The Mirror Alignment Principle:
Morpheme Ordering at the Morphosyntax-Phonology Interface (Part II: Arabic)*

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1 Introduction

CLAIM: *Arabic is Bantu in disguise (without CARP ordering restrictions)*
Arabic has a limited set of verbal derivational morphemes (VDMs; ~ CARP-like elements) which can be combined in multiple orders. These multiple orders (roughly) correlate with semantic scope. This is the same sort of picture we observed in Bantu (Zukoff 2016).

- This set of properties is disguised in several ways:
    - The morphological/phonological system it is embedded in is *nonconcatenative*.
        - The VDMs, and their ordering in the output form, are less easy to identify than in a concatenative language.
        - The VDMs interact with the Root and Aspect+Voice morphemes in interesting (though consistent) ways, further disguising their ordering properties.
    - The morphosemantics are less transparent than in Bantu.
        - Some of the VDMs supply fairly straightforward and consistent semantic values (like Causative in Form IV & Form X).
        - The semantic contribution of some other VDMs is far less clear, and far less consistent across different roots.

- The Mirror Alignment Principle (MAP) approach to morpheme ordering (introduced last week at Ling Lunch; Zukoff 2016) provides the tools for deciphering this system.
- By using Alignment constraints (McCarthy & Prince 1993) to implement ordering in the phonological component, ordering preferences can interact with phonological constraints.
    - The interaction between Alignment constraints and syllable well-formedness constraints will allow us to analyze the phonological aspects of the nonconcatenative system without any appeal to prosodic templates (McCarthy 1979, 1981).
- Since the MAP directly relates the ranking of Alignment constraints to hierarchical syntactic structure, the rankings determined through this phonological analysis inform syntactic structure.
    - The MAP thus allows us to reverse engineer the syntax from the phonology.
- In considering the syntax deduced by this reasoning, we will observe some larger regularities within the system.
    - Based on these generalizations, I will suggest that certain apparent surface distinctions can be collapsed, such that the overall system very strongly resembles the CARP system of Bantu (minus any effects of a morphological template).

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- This approach will demonstrate that nonconcatenative morphological processes are fully compatible with the Mirror Principle, something that Baker's (1985) original proposal was unable to accommodate.

2 The Mirror Alignment Principle approach to morpheme ordering

2.1 The basic proposal[1]

- The Mirror Alignment Principle is an algorithm which relates hierarchical (morpho)syntactic structure to rankings of Alignment constraints (McCarthy & Prince 1993):

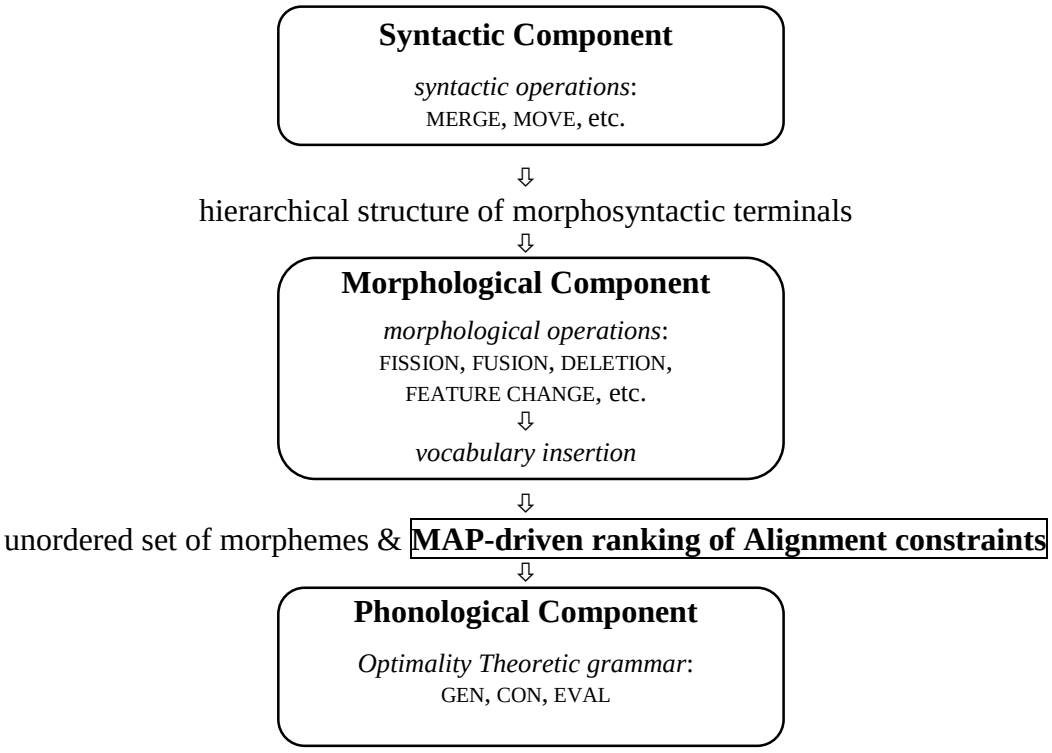
(1) The Mirror Alignment Principle (The MAP)

