes"). In Huave, it is quite clear that the alternation between prefixal and suffixal realizations is dependent primarily on *phonological* properties. Specifically, Huave does not permit consonant clusters, and a consonantal affix will surface as a prefix if the right edge of the stem ends in a consonant but the left edge of the stem begins with a vowel. (All of Huave's mobile affixes appear to consist of a single consonantal segment.) If the segments at both edges of the stem are both consonants or both vowels, the affix "defaults" to the right edge (i.e., as a suffix).[37] If this creates a consonant cluster, vowel epenthesis occurs. The apparent generalization to be drawn from this behavior is that these affixes can diverge from their preferred position in order to avoid creating a consonant cluster and thus causing epenthesis.

In this section, building on Kim (2008, 2010), I will demonstrate that the interaction between ranked, competing Alignment constraints and a ban on consonant clusters / dispreference for epenthesis directly generates the surface distributions. I will not perform a full morphosyntactic analysis of Huave (see Kim 2008 for a fuller discussion); however, in performing the phonological analysis, we will obtain a ranking of Alignment constraints which, when viewed through the lens of the Mirror Alignment Principle, makes predictions about the morphosyntactic structure. These predictions can inform future syntactic investigation.

5.1 Root + one affix

I will focus here on what Kim calls the "Layer 1" affixes. These are the affixes which appear closest to the verbal root. There is one such affix which is invariably prefixal: the 2nd person subject marker, which alternates between [i] and [e] for phonological reasons. The Layer 1 mobile affixes are as follows:

(60) Layer 1 mobile affixes (Kim 2010:139)

a. /t/ Completive [CP]
b. /n/ Stative [ST]
c. /n/ Subordinate (1st person) [SB1]
d. /m/ Subordinate (non-1st person) [SB]
e. /r/ 2nd Person Intransitive (occurs only in conjunction with 2nd /i/) [2I]

The Completive, Stative, and Subordinate markers cannot co-occur, implying that they are all members of a single morphosyntactic category; I will refer to this as Aspect (Asp) (though this will be scrutinized below).

[36] Yu's (2007) analyses, at least, suffer in part from a lack of attention to additional phonological and (morpho)syntactic considerations which could be at work in his case studies. For instance, Base-Derivative faithfulness to (edge-based) stress domains has the potential to force infixation past that domain. He does not entertain any such ideas. Likewise, he does not consider how the Mirror Principle or any related notions might affect the relative ordering of (edges of) affixes.

[37] There are a few additional complications which I will not take up here, for which one should consult Kim (2010).

They also (for the most part) behave identically in terms of ordering. In forms with only a single affix which is of this type, there are two options: (i) if the verbal root begins in a consonant and ends in a vowel (C…V), the affix surfaces to the right of the root, as shown in (62);[38] (ii) if the verbal root begins in a vowel and ends in a consonant (V…C), the affix surfaces to the left of the root, as shown in (64). (No root, when taken together with its theme vowel, both begins and ends in a consonant (C…C), though this configuration frequently occurs when multiple affixes are present. This situation will be discussed below.) This part of the distribution can thus be completely described through phonotactics: place the affix where it will not create a consonant cluster, i.e., obey *CC. That is to say, a phonological markedness constraint (*CC) *outranks* any Alignment constraints referencing these morphemes. (It will be demonstrated below that these morphemes each have a Right-alignment constraint.) Therefore, the ranking given in (61) generates the proper distribution.

(61) Ranking: *CC » ALIGN-ASP-R

(62) Mobile affixes to C(…)V roots

Example: mo^{h}ko-t[39]
face.down-CP
's/he lay face down' (Kim 2010:140, ex. 12h)

/mo^{h}ko$_{\text{ROOT}}$, t$_{\text{CP}}$/	*CC	ALIGN-ASP-R
a. ☞ mo^{h}ko-t		
b. t-mo^{h}ko	*!	**** (m,o,^{h}k,o)

In C(…)V roots, optimal alignment of the Aspect morpheme as a suffix complements the desire to avoid clusters. However, in V(…)C roots, these two goals are at odds, since right-aligning the Aspect morpheme will lead to a cluster. This conflict could be resolved in at least two ways: deploy the optimal suffixal alignment and epenthesize to resolve the cluster, or flop the affix to the opposite side of the root where it can attach without any phonotactic complications. Huave chooses the latter. This behavior is what we are referring to as affix mobility. Since mobility is preferred to epenthesis, we know that DEP also outranks all Alignment constraints, here illustrated by ALIGN-ASP-R:

(63) Ranking: *CC, DEP » ALIGN-ASP-R

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[38] Kim (2008, 2010) analyzes Huave verbs as involving theme vowels, which may be either prefixing or suffixing. The exact function of these theme vowels is unclear. For simplicity, I will treat them as if they were part of the root. This does not affect the present analysis.

[39] Kim (2008, 2010) uses a non-IPA transcription convention. I employ IPA notation, as in Kim (2015). See Kim (2010:134, fn.2) for the translation between her earlier transcription convention and IPA.

(64) Mobile affixes to V(…)C roots

Example: t-uc

CP-eat

's/he ate' (intransitive) (Kim 2010:140, ex. 12b)

/uc$_{ROOT}$, t$_{CP}$/	*CC	DEP	ALIGN-ASP-R
a. uc-t	*!		
b. uc-*a*t		*!	
c. ☞ t-uc			** (u,c)

5.2 Root + two affixes

The complexity of the mobile affixes truly shows itself only when multiple such affixes co-occur. In these cases, the activity of *CC (and DEP, which will be omitted for the time being), plus the interaction of multiple Alignment constraints, generates the unique mobile behavior. The tableaux below show what happens in two sets of cases: tableaux (66) and (67) illustrate what happens when the 2nd person prefix /i/ co-occurs with the 2nd person intransitive mobile affix /r/ for the two respective root shapes; tableaux (68) and (69) illustrate what happens when these forms are accompanied by one of the mobile Aspect markers (here the Completive /t/) for the two respective root shapes.

The behavior can be modeled through the ranking of multiple Alignment constraints. The 2nd person /i/ morpheme has a Left-alignment constraint (ALIGN-2-L), which is responsible for its prefixal behavior. The 2nd person intransitive /r/ morpheme has a Right-alignment constraint (ALIGN-2I-R). Its domination by *CC and ALIGN-2-L generate its mobile behavior. Likewise, the Aspect markers have a Right-alignment constraint (ALIGN-ASP-R), which is at the bottom of the ranking. This low ranking is again responsible for mobility.

(65) Ranking: *CC » ALIGN-2-L » ALIGN-2I-R » ALIGN-ASP-R

For the C(…)V roots in (66), just as in (62) above, all constraints, both phonotactic and Alignment, can be fully satisfied, because none of their requirements conflict in this case: the 2nd person morpheme /i/ can surface at the left edge and the 2nd person intransitive morpheme /r/ can surface at the right edge without creating any clusters.

(66) 2nd person intransitives to C(…)V roots

Example: i-mo^{h}ko-r

2-face.down-2I

'you (sg.) lie face down' (Kim 2010:140, ex. 12j)

/mo^{h}ko$_{ROOT}$, r$_{2I}$, i$_{2}$/	*CC	ALIGN-2-L	ALIGN-2I-R
a. mo^{h}ko-i-r		*!*** (m,o,^{h}k,o)	
b. mo^{h}ko-r-i		*!**** (m,o,^{h}k,o, r)	* (i)
c. ☞ i-mo^{h}ko-r			
d. r-mo^{h}ko-i	*!	***** (r, m,o,^{h}k,o)	***** (m,o,^{h}k,o, i)
e. i-r-mo^{h}ko	*!		**** (m,o,^{h}k,o)
f. r-i-mo^{h}ko		*! (r)	***** (i, m,o,^{h}k,o)

The conflict again arises in V(…)C roots, where desired right-edge alignment of the 2nd person intransitive suffix (candidate (67)c) would create a consonant cluster. Since there are other orderings which can avoid creating a cluster, this candidate order is discarded. There are two main options for re-ordering: move the 2nd person intransitive /r/ leftward, or move the 2nd person /i/ rightward. Since ALIGN-2-L » ALIGN-2I-L, displacement of the 2nd person intransitive /r/ is preferred. This option is represented by candidates (67)e and (67)f. Both Alignment constraints prefer candidate (67)e, in which the 2nd person /i/ is leftmost, since this fully satisfies ALIGN-2-L while also placing the 2nd person intransitive /r/ closer to the right edge (only the Root segments intervene, rather than both the Root and the 2nd person /i/). This shows that mobility, while induced by *CC, remains sensitive to desired placement of the various affixes. There is no need to assume a "default to opposite"-type logic in this situation – each affix's alignment is optimized, subject to constraint ranking.