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**

- When this algorithm is calculated at the morphology-phonology interface in a grammar with the characteristics in (2), it generates Mirror Principle-compliant morpheme ordering.

(2) The modular grammar

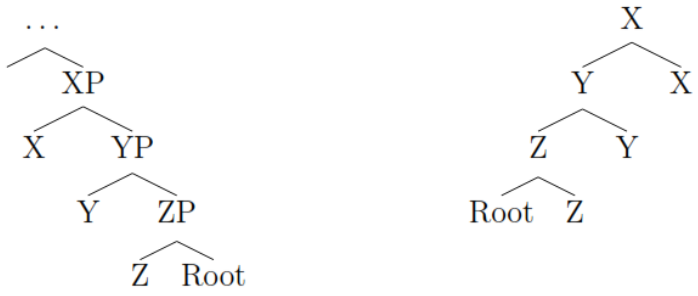


[1] For a more detailed introduction to the proposal, consult Zukoff (2016).

❖ The operation of this system can be illustrated with following schematic example:
- A word contains a Root plus three affixal morphemes: X, Y, and Z.
- It has the syntactic structure shown in (3):

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

a. Base generated structure → b. Complex head



- Given this structure, the Mirror Principle (Baker 1985) dictates that:
  - Z surface closest to the Root
  - Y surface next closest
  - X surface farthest away

  ⇒ Total order (assuming the affixes to all be suffixes): [Root-Z-Y-X].

- When the MAP is calculated over this structure, it generates the ranking of Alignment constraints shown in (4):

(4) The MAP-prescribed ranking

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

- This ranking selects the Mirror Principle-compliant morpheme order ((5)f):

(5) Generating the [Root-Z-Y-X] order with the MAP

/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		*	**

➢ This shows that mapping hierarchical syntactic relations onto ranking relations among Alignment constraints generates the Mirror Principle-compliant order of morphemes.

2.2 Generating nonconcatenative behavior: CONTIGUITY and Alignment

- The MAP makes an interesting prediction when considered in tandem with the faithfulness constraint CONTIGUITY (Kenstowicz 1994, McCarthy & Prince 1995):

(6) 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.

- 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].[2]

➢ CONTIGUITY violations can also be incurred when (a piece of) a morpheme trespasses inside another morpheme. Alignment constraints provide a potential trigger for such intrusion.

Consider the following schematic example:
- A word consists of two morphemes: a morpheme /*x*/ and a morpheme /*abcde*/.
- Alignment constraints: 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.

- Syntactic structure: /*abcde*/ asymmetrically c-commands /*x*/.
- The MAP generates the ranking ALIGN-/*abcde*/-L » ALIGN-/*x*/-L.
  - The segment *a* must therefore 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's 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*]
  - The *non*concatenative/infixing output [*a-x-bcde*]

[2] It is crucial in this conception that precedence/adjacency relations are not established between segments belonging to distinct morphemes.

(7) 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 than the lower-ranked Alignment constraint ((7)(i)):
  - It is more important to retain the adjacency relationships of all segments belonging to that first morpheme than to optimally align the second morpheme.
  - So, 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, selecting candidate (a).

- But, when the lower-ranked Alignment constraint ranks *over* CONTIGUITY ((7)(ii)):
  - The second morpheme can and does intrude on the first in order to optimize its alignment, selecting candidate (b).
  - 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),[3] 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.