(67) 2nd person intransitives to V(…)C roots

Example: i-r-uc
2-2I-eat
'you (sg.) eat' (intransitive) (Kim 2010:140, ex. 12d)

/uc_{ROOT}, r_{2I}, i_{2}/	*CC	ALIGN-2-L	ALIGN-2I-R
a. uc-i-r		*!* (u,c)	
b. uc-r-i	*!	*** (u,c, r)	* (i)
c. i-uc-r	*!		
d. r-uc-i		*!** (r, u,c)	*** (u,c, i)
e. ☞ i-r-uc			** (u,c)
f. r-i-uc		*! (r)	*** (i, u,c)

5.3 Root + three affixes

The following tableaux illustrate what happens when a third affix is added to the mix, namely one of the Aspect markers. Since both the 2nd person intransitive /r/ and all the Aspect markers are consonantal and preferentially Right-aligned, it is, in this case, impossible for both to surface in their desired location (towards the right edge), as this would create a cluster. One must move to the left of the root, where it can surface adjacent to a vowel, provided by the 2nd person /i/ (surfacing here as [e]). The choice of which affix moves is determined by the relative ranking of their Alignment constraints: it will be the affix with the lower-ranked Alignment constraint, Aspect, which gets displaced. In these tableaux, *CC-violating candidates are omitted for reasons of space and clarity. This demonstrates that the application of phonotactics can severely limit the space of possible orders.

(68) 2nd person intransitive *completives* to C(…)V roots

Example: t-e-mo^{h}ko-r
CP-2-face.down-2I
'you (sg.) lay face down' (Kim 2010:140, ex. 12k)

/mo^{h}ko$_{ROOT}$, r$_{2I}$, e$_{2}$, t$_{ASP}$/	*CC	ALIGN-2-L	ALIGN-2I-R	ALIGN-ASP-R
a. mo^{h}ko-t-e-r		**!*** (m,o,^{h}k,o, t)		** (e, r)
b. mo^{h}ko-r-e-t		**!*** (m,o,^{h}k,o, r)	** (e, t)	
c. ☞ t-e-mo^{h}ko-r		* (t)		****** (e, m,o,^{h}k,o, r)
d. r-e-mo^{h}ko-t		* (r)	*!**** (e, m,o,^{h}k,o)	

(69) 2nd person intransitives *completives* to V(…)C roots

Example: t-e-r-uc
CP-2-2I-eat
'you (sg.) ate' (intransitive) (Kim 2010:140, ex. 12e)

/uc$_{ROOT}$, r$_{2I}$, e$_{2}$, t$_{ASP}$/	*CC	ALIGN-2-L	ALIGN-2I-R	ALIGN-ASP-R
a. t-uc-e-r		**!* (t, u,c)		**** (u,c, e, r)
b. r-uc-e-t		**!* (r, u,c)	**** (u,c, e, t)	
c. ☞ t-e-r-uc		* (t)	** (u,c)	**** (e, r, u,c)
d. r-e-t-uc		* (r)	***!* (e, t, u,c)	** (u,c)

5.4 The mobile 1st person /s/

Up to this point, I have simply asserted that the Aspect markers' Alignment constraints were right-oriented, but no evidence could be gleaned to support this, since ALIGN-ASP was never active in the evaluation. The test case for the Right-alignment analysis of the Aspect markers comes when we add in to the mix the other mobile affix in the system, the 1st person marker /s/. Kim assigns this morpheme to "Layer 3", since it tends to occur outside of the Layer 1 and Layer 2 affixes. (There are two Layer 2 affixes (Kim 2010:240-1), both of which are vocalic: a prefixal Future marker /i/ and a suffixal Reflexive marker /e/.) It is in large part due to the behavior of the mobile /s/ that Kim adopts a cyclic, layered analysis of affixation. Compare the following forms:

(70) Interaction between mobile 1st person /s/ and mobile "Aspect" markers

italicized vowels are epenthetic vowels breaking up clusters

a. ʃ-i-n-a^{h}tʃ [40] (subordinate with V…C root)
1-FUT-SB1-give
'(that) I will give (it)' (Kim 2010:141, ex. 15b)

b. ʃ-i-tʃutu-n (subordinate with C…V root)
1-FUT-sit-SB1
'(that) I will sit' (Kim 2010:141, ex. 15c)

[40] /s/ → [ʃ] / _i

c. tʃutu-t-u-s (aspectual with C…V root)
sit-CP-ITR-1
'I sat down' (intransitive) (Kim 2010:141, ex. 15g)

d. ɲ-ukʷal-*a*s (aspectual with V…C root)
ST-child-1
'I am pregnant' (Kim 2010:141, ex. 15h)

e. t-aʰtʃ-*ju*s (aspectual with V…C root)
CP-give-1
'I gave (it)' (Kim 2010:141, ex. 15d)

The question at hand is the relative linear order of the 1st person /s/ vs. the "Aspect" markers. Earlier, I claimed that the subordinate markers /n/ & /m/, the Completive marker /t/, and the Stative marker /n/ ([n]~[ɲ]) were all members of a single class of "Aspect" markers. However, when examining this set of data, there is one interpretation in which the Subordinate markers are acting differently than the Completive and Stative markers.

First, consider the interpretation where they are all acting identically. If we assume, as Kim does, that affixation is basically cyclic, then the Layer 1 affixes select their position prior to the addition of the Layer 3 1st person marker /s/. If this is the case, then all of the "Aspect" markers act the same: they attach to the edge of the root/stem that furnishes a vowel, thus avoiding a cluster; the /s/ then attaches afterward by the same principle. This approach accurately captures the data, and could be accommodated within the Alignment approach developed in this paper (as proposed also by Kim 2008, 2010) if the grammar admits of multiple cycles/strata.

However, the strongest version of the Alignment approach would claim that all affixes are attached simultaneously, and their order is sorted out solely through constraint interaction, rather than being attached sequentially. I believe that this approach can be made consistent with the available data, if we assume that the Subordinates do not pattern precisely with the Completive and Stative markers. If they have different Alignment constraints that are ranked differently with respect to the 1st person's Alignment constraint, as in the ranking ALIGN-SB-R » ALIGN-1-R » ALIGN-ASP-R (where Asp = Completive and Stative), the orders in (70) can be generated in a single pass. The only necessary additional pieces are to have the Alignment constraints for the "Layer 2" affixes (namely Future /i/) rank above ALIGN-SB-R, and the Alignment constraint on the "Layer 1" Intransitive suffix /u/ rank above ALIGN-1-R:

(71) Ranking: ALIGN-FUT-L » ALIGN-SB-R » ALIGN-1-R » ALIGN-ASP-R
ALIGN-ITR-L » ALIGN-1-R » ALIGN-ASP-R

These rankings generate the forms in (70)a-c, as demonstrated by the following tableaux.

(72) Tableau for (70)a [ʃ-i-n-a^{h}tʃ]

/a^{h}tʃ$_{\text{ROOT}}$, n$_{\text{1SB}}$, i$_{\text{FUT}}$, s$_1$	*CC	Align-fut-L	Align-sb-R	Align-1-R
a. s-a^{h}tʃ-i-n		**!* (s, a,^{h}tʃ)		
b. n-a^{h}tʃ-i-s		**!* (n, a,^{h}tʃ)	**** (a,^{h}tʃ, i, s)	
c. ☞ ʃ-i-n-a^{h}tʃ		* (ʃ)	** (a,^{h}tʃ)	**** (i, n, a,^{h}tʃ)
d. n-i-s-a^{h}tʃ		* (n)	***!* (i, s, a,^{h}tʃ)	** (a,^{h}tʃ)

(73) Tableau for (70)b [ʃ-i-tʃutu-n]

/tʃutu$_{\text{ROOT}}$, n$_{\text{1SB}}$, i$_{\text{FUT}}$, s$_1$	*CC	Align-fut-L	Align-sb-R	Align-1-R
a. tʃutu-ʃ-i-n		**!*** (tʃ,u,t,u, ʃ)		** (i, n)
b. tʃutu-n-i-s		**!*** (tʃ,u,t,u, n)	** (i, s)	
c. ☞ ʃ-i-tʃutu-n		* (ʃ)		****** (i, tʃ,u,t,u, n)
d. n-i-tʃutu-s		* (n)	*!**** (i, tʃ,u,t,u)	

(74) Tableau for (70)c [tʃutu-t-u-s]

/tʃutu$_{\text{ROOT}}$, t$_{\text{ASP}}$, u$_{\text{ITR}}$, s$_1$	*CC	Align-itr-R	Align-1-R	Align-asp-R
a. tʃutu-s-u-t		* (t)	*!* (u, t)	
b. ☞ tʃutu-t-u-s		* (s)		** (u, s)
c. s-u-tʃutu-t		**!*** (tʃ,u,t,u, t)	****** (u, tʃ,u,t,u, t)	
d. t-u-tʃutu-s		**!*** (tʃ,u,t,u, s)		***** (u, tʃ,u,t,u)

With (70)a-c explained, we can finally consider a case where epenthesis is unavoidable, namely (70)d-e. Because the root will have only one edge with a vowel,[41] when two consonantal affixes (and no vocalic affixes) are added, there is no way to totally avoid consonant clusters simply through optimizing ordering; epenthesis is required.

Tableau (75) contains the maximal assortment of candidates. They are organized pairwise: the first of each pair shows a particular morpheme order without cluster-breaking epenthesis, the second shows that same order with all clusters broken up by an epenthetic vowel. All possible orderings of the three morphemes are shown. What we see is that the ranking *CC » Dep automatically prefers the variants with epenthetic vowels to the variants with clusters. Since there are no possible orderings which, without epenthesis, lack clusters, there will necessarily be a Dep violation in the winning candidate. However, epenthesis never alters the relative harmony between candidate orders. Therefore, in effect, the ordering procedure operates, via optimal satisfaction of Alignment constraints, just as if epenthesis was not needed. The choice between candidates which suffer from minimal Dep violations (i.e., one, not more than one, as in candidates (f) and (h)) is adjudicated by the highest ranking Alignment constraint, in this case Align-1-R. It is avoidance of the extra Dep violation which causes the mobility of the Aspect marker /n/ in this case.

[41] Kim (2010:149-52) does discuss the behavior of the rare VCV roots, which behave contrary to expectation. It appears that there is some sort of morphological interference. I will not take this up further. See also Kim (2015).

(75) Tableau for (70)d [ɲ-ukʷal-*a*s] (equivalent to (70)e)

/ukʷal$_{\text{ROOT}}$, n$_{\text{ASP}}$, s$_1$/	*CC	DEP	ALIGN-1-R	ALIGN-ASP-R
a. s-ukʷal-n	*!		***** (u,kʷ,a,l, n)	
b. s-ukʷal-*a*n		*	*!***** (u,kʷ,a,l, *a*,n)	
c. ɲ-ukʷal-s	*!			***** (u,kʷ,a,l, s)
d. ☞ ɲ-ukʷal-*a*s		*		****** (u,kʷ,a,l, *a*,s)
e. ukʷal-s-n	*!*		* (n)	
f. ukʷal-*a*s-*a*n		**!	** (*a*,n)	
g. ukʷal-n-s	*!*			* (s)
h. ukʷal-*a*n-*a*s		**!		** (*a*,s)
i. s-ɲ-ukʷal	*!		***** (n, u,kʷ,a,l)	**** (u,kʷ,a,l)
j. s*a*-ɲ-ukʷal		*	*!***** (*a*,n, u,kʷ,a,l)	**** (u,kʷ,a,l)
k. n-s-ukʷal	*!		**** (u,kʷ,a,l)	***** (s, u,kʷ,a,l)
l. n*a*-s-ukʷal		*	*!*** (u,kʷ,a,l)	****** (*a*,s, u,kʷ,a,l)

The Alignment constraints for the Subordinate and the true Aspect markers are broken up only by the 1st person's Alignment constraint. This means that, in the absence of the 1st person morpheme, Subordinate and Aspect will behave identically, hence the earlier conflation.

5.5 Local summary

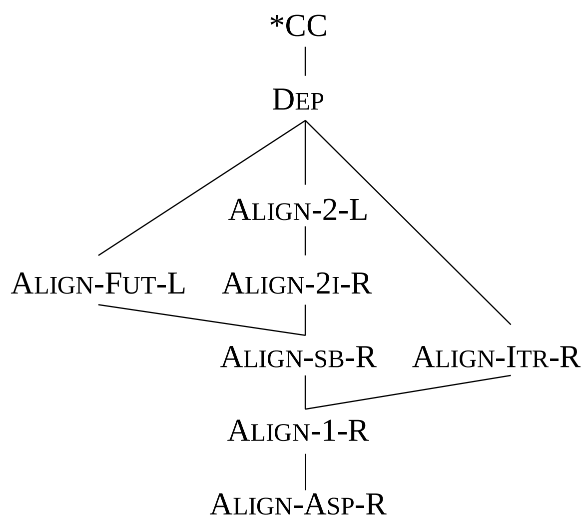
This section demonstrated that the mobile affixation patterns of Huave can be described by the interaction of ranked, competing Alignment constraints with a ban on consonant clusters and a dispreference for repairing clusters via epenthesis. When creating a cluster or performing epenthesis can be avoided by placing an affix outside of its preferred location, this strategy is selected. This interaction is responsible for the descriptive mobility of certain affixes. The mobile affixes are the ones which have an initial consonant. This pre-condition for mobility is only sensible if this phenomenon is located in the phonology. This analysis, following Kim (2008, 2010), captures this generalization by means of the high-ranking of *CC and DEP, whose effects will only be triggered when there are affixes which could create consonant clusters, i.e., those which are consonant-initial.

This analysis makes an additional prediction: no verb-word which begins in a vowel should ever display cluster-breaking epenthesis. (There appears to be some sorts of epenthesis for other reasons, for example a sort of word minimality condition on VCV roots.) Based on the available examples, it appears that this prediction is confirmed.

The following Hasse diagram summarizes the rankings developed in this section. ALIGN-2I-R must dominate ALIGN-SB-R, as ALIGN-2I-R dominated the ALIGN-ASP-R which was employed at the beginning of this section, which included both the Subordinate morphemes and the true Aspect markers.[42]

[42] Given that the operation of the Mirror Alignment Principle may yield different rankings based on different syntactic structures, as laid out in Sections 3 and 4, it is possible that the rankings established via transitivity across different forms do not actually hold. However, each individual ranking fragment asserted earlier in this section must hold for the forms to which it applies, regardless of the overall picture.

(76) Hasse diagram for Huave



While Huave clearly does, according to the proposed analysis, represent what could be called a case of "phonological affix ordering", when couched within the Mirror Alignment Principle framework, it is not the case that phonology is doing the entire job. The mobility of certain affixes obscures the fact that a fixed relative ranking of Alignment constraints on different affixes is crucial for generating the observed distribution. If indeed it can be shown that the (morpho)syntax generates a hierarchical structure consistent with this ranking according to the Mirror Alignment Principle, then indeed most of the work in affix ordering is truly still being undertaken by the (morpho)syntax in a nonarbitrary way.

6 Conclusion

This paper has introduced and developed a new proposal regarding the nature of morpheme ordering, based on the operation of the Mirror Alignment Principle (MAP) at the morphology-phonology interface. The MAP is an algorithm that translates hierarchical structural relations (asymmetric c-command) between morphosyntactic terminals into ranking domination relations between Alignment constraints (McCarthy & Prince 1993, Prince & Smolensky 1993/2004) on the exponents of those morphosyntactic terminals in the phonological component of the grammar (namely in CON).

This algorithm provides a principled means of capturing so-called "Mirror Principle" effects (Baker 1985), whereby the order of morphemes in a complex word mirrors the order of syntactic derivation and hierarchical morphosyntactic structure. This was exemplified by the mirror-image morpheme orderings seen in certain Bantu languages (Section 3), and, in a less direct fashion, by the complex ordering properties of certain verbal derivational affixes in Classical Arabic, especially the Reflexive (Section 4). In the Bantu case, the asymmetric interaction between mirror-image orderings and semantic interpretation supported a traditional, modular approach to grammar, where operations in the post-syntactic component of the PF branch (identified in this paper as the morphological component) could affect the surface order of morphemes (since it feeds the operation of the MAP algorithm) but could not affect semantic interpretation, because that is determined by the syntactic input to the LF branch. This notion that distinctions in (morpho)syntactic structure can produce differences in surface ordering effects via the MAP made available a new type of explanatory force behind an Alignment-based analysis of Classical Arabic nonconcatenative verbal morphology. After examining the morphosyntactic elements involved in verbal derivation, it was argued that differences in structure correlated with differences in Alignment ranking, as predicted by the MAP, in a way that could derive the phonological behavior of a number of different complex morphological categories. Therefore, not only do we now have a more complete understanding of the phonological behavior of the system, but it is backed by a principled relationship with the underlying syntax.

This framework derives morpheme order without positing any "affixation" operations, *per se*, at any point in the grammar, contrary to declarative theories of morphology. That is to say, affixes are not "attached" to a derivational base, either by an affixation operation or a subcategorization requirement. The concept of "prefix" or "suffix" is thus epiphenomenal. Rather, prefixal or suffixal behavior, or indeed more complicated behavior such as nonconcatenative behavior, as in Classical Arabic (Section 4), or mobility, as in Huave (Section 5), results from language-specific properties of morphosyntactic exponents, i.e., whether a terminal's exponent is controlled by a Left-, Right-, or Edge-alignment constraint, and the way these properties interact with other aspects of the *phonological* grammar. Since these behaviors are attributed to the phonological component, where the ultimate surface output is determined through constraint interaction, these behavioral preferences need not be realized fully when other, conflicting constraints take precedence in the phonological evaluation (i.e., are higher ranked).