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. This is made explicit in the Appendix (Section 7.6)

- Even in a nonconcatenative system, we can calculate the Mirror Principle by looking at the Alignment ranking.
- Therefore, by using an Alignment approach to morpheme ordering, nonconcatenative systems can be brought into the fold of the Mirror Principle, contrary to Baker's (1985:401-3) worries.

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

3 Nonconcatenative Morphology in Arabic

- In the Semitic languages, unlike most other languages, morphological derivation of complex forms does not straightforwardly consist of sequential affixation to a fixed base of derivation.[4]
    - Individual morphemes can be segmented and identified, *but*
    - 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 Arabic (Classical/Modern Standard).
    - This is illustrated in (8) with the 3SG.MASC inflected forms of the root *ktb* 'write'.

(8) The Arabic verbal system (adapted from McCarthy 1981:385)[5]

Form	"Template"	Perfective		Imperfective	
		Active	Passive	Active	Passive
I	$C_1VC_2VC_3$-	kataba	kutiba	yaktubu	yuktabu
II	$C_1VC_2C_2VC_3$-	kattaba	kuttiba	yukattibu	yukattabu
III	$C_1V_iV_iC_2VC_3$-	kaataba	kuutiba	yukaatibu	yukaatabu
IV	ʔ$VC_1C_2VC_3$-	ʔaktaba	ʔuktiba	yuʔaktibu	yuʔaktabu
V	t$VC_1VC_2C_2VC_3$-	takattaba	tukuttiba	yatakattabu	yutakattabu
VI	t$VC_1V_iV_iC_2VC_3$-	takaataba	tukuutiba	yatakaatabu	yutakaatabu
VII	n$C_1VC_2VC_3$-	(ʔi)nkataba	(ʔu)nkutiba	yankatibu	yunkatabu
VIII	C_1tVC_2VC_3-	(ʔi)ktataba	(ʔu)ktutiba	yaktatibu	yuktatabu
IX	$C_1C_2VC_3VC_3$-	(ʔi)ktababa		yaktabibu	
X	st$VC_1C_2VC_3$-	(ʔi)staktaba	(ʔu)stuktiba	yastaktibu	yustaktabu
XI	$C_1C_2V_iV_iC_3VC_3$-	(ʔi)ktaababa		yaktaabibu	
XII	C_1C_2VwC_2VC_3-	(ʔi)ktawtaba		yaktawtibu	
XIII	C_1C_2VwwVC_3-	(ʔi)ktawwaba		yaktawwibu	
XIV	C_1C_2VnC_3VC_3-	(ʔi)ktanbaba		yaktanbibu	
XV	C_1C_2VnC_3Vy-	(ʔi)ktanbaya		yaktanbiyu	

- Descriptively, each "Form" can be characterized by a particular sequence of consonant and vowel slots, which gets filled in by the featural values of the specific morphemes involved.

[4] For recent work on the phonology of Arabic nonconcatenative morphology, see Bat-el (2003, 2011), Ussishkin (2000a, 2000b, 2003, 2005), Tucker (2010, 2011), Wallace (2013), *among others*. 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.

[5] 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 for phonotactic reasons when the word is not in connected context.

- Each Form is associated with some range of morphosemantic values.
    - For some Forms, the semantics are largely consistent across roots which display the pattern; for example, Form IV is very clearly Causative in virtually all its occurrences.
    - For other Forms, the semantics are much less consistent, making it more difficult to conceptualize the Form as somehow exponing a particular morphosemantic value.

➢ Nonetheless, I will assume that each Form represents *a single morphosyntactic structure*, and that this structure is independent of fine-grained interpretation.
    - This allows us to attempt morpheme segmentation in the usual way.

I will use the following as guiding principles in morpheme segmentation:

- If the same (or significantly similar) phonological content can be connected across different Forms with similar meanings,[6] I will identify it as a single morpheme.
    - Reflexive = /t/ in multiple Forms
    - Causative = /s/ ~ /ʔ/
        - Form IV and Form X both very clearly have Causative meaning.
        - The morpheme in Form IV is /ʔ/; the morpheme in Form X is /s/.
        - These are historically related (*/s/ > /ʔ/) (Yushmanov 1961:49, Fischer 2002:97).
- If phonological content cannot be connected in this way, even if there is similarity of meaning, I will identify it as a distinct morpheme (though we will revise some of these later).
    - Transitive = *consonantal mora* (/μ_C/) (~ gemination)
        - It has very similar function to Causative, but since it doesn't have overlapping phonological content, I will leave it separate.