This is most strikingly apparent in the case of the mobile affixes of Huave (Section 5), where the determination of prefixal or suffixal positioning of an affix depends both on the overt segmental properties of the exponents involved (deriving from the ban on consonant clusters) and also the ranked prioritization of Alignment conditions on the various morphemes involved. The interaction between Alignment constraints and phonotactics also helps explain certain aspects of Classical Arabic. For example, the requirements that all syllables have onsets and that all consonants be adjacent to a vowel constrain the range of segmental orders which can arise from interspersing the segments of different morphemes. In fact, it requires nonconcatenative behavior, because the idiosyncratic nature of the underlying representations of Roots and Aspect+Voice morphemes (all consonants in the first case, all vowels in the second) makes direct concatenation incompatible with the demands of syllable structure.

While this proposal makes strong predictions about the relationship between syntactic structure and the surface order of morphemes, these predictions are mediated by the operation of the morphological component of the grammar, which links the output of the narrow syntax with the input of the phonological evaluation. As detailed further in Appendix A, certain aspects of the analysis of Bantu and Classical Arabic require that operations in the morphology alter the hierarchical structure produced by the syntax. Therefore, understanding the full range of typological predictions of the Mirror Alignment Principle hypothesis is dependent on understanding the full range of possible morphological operations. This is already the subject of a great deal of ongoing research within Distributed Morphology. The Mirror Alignment Principle, given that it makes strong predictions about the relationship between syntactic structure and morpheme order, thus yields a new means of investigating morphological operations, insofar as divergences from the predictions of the MAP are most likely to be accounted for by the activity of operations within the morphology.

The architecture of the grammar which is required for this proposal forces us to take a particular position on the nature of allomorphy and the ordering of morphological operations.

Since “linearization” within the morphological word is determined purely in the phonological module, and, at least by hypothesis, the underlying phonological representation of a morpheme is determined by vocabulary insertion in the morphological component (which is derivationally prior to the phonological component), morphologically conditioned allomorphy, and indeed any other morphological operation, can, according to this theory of grammar, only be conditioned on hierarchical structure. Linear structure is not present throughout the morphological component, and therefore any operations within the morphological component cannot be sensitive to linear order. Arregi & Nevins (2012) argue that certain morphological operations, including vocabulary insertion, can and do follow linearization in PF Spellout (see Arregi & Nevins 2012:4, Fig. 1.1). If the details of the Mirror Alignment Principle put forth in this paper are to be upheld, it must be the case that all effects which Arregi & Nevins and others attribute to linearization and/or post-linearization operations can be explained in the phonological component. I leave this as an open question for future investigation.

The Mirror Alignment Principle also opens up new possibilities for the analysis of other nonconcatenative morphological phenomena. Yu (2007) develops a theory of infixation based on a declarative model of the morphology-phonology interface, specifically arguing against the Generalized Alignment-based approach. However, he never takes into account what might result from the use of multiple Alignment constraints competing for the same edge. When combined with additional considerations, such as Base-Derivative faithfulness constraints relating to stress, or perhaps an enriched set properties referenceable by faithfulness constraints (such as CV transitions), the MAP-driven Alignment model may be able to equally well describe the patterns surveyed by Yu. Alignment constraints have also been used in the analysis of reduplication. For example, in non-templatic analyses of partial reduplication (see, e.g., Hendricks 1999), Alignment constraints have been employed as “size restrictor” constraints to keep the reduplicant to a minimal length. Couched within the MAP framework, these Alignment constraints would independently be expected to appear in the grammar, and thus we should expect exactly such effects. If these interactions can be shown to comport with the Mirror Alignment Principle algorithm, then we have further support for an Alignment-based theory of morpheme ordering.

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8 Appendix A: Morphological operations in Bantu and Arabic

In Sections 3 and 4, it was shown that certain aspects of morpheme ordering in Bantu and Arabic, respectively, did not immediately follow from the expected syntactic structure. I suggested that the way to explain these divergences was by means of operations that applied in the morphological component, adjusting the syntactic structure in such a way that it could supply the Mirror Alignment Principle with a hierarchical structure that would generate the ranking required by the phonology. In this Appendix, I briefly explore the nature of these morphological operations, and show that such operations could, in fact, generate the desired outcomes via the MAP.

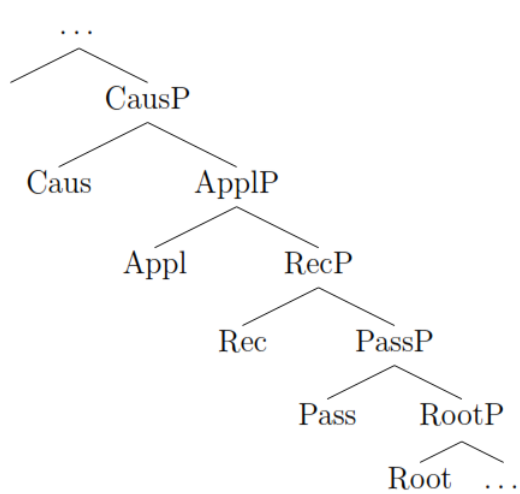
8.1 The CARP operation in Bantu

In the discussion surrounding example (15) in Section 3.2, I showed that a morphological operation which reordered the phrase-level constituents in the hierarchical structure was capable of creating the structure which we required in order for the MAP to generate the proper relation between surface order of morphemes and semantic interpretation. This was admittedly a simplification. In the discussion of Classical Arabic, it became clear that we needed the MAP to be computed over the complex head structure generated by head movement, or else we would not have been able to bring to bear the asymmetry between the lowest functional head merged above Root and all higher functional heads. The equivalent operation over the complex head structure would, though, achieve exactly the same result.

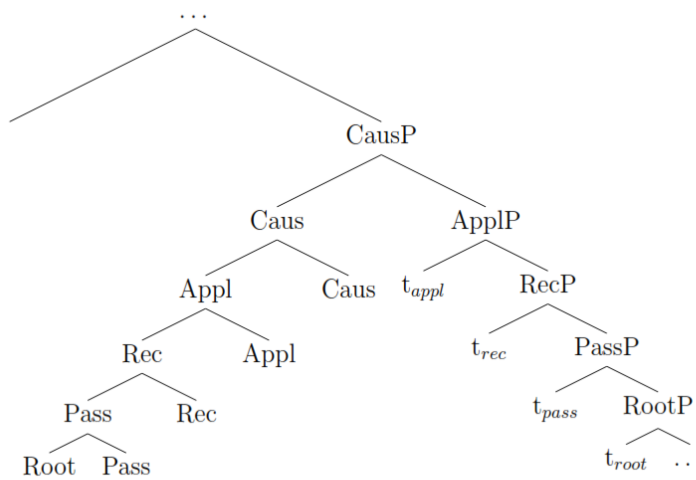
The following trees demonstrate, for a hypothetical example involving one each of the CARP elements, the base-generated syntactic structure, the result of head-movement, and the result of an operation which can freely re-order the hierarchical structure of heads within a complex head structure.

(77) CARP and head-movement

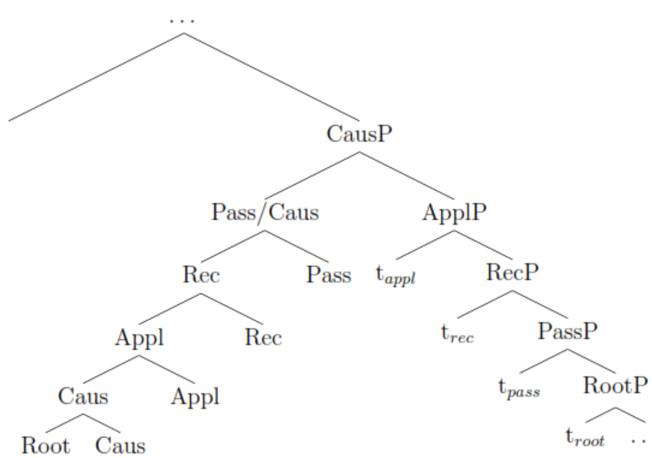
a. Base-generated syntactic structure



b. Head-movement structure



c. Morphological re-ordering operation



This operation would be extremely powerful. It basically allows for the morphology to completely override the syntax in a particular case, creating any binary-branching structure it wants. While we may not want to give the morphology such a powerful device, we can at least formalize what would motivate such an operation.

In the model of Arregi & Nevins (2012), morphological operations (at least within the "Feature Markedness" module; cf. p.4, Fig. 1.1) are triggered by markedness constraints which prohibit particular structures. The constraints they employ primarily target feature sequences and feature co-occurrences, but we could also imagine markedness constraints penalizing specific structural configurations. The CARP "template" could be conceived in exactly this way, namely as a set of constraints against pairwise c-command relations between CARP heads in the head-movement structure, as follows:

(78) CARP morphological markedness constraints

a. Constraints on Pass
   i. Pass may not be c-commanded by Caus (*Caus > Pass)
   ii. Pass may not be c-commanded by Appl (*Appl > Pass)
   iii. Pass may not be c-commanded by Rec (*Rec > Pass)

b. Constraints on Rec
   i. Rec may not be c-commanded by Caus (*Caus > Rec)
   ii. Rec may not be c-commanded by Appl (*Appl > Rec)

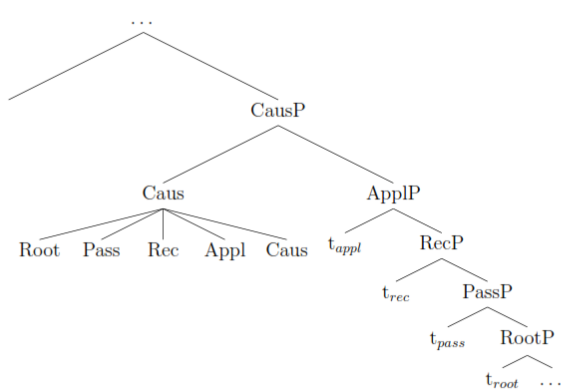
c. Constraint on Appl
   i. Appl may not be c-commanded by Caus (*Caus > Appl)

In the scenario in (77), the repair for violations of any and all of these markedness constraints is hierarchical re-organization of the complex head.

A benefit of this separation into pairwise ordering constraints emerges when viewed from the microtypology of Bantu. Even in languages where some particular CARP-violating order(s), it is not the case that that language allows all CARP-violating orders; it selects a subset which are permitted (cf. Hyman 2003). The CARP template is therefore not an all or nothing proposition. With this articulated set of constraints, it would be the case that, if a language permits a specific mirror-image order, the constraint against that CARP-violating order *optionally* induces a repair.[43] For example, Chichewa permits both Root-Caus-Rec and Root-Rec-Caus; therefore, the **Caus > Rec* constraint optionally induces repair in Chichewa.[44]

However, in the Arregi & Nevins (2012) framework, building on insights from constraint-based phonological theories, the repair is separated from the markedness constraint. Therefore, the observation about the morphological markedness constraint could be correct while we have failed to posit the proper repair. One alternative to the total re-ordering repair could be a sort of "flattening" operation. If the markedness constraints are indeed defined over asymmetric c-command, then an operation which created a non-binary-branching flat structure within the complex head would be a way to satisfy the markedness constraints. The result of this operation, performed on the structure in (77)b, is schematized in (79).

(79) Morphological flattening operation



[43] On the optionality of the operation, see again Section 3.2.

[44] It could be the case that there are implicational relations among these constraints, such that if a language fails to enforce some particular constraint, it also fails to enforce another constraint. I leave this as a question for future investigation.

As with the re-ordering operation, if only certain morphological markedness constraints were obligatorily active in a language, this operation would only be performed optionally in the cases where only those markedness constraints would be violated.

This strategy on its own would not be sufficient to derive the results of the MAP claimed in Section 3.2. This is because this structure, by design, has no asymmetric c-command relations between CARP elements, and thus the MAP does not prescribe a ranking between any of their Alignment constraints. This could be solved using default ranking statements at the morphology-phonology interface that kick in in the absence of MAP-prescribed rankings, just as we did with Root-alignment in Arabic. However, this approach runs into a serious duplication problem. The necessary ranking statements would be exactly correlated with the morphological markedness constraints in (78):

(80) Ordering statements

a. Rankings of Pass

i. ALIGN-PASS-R » ALIGN-CAUS-R	cf.	*Caus > Pass
ii. ALIGN-PASS-R » ALIGN-APPL-R		*Appl > Pass
iii. ALIGN-PASS-R » ALIGN-REC-R		*Rec > Pass

b. Rankings of Rec

i. ALIGN-REC-R » ALIGN-CAUS-R		*Caus > Rec
ii. ALIGN-REC-R » ALIGN-APPL-R		*Appl > Rec

c. Rankings of Appl

i. ALIGN-APPL-R » ALIGN-CAUS-R		*Caus > Appl

One way out of the duplication problem is to say that there was actually no morphological operation at all, that these ordering statements take precedence over the MAP at the morphology-phonology interface, either obligatorily or optionally. This is virtually equivalent to the approach taken by Hyman (2003), where, in the phonology, a "Template" constraint competes with a "Mirror" constraint (relativized to specific pairwise combinations).

I believe that this approach is empirically equivalent to one involving a morphological operation(s). The downside theoretically is that it weakens the predictive power of the Mirror Alignment Principle in a (presumably) unpredictable way. That is to say, if any random, stipulated ordering statement has the potential override the MAP in any given language, then the MAP has zero predictive power. If, on the other hand, it is a morphological operation that applies, feeding the MAP algorithm, then we have a way to constrain the predictions of the MAP: it is calculated over the set of hierarchical structures which can be the output of morphological operations. Since we have independent ways of investigating and diagnosing morphological operations within the framework of Distributed Morphology, this does not fully undermine the predictive power of the Mirror Alignment Principle. Unless we could develop a principled theory about how, why, and when ordering statements can override the MAP, then the MAP lacks any predictive power. Therefore, while potentially empirically equivalent, an approach based purely on ordering statements is not worth pursuing, since there is little hope for further insight.

8.2 Aspect + Voice in Classical Arabic

In constructing the analysis of the basic verbal forms of Classical Arabic in Section 4.3, we required the following ranking of Alignment constraints (repeated from (34)):

(81) Ranking: ALIGN-AGR-R-PWD » ALIGN-ROOT-E-MWD » ALIGN-AV-E-MWD

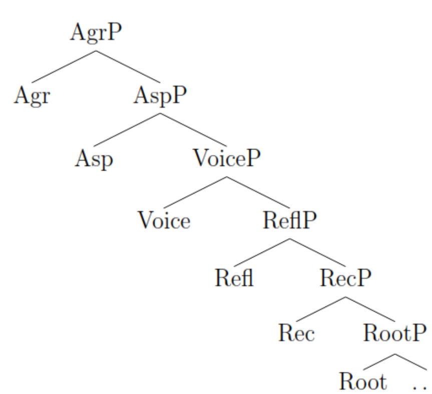
The high-ranking of ALIGN-AGR follows directly from the MAP, since the Agr head will be the highest head in the tree according to standard theories about the position of agreement. The low-ranking of ALIGN-AV, however, is problematic. Aspect and Voice are higher in the syntactic structure than Root, yet the Alignment constraint on the combined Aspect+Voice morpheme is ranked lower than ALIGN-ROOT.

The full analysis of Classical Arabic provides hints as to the potential fix to this MAP problem. First of all, the fact that, on the surface, Aspect and Voice always appear as a single portmanteau morpheme suggests that the morphological component is treating these two heads in a special way. This must certainly be the case in terms of vocabulary insertion, but might also be the case in terms of structure-changing operations earlier in the morphological component. Without a morphological operation, it would be an accident of vocabulary entries and the vocabulary insertion procedure that the two morphosyntactic functions were exponed by a single output morpheme. Since this seems to be a fact of the system rather than an accident, this should be encoded in a morphological operation. Second, the analysis of the verbal derivational morphemes vis-à-vis the MAP already includes a mechanism by which ALIGN-ROOT attains a higher ranking than expected. This is the default preference for Root-alignment that exerts itself in the absence of asymmetric c-command. Therefore, if we can construct a morphological operation which bleeds asymmetric c-command between Aspect/Voice and Root, then the default Root-alignment preference can generate the required ranking.

One way to generate the morphosyntactic structure that would meet these conditions is to have an early head-movement operation that moves Voice to Aspect, prior to the snowballing head-movement that joins Root with the higher functional material, such that it can be spelled out in a single morphological word. This operation, within the full morphosyntactic derivation, is schematized in (82)-(86) for a Form VI (reflexive reciprocal) perfective passive, so as to demonstrate this behavior relative to verbal derivational morphemes as well.