- Table (9) shows the results of morpheme segmentation (exponents of VDMs are bolded).[7]

(9) Morpheme segmentation (3SG.MASC of root *ktb* 'write')

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	*transitive*: /μ_C/	ka**tt**ab-a	ku**tt**ib-a	y-uka**tt**ib-u	y-uka**tt**ab-u
III	*applicative*: /μ_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 *transitive*: /μ_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 *applicative*: /μ_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	*"middle"*: /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
X	*causative*: /s/ + *reflexive*: /t/	(*ʔi*)**st**aktab-a	(*ʔu*)**st**uktib-a	y-a**st**aktib-u	y-u**st**aktab-u

[6] The suggested derivational meanings of each Form are based on my reading of a number of sources, including Wright (1896:29-46), Schramm (1962:361-2), Fischer (2002:99-100), Ratcliffe (2005), Ryding (2005).

[7] Forms IX & XI-XV are omitted due to their rarity and non-productivity (Form IX is slightly more productive). These Forms have certain phonological behaviors that do not immediately follow from the account to be developed below.

Notes

- Form III isn't typically described as applicative, but the description in Ryding (2005:503-4) – who identifies it as "associative" – makes applicative seem like a reasonable interpretation.
- Form VII is often referred to as the "middle", having a wide range of non-active meanings, including reflexive, resultative, passive, mediopassive, intransitive (Ryding 2005:555-6).
    - It seems unlikely that it is truly a "Voice" morpheme, since it can have both active and passive inflection.
    - The function may best be summarized as suppressing an argument (de-transitivizing?).
- Many of the Forms can sometimes have a reciprocal interpretation, but it doesn't seem like any of the VDMs are reciprocal morphemes *per se*.

Preview

- We can immediately observe that something interesting is going on with the Reflexive /t/:

(10) Reflexives

		perfective active	imperfective passive
a. Form V	*reflexive of the transitive*	takattaba	yutakattabu
b. Form VI	*reflexive of the applicative*	takaataba	yutakaatabu
c. Form X	*causative of the reflexive*	(*ʔi*)staktaba	yustaktabu
vs.			
d. Form VIII	*simple reflexive*	(*ʔi*)kttataba	yuktatabu

- The reflexive morpheme is *t* not *ta* ; cf. Form V perfective passive ***tu****kuttiba*

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

❖ Previous accounts had to stipulate a solution to the idiosyncratic infixal behavior of Form VIII.

- McCarthy (1981:389-90) posits an autosegmental re-association rule (the "Eighth Binyan [= Form] Flop") that effectively metathesizes the *t* with the first root consonant.
- Tucker (2010), in an Alignment-based approach, stipulates that the *t* of Form VIII comprises a separate morpheme class ("Prefix2") whose Alignment constraint ranks below, rather than above, the Root's Alignment constraint. (See also Ussishkin 2003.)
    - ALIGN-PREFIX1-L » ALIGN-ROOT-L » ALIGN-PREFIX2-L
    - **NB**: the Reflexive *t* in other forms belongs to the PREFIX1 class.[8]

- The Mirror Alignment Principle allows for an explanation of this problem.
    - Since Alignment ranking is dependent on syntactic structure, differences in Alignment ranking signal differences in syntactic structure.
    - Therefore, Form VIII's behavior is the result of a different syntactic structure.
- Ultimately, this sort of distinction can and will be used to explain other, broader patterns within the verbal formations, such that the system is less chaotic than it may appear.

[8] 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.

4 The basics of the phonological analysis

- In this section, I will illustrate the basic mechanics of the Alignment-based phonological analysis using Form I, the most basic verbal category, both morphologically and semantically.
- This will prepare us to start examining the more complex Forms involving (multiple) VDMs, which will ultimately be the evidence for Mirror Principle behavior.