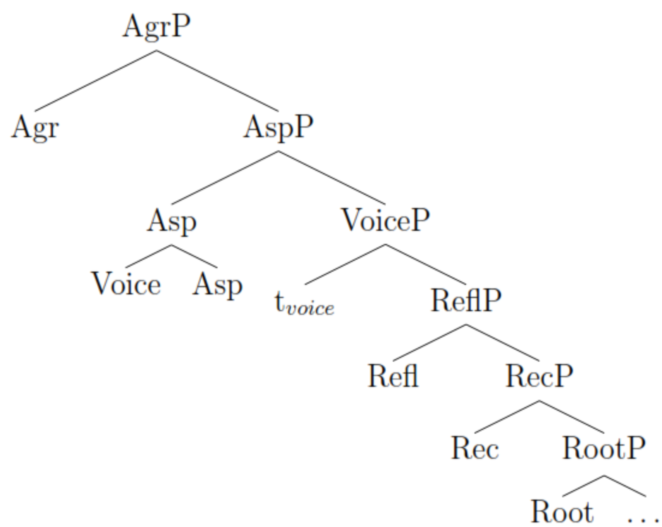
The tree in (82) represents the base-generated structure submitted to the morphological component by the narrow syntax. Each functional head is merged cyclically along the clausal spine. If no further operations occurred other than the expected snowballing head movement, then the MAP would not generate the ranking in (81). This is what motivates positing a subsequent morphological operation.

(82) Base generated syntactic structure



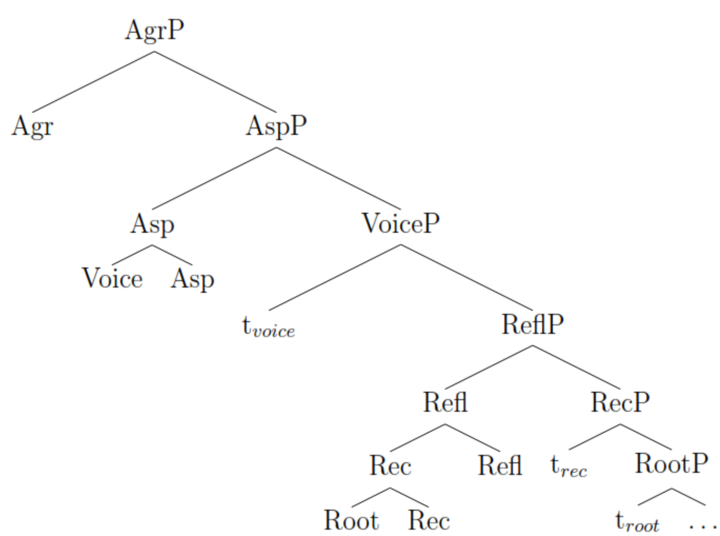
In order to deprive the MAP of the c-command relations that would motivate the undesired ranking ALIGN-AV » ALIGN-ROOT, we must perform a counter-cyclic operation involving Asp and Voice. If the Voice head moves to the Asp head, the terminals of the resulting complex head will be separated from the clausal spine by a segment of Asp, as shown in (83). If this operation precedes the snowballing head-movement which joins Root to the higher functional material, it has the potential to disrupt the c-command relations that are expect based on the original syntactic structure.

(83) Voice-to-Aspect morphological movement operation



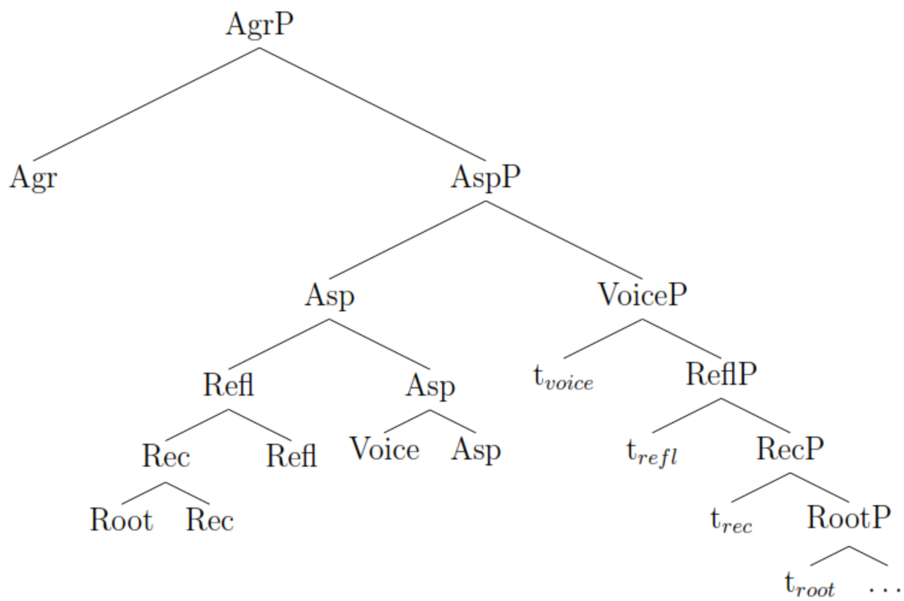
The following tree shows the result of the first two steps of snowballing head movement, which joins Root and Rec with Refl. At this stage, there are two complex heads in the structure, the complex Refl head, and the complex Asp head.

(84) First two steps of snowballing head movement



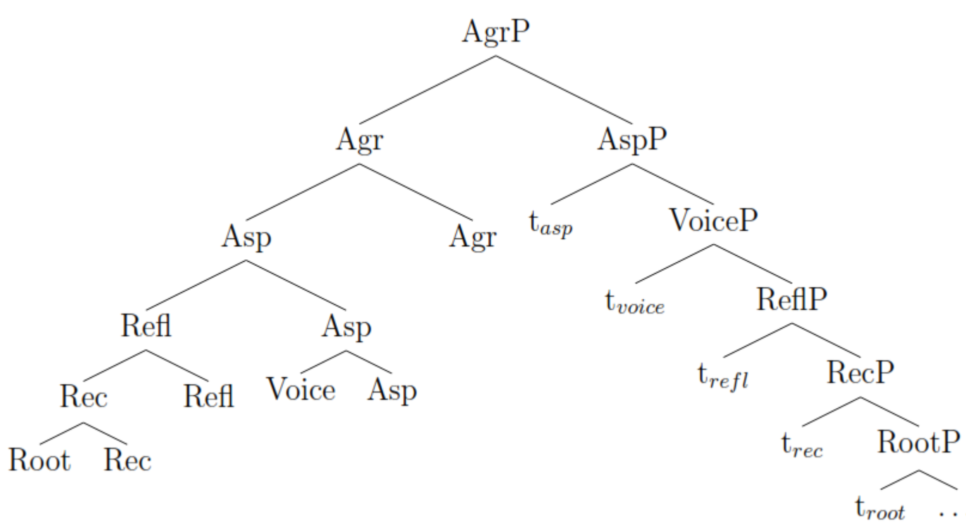
There is a question about where the Refl head will adjoin to the complex Asp head on the next movement step. If it attaches to the terminal segment of either Voice or Asp, both terminals will end up c-commanding Root, so this would not solve our problem. If, on the other hand, it attaches to the higher segment of Asp, then we have the structure in (85), where there are no c-command relations between Root and either Asp or Voice. (The same result would hold even without an overt verbal derivational morpheme, as $v_{default}$ would still intervene and create the double complex-head structure.)

(85) Movement of complex Refl head to complex Asp head



Lastly, the tree in (86) shows the final head-movement step where the complex Asp head moves to Agr.

(86) Head movement of complex Asp head to Agr



This is the structure over which the MAP is calculated. It dictates that ALIGN-AGR dominate all other Alignment constraints, as the terminal segment of Agr asymmetrically c-commands all other terminal heads. It dictates that ALIGN-REFL dominate ALIGN-ROOT and ALIGN-REC, since the terminal segment of Refl c-commands the terminals of both Root and Rec. The MAP prescribes no further rankings, because there are no additional asymmetric c-command relations. At the morphology-phonology interface, the preference that ALIGN-ROOT outrank all other Alignment constraints with respect to which it has not yet been ranked applies. This fixes ALIGN-ROOT over ALIGN-REC, and also ALIGN-AV (or separate ALIGN-VOICE and ALIGN-ASP, if they have somehow not yet been combined). These are exactly the rankings which we needed in order to carry out the phonological analysis. ALIGN-REFL dominates ALIGN-AV by transitivity through ALIGN-ROOT, but nothing yet in the system determines a ranking between ALIGN-AV and the Alignment constraint on the head which is sister to Root (here ALIGN-REC), since these also do not stand in a c-command relation. In the tableau illustrating the phonological derivation for Form VI in (58), neither ALIGN-REC nor ALIGN-AV is high-enough ranked to affect the evaluation; therefore, we do not actually have evidence for their relative ranking in such a case.

By implementing the Voice-to-Asp movement operation early in the morphological component, we thus create a structure which with a MAP-compliant ranking that is consistent with the ranking we required for the phonological analysis. Therefore, if we can tolerate this morphological operation, or one which creates an equivalent structure, as part of the grammar, then the apparent challenge to the MAP posed by the ranking ALIGN-ROOT » ALIGN-AV is nullified. The total ranking is summarized in (87):

(87) MAP-prescribed rankings supplemented with Root-alignment preference in Form VI:
ALIGN-AGR-R-PWD » ALIGN-REFL-L-MWD » ALIGN-ROOT-E-MWD »
ALIGN-REC-L-PWD, ALIGN-AV-E-MWD

9 Appendix B: Additional analysis of Arabic

While the purpose of this paper has been to develop and support the Mirror Alignment Principle hypothesis, one if its further contributions is in the phonological analysis of Classical Arabic nonconcatenative morphology itself. This Appendix explores a few additional pieces of this analysis, including a strong piece of evidence against the use of templates (or at least of autosegmental association to templates), namely that generalizations regarding vowel copying/spreading are phonological rather than directional.

9.1 The perfective active of Form I

Across all Forms, the only vowel in the perfective active is [a].[45] This [a] always has at least two instantiations/copies. An analysis that mirrored that of the AV morpheme for the passive (both perfective and imperfective) would identify the perfective active AV morpheme as underlyingly having the shape /aa/ (where the two /a/'s are separate vowels, not a single long vowel). However, this underlying representation would seem to violate the OCP (cf. McCarthy 1986), which appears to be active in shaping what is an allowable co-occurrence in the root morpheme (McCarthy 1986, 1991), since it has two adjacent identical segments. While this is not strictly a problem in OT given

[45] Certain roots do have different vowel patterns in Form I, but these do not carry over to other Forms.

Richness of the Base (Prince & Smolensky 1993/2004), a way around this problem entirely is to say that the morpheme is simply /a/. Given that there are always multiple instantiations of the [a], this would entail that there is always a violation of INTEGRITY (McCarthy & Prince 1995) in the outputs of the perfective active.

(88) INTEGRITY-IO

Assign one violation mark * for each segment in the input which has multiple correspondents in the output.

If this constraint is sufficiently low-ranked, splitting of the AV vowel proves to be a viable analysis for the perfective active.

(89) Perfective active of Form I: 3PL.MASC *katabuː* [46]

/ktb, a, uː/	C//V	ALIGN-ROOT-E-MWD	ALIGN-AV-E-MWD	INTEGRITY
a. {[ktabuː]}	*!	* (| uː)	**** (k,t | b,uː)	
b. {*ʔi*[ktabuː]}		* (| uː)	****! (k,t! | b,uː)	
c. {[katbuː]}		* (| uː)	****! (k | t!,b,uː)	
d. ☞ {[katabuː]}		* (| uː)	*** (k | b,uː)	*
e. {[katba.uː]}		**! (| a!,uː)	** (k | uː)	*
f. {*ʔ*[aktabuː]}		**! (a! | uː)	** (| b,uː)	*

Even though there is only one /a/ in the underlying representation, syllable structure and Alignment dictates that it must have multiple exponents in the output. C//V prevents placement of a single exponent between the second and third radical in candidate (a). This candidate would be ruled out anyway by ALIGN-AV-E. Such is the case with candidate (b), which is equivalent to (a) but with the C//V violation fixed by (MWD-external) epenthesis. Candidate (c), which avoids the C//V violation by placing the single AV vowel between radical one and two, is likewise ruled out by ALIGN-AV-E, but because it has accumulated violations on the right rather than the left. While having perfect syllable structure, optimal root alignment, and no INTEGRITY violations (and not even epenthesis outside of the morphological word, as in (b)), having only one exponent of the /a/ makes optimal AV-alignment impossible. Since there is only one [a] in (a-c), there will necessarily be two root consonants intervening between the AV vowel and one edge of the morphological word.

When there is a second surface instantiation of the AV vowel placed between the two root consonants that would otherwise both intervene to misalign the AV morpheme, one of those consonants will no longer cause an AV-alignment violation. Therefore, if AV alignment is more significant than not having multiple exponents of an underling segment (i.e., ALIGN-AV-E » INTEGRITY), then having the second [a] will be preferable in this situation. Thus we properly select (d) over (b) and (c).

Candidates (e) and (f) are similar to the optimal candidate (d) in that they have multiple exponents of the AV /a/. However, in both cases, one of the additional exponents worsens Root-alignment in favor of AV-alignment, which is obviously ruled out by the ranking of ALIGN-ROOT-

[46] So as to keep track of what corresponds to what, I will use the 3rd pl. masculine ending *-uː* rather than the sing. *-a*.

E » ALIGN-AV-E. Thus, the assumption that the underlying form of the perfective active AV is /a/ is consistent with our already established ranking.[47]

9.2 The imperfective passive of Form VII

Now let us consider the imperfective passive of Form VII. First we will focus on getting the proper segmental string, and then we will more closely examine the vowels.

(90) Imperfective passive of Form VII: 3SG MASC *yunkatabu*

/y, n, ktb, ua, u/	C//V	ALIGN-AGR$_{IPFP}$-L-PWD	ALIGN-REC-L-MWD	ALIGN-ROOT-E-MWD	ALIGN-AV-E-MWD	INTEG
a. {[yunktabu]}	*!		** (y,u)	**** (y,u,n | u)	*** (y | b,u)	
b. {[ynuktabu]}	*!		* (y)	**** (y,n,u | u)	**** (y,n | b,u)	
c. {[yunkatbu]}			*!* (y!,u!)	**** (y,u,n | u)	****! (y | t!, b,u)	
d. {[yun**a**kt**a**bu]}			*!* (y!,u!)	*****! (y,u,n,a! | u)	*** (y | b,u)	*
e. ☞ {[yunk**a**t**a**bu]}			*!* (y!,u!)	**** (y,u,n | u)	*** (y | b,u)	*
f. {[nuyk**a**t**a**bu]}		*!* (n!,u!)		**** (n,u,y | u)	*** (n | b,u)	*
g. {*ʔu*[ynuktabu]}		*!* (ʔ!,u!)	* (y)	**** (y,n,u | u)	**** (y,n | b,u)	

With C//V and imperfective alignment (to the prosodic word) still undominated, candidates (a), (b), (f), and (g) are quickly eliminated. Candidate (d) places an extra vowel before the root, and thus is ruled out by ALIGN-ROOT-E. Candidate (c), which has only one exponent of the AV's second vowel /a/, is eliminated by ALIGN-AV-E due to the Root-medial [t]. This gives us the desired candidate (d), and the segmental string [CVCCVCVCV].

There must therefore be a vowel between the first and second radical; however, there are several ways that that vowel could be obtained. There are essentially three options, laid out in (91) below: desired candidate (a), which splits the second AV vowel /a/; candidate (b), which splits the first AV vowel /u/; and candidate (c), which gets the vowel through default epenthesis [i]. The splitting candidates violate INTEGRITY, while the epenthesis candidate violates DEP. Since epenthesis is not optimal, the ranking must be DEP » INTEGRITY, as shown in (91).[48] But, this ranking does not sufficiently distinguish between the different splitting candidates.

(91) Imperfective Passive of Form VII: 3SG.MASC *yunkatabu*

/y, n, ktb, ua, u/	DEP	INTEGRITY
a. ☹ {[yun.k**a**.t**a**.bu]}		*
b. 💣 {[y**u**n.k**u**.ta.bu]}		*
c. {[yun.k*i*.ta.bu]}	*!	

[47] Since the splitting is motivated not by phonotactics but by Alignment, epenthesis of a default vowel (*[k*i*tabu] or *[kat*i*bu]) will not harmonically improve the output, regardless of the relative ranking of INTEGRITY and DEP.

[48] This ranking is superficially worrisome in light of the epenthesis we see word-externally to support initial clusters created by Alignment in forms like the perfective of Form VII, since it would prefer splitting of left-edge segments to epenthesis. But, as long as DEP ranks below the active Alignment constraints (specifically, below ALIGN-ROOT-E-MWD), epenthesis outside of the morphological word will still be optimal, since it accrues the necessary CV support sequence without worsening Root-alignment, which would be the case if non-root segments were split for the same purpose.

To solve this problem, we can observe a broad generalization from the data in (18) above: it is *phonologically* predictable which vowel will have multiple exponents.

(92) *If there are multiple copies of a vowel from the aspect + voice morpheme,*

a. it is [a] if there is an /a/ in the underlying form;
b. it is [u] if there is a /u/ but no /a/ in the underlying form;
c. it is [i] if there is an /i/ but no /a/ or /u/ in the underlying form.

This generalization holds up across the four *aspect + voice* categories. In the *perfective active*, there is only /a/ in the underlying form, and this is the vowel that splits. In the *perfective passive*, the underlying form of the AV morpheme is /ui/. In the Forms that require at least three instantiations of an AV vowel (V, VI, and maybe III), it is the /u/ that spreads. In the *imperfective active*, the underlying form of the AV morpheme is harder to isolate – it seems possible that there are different morphemes for different groups of Forms. But, whatever the full underlying form, either /uai/ or /ai/, the vowel that spreads in all cases is /a/. In the *imperfective passive*, the underlying AV morpheme is /ua/, and again the spreading vowel is /a/.

Given the contrast between the *perfective passive* and the *imperfective passive* with respect to spreading, it is clear that the generalization should not be related to the order of the vowels in the morpheme: in the *perfective*, it is the first of the two vowels; in the *imperfective*, it is the second. Note that, if we adhered to an autosegmental model, such as McCarthy (1979, 1981), where the determination of which segments to spread onto empty slots is made by the universal left-to-right association convention, we expect directionality to be the primary factor here. But instead the choice is made based on phonological/melodic information. To put our generalizations another way, it is better to have multiple exponents of /a/ than /u/ or /i/, and it is better to have multiple exponents of /u/ than /i/. Notice that this scale correlates with the relative sonority/duration of the different segments: [a] > [u] > [i].

If we assume that INTEGRITY can be relativized to specific segments (or, maybe, features), we can capture this generalization with the following constraints:

(93) Relativized INTEGRITY constraints

a. INTEGRITY(i): /i/ may not have multiple correspondents in the output.
b. INTEGRITY(u): /u/ may not have multiple correspondents in the output.
c. INTEGRITY(a): /a/ may not have multiple correspondents in the output.

(94) Ranking: INTEGRITY(i) » INTEGRITY(u) » INTEGRITY(a)

When INTEGRITY is expanded and differentiated in this way, we derive the proper distribution of vowels in the imperfective passive of Form VII. This result is transferrable to all other relevant cases.

(95) Imperfective Passive of Form VII: 3SG.MASC *yunkatabu*

/y, n, ktb, ua, u/	DEP	INTEGRITY(i)	INTEGRITY(u)	INTEGRITY(a)
a. ☞{[yunk**a**t**a**bu]}				*
b. {[y**u**nk**u**tabu]}			*!	
c. {[yunk*i*tabu]}	*!			

9.3 Form IV ("causative" = high CAUSATIVE)

In Section 4.5, we saw that we required a phonotactic constraint *tC in order to generate the correct placement of vowels in Forms involving the Reflexive /t/ (namely Form V and VI). The same behavior is displayed by the *ʔ* of Form IV (the high Causative). Just like the Reflexive *t*, the Causative *ʔ* seeks the left edge but must be followed by a vowel, i.e., it does not permit clustering like that seen in Form VII. Glottal stops have a restricted distribution in Classical Arabic: they cannot surface pre-consonantally. When they would surface in this position, they are typically deleted. This motivates a ranking: *ʔC » MAX-ʔ. If *ʔC also outranks ALIGN-ROOT-E, then we can generate the desired non-clustering behavior on phonotactic grounds.

(96) ALIGN (CAUSATIVE, L; MORPHWD, L) [ALIGN-CAUS-L-MWD]

Assign one violation mark for each segment that intervenes between the left edge of the Causative morpheme and the left edge of the morphological word.

Causative is underlyingly /ʔ/ (Form IV) or /s/ (Form X) when not syntactically adjacent to the Root; it is underlyingly a consonantal timing slot when syntactically adjacent to the Root (Forms II & V).

(97) Ranking (in Form IV): *ʔC, ALIGN-CAUS-L-MWD » ALIGN-ROOT-E-MWD

This ranking generates the desired outputs, as illustrated in the following tableaux: [49]

(98) Perfective passive of Form IV: 3SG.MASC *ʔuktiba*

/ʔ, ktb, ui, a/	*ʔC	ALIGN-CAUS-L-MWD	ALIGN-ROOT-E-MWD	ALIGN-AV-E-MWD
a. ☞ {[ʔuktiba]}			*** (ʔ,u | a)	*** (ʔ | b,a)
b. {[ʔukitba]}			*** (ʔ,u | a)	****! (ʔ | t!,b,a)
c. {[kuʔtiba]}	*!	** (k,u)	* (| a)	*** (k | b,a)
d. {*ʔ*[ukʔitba]}		** (u!,k!)	** (u | a)	*** (| t,b,a)
e. {*ʔu*[ʔkutiba]}	*!		** (ʔ | a)	**** (ʔ,k | b,a)
f. {*ʔu*[kʔutiba]}		* (k!)	* (| a)	**** (k,ʔ | b,a)

[49] It appears as though the [-ʔV-] sequence generated in the imperfective is deleted on the surface. McCarthy (1979, 1981) treats this as a sort of post-lexical process, where the morphological form includes the sequence and it is deleted later. I will tentatively follow this approach, but little of the analysis would be lost if we included the deletion step in the same part of the derivation – the only problem will be accounting for the vowel pattern in the imperfective active (and the AV vowels of the imperfective active are difficult to begin with).

(99) Imperfective passive of Form IV: 3SG.MASC *yuʔaktabu*

/y, ʔ, ktb, ua, u/	*ʔC	ALIGN-AGRIPFL-L-PRWD	ALIGN-CAUS-L-MWD	ALIGN-ROOT-E-MWD	ALIGN-AV-E-MWD
a. {[yuʔkatbu]}	*!		** (y,u)	*** (y,u,ʔ)	**** (y | t,b,u)
b. ☞ {[yuʔ**a**kt**a**bu]}			** (y,u)	**** (y,u,ʔ,a)	*** (y | b,u)
c. {[yuʔ**a**k**a**tbu]}			** (y,u)	**** (y,u,ʔ,a)	****! (y | t!,b,u)
d. {[ʔuy**a**kt**a**bu]}		** (ʔ!,u!)		**** (ʔ,u,y,a)	*** (ʔ | b,u)

9.4 Form X: the causative of the reflexive

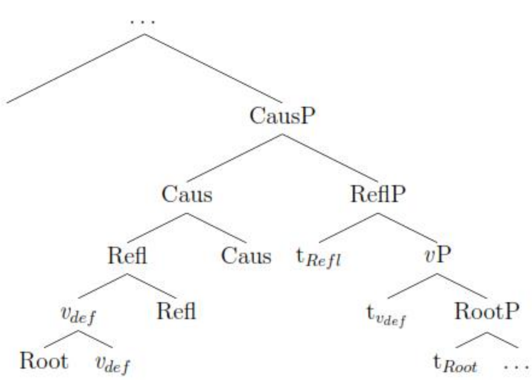
Section 4.5 dealt with the behavior of the Reflexive *t*. There is one other case not yet fully discussed where this morpheme appears, in Form X. In this category, it co-occurs with the Causative marker /s/ (which is likely etymologically related to the Causative /ʔ/ of Form IV; Yushmanov 1961: 49).

(100) Form X

Form X	Perfective		Imperfective	
	Active	Passive	Active	Passive
causative: /s/ + *reflexive*: /t/	(*ʔi*)**st**aktab-a	(*ʔu*)**st**uktib-a	y-a**st**aktib-u	y-u**st**aktab-u

The behavior of this Form category is exactly as we would expect, given all the independent pieces introduced up to this point. As long as we adhere to the structure posited in (24)h, repeated immediately below, then we expect, via the MAP, the ranking ALIGN-CAUS » ALIGN-ALIGN-REFL » ALIGN-ROOT, as shown in (102). This ranking properly derives the forms, as illustrated in (103) and (104).

(101) Morphosyntactic structure of Form X



(102) Ranking (Form X): ALIGN-CAUS-L-MWD » ALIGN-REFL-L-MWD » ALIGN-ROOT-E-MWD

(103) Perfective Passive of Form X: 3SG.MASC *ʔustuktiba*

/s, t, ktb, ui, a/	ALIGN-CAUS-L-MWD	ALIGN-REFL-L-MWD	ALIGN-ROOT-E-MWD
a. {[sutkitba]}		**! (s,u!)	**** (s,u,t | a)
b. ☞ {*ʔu*[stuktiba]}		* (s)	**** (s,t,u | a)
c. {[tuskitba]}	*!* (t!,u!)		**** (t,u,s | a)
d. {*ʔu*[tsuktiba]}	*! (t!)		**** (t,s,u | a)
e. {[kustitba]}	*!* (k!,u!)	*** (k,u,s)	* (| a)

(104) Imperfective Passive of Form X: 3SG.MASC *yustaktabu*

/y, s, t, ktb, ua, u/	ALIGN-AGR$_{IPFP}$-L-PWD	ALIGN-CAUS-L-MWD	ALIGN-REFL-L-MWD	ALIGN-ROOT-E-MWD
a. ☞ {[yustaktabu]}		** (y,u)	*** (y,u,s)	****** (y,u,s,t,a | u)
b. {[yuskattabu]}		** (y,u)	****!* (y,u,s,k!,a!)	**** (y,u,s | u)
c. {[yutsaktabu]}		***! (y,u,t!)	** (y,u)	****** (y,u,t,s,a | u)
d. {[yuksattabu]}		***! (y,u,k!)	***** (y,u,k,s,a)	*** (y,u | u)
e. {[suytaktabu]}	*!* (s!,u!)		*** (s,u,y)	****** (s,u,y,t,a | u)