4.1 Phonological preliminaries

❖ Two surface true syllable structure restrictions (undominated constraints):
- No onsetless syllables: ONSET (Prince & Smolensky 1993/2004)
- No three-consonant clusters; no word-initial two-consonant clusters: C//V

(11) C//V: Assign one violation mark for each non-word-final consonant not adjacent to a vowel.

- In the tableaux below, only candidates that satisfy ONSET and C//V will be considered.
    - Many of the candidates ruled out by these constraints would have been suboptimal anyway given the ranking of Alignment constraints.

❖ Word-initial clusters are broken up by epenthesis:
    - Generally #ʔ*i*-, but #ʔ*u*- if the first vowel is *u*.
    - These segments must be outside the normal domain of Alignment.

➢ I call the normal domain of Alignment the MORPHOLOGICAL WORD (MWD).[9]
➢ I call the domain which includes the epenthetic segments the PROSODIC WORD (PWD).

- There will be one class of morphemes (the imperfective agreement prefixes) which are aligned over the PWD.

❖ In the standard definition of Alignment constraints (McCarthy & Prince 1993:2), evaluation is conducted with respect to a particular edge of the two constituents, either Left or Right.
- I propose a slight addition to this inventory: "Edge-alignment" (E-alignment):

(12) ALIGN (CATEGORY1, E; CATEGORY2, E)
Assign one violation mark for each segment that intervenes between the left edge of CAT1 and the left edge of CAT2, **AND** assign one violation mark for each segment that intervenes between the right edge of CAT1 and the right edge of CAT2.[10]

[9] The two domains are defined as follows:
(i) Definition of morphological word (MWd)
In the evaluation of the word-level phonology, the string bounded by the leftmost segment with an underlying correspondent and the rightmost segment with an underlying correspondent.
(ii) Definition of prosodic word (PWd)
In the evaluation of the word-level phonology, the string bounded by the leftmost segment and the rightmost segment (regardless of morphological affiliation).

[10] An essentially identical alternative 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 effect, these constraints are the combination of the Left- and Right-alignment constraints relating the same two categories.
- I will claim that the Root and the Aspect+Voice morphemes have the property of E-alignment.

4.2 Phonological Analysis of Form I

4.2.1 The perfective (passive) of Form I

- The 3SG.MASC perfective passive of Form I for the root *ktb* 'write' is *kutiba*.

(13) 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 (14).

(14) 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.

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.[11]

- When these constraints are ranked as in (15), the desired output is selected.[12]

(15) 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 (17) 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 (16), and described immediately below.

(16) Constructing the word

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

[11] Alignment to PWD rather than MWD is for the sake of parallelism with the imperfective, but otherwise not strictly necessary.

[12] The ranking ALIGN-ROOT » ALIGN-AV does not seem to follow from the MAP, since the Aspect and Voice heads would be expected to merge higher in the syntactic structure than Root. See the Appendix (Section 7.7) for a suggestion on how to derive this using a morphological operation.

❖ Step (i): ALIGN-AGR-R-PWD
- *Place (the rightmost segment of) the Agreement affix ([a]) as close to the right-edge word boundary as possible. This can be satisfied fully. No subsequent material can intervene between the [a] and the right-edge word boundary.*

❖ Step (ii): ALIGN-ROOT-E-MWD
- *Place 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.*
- *Also, place 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): ALIGN-AV-E-MWD
- *Place 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].*
- *Also, place 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].*

❖ 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].*

- This derivation, in more typical terms, is demonstrated in tableau (17) below.
  - {…} = boundaries of the prosodic word; […] = boundaries of the morphological word
  - *Italics* identify a segment as epenthetic.
  - Alignment violation cells indicate the segments which cause the violations.
  - For 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.

(17) 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); 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); 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.

- Even when we include the undominated syllabic well-formedness constraints C//V and ONSET, we still need the ranking of the Alignment constraints presented thus far.
- This tableau also shows candidates which repair these phonotactic violations through epenthesis. These candidates are still ruled out by Alignment.

(18) 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. {*ʔu*[ktubiʔa]}			**!* (| i!,ʔ!,a)	**** (k,t | ʔ,a)

- The syllable well-formedness constraints rule out many of the permutations (b,d,f,h).
- The equivalent candidates that employ epenthesis to fix the syllable structure problems (c,e,g,i) are still 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 ALIGN-ROOT-E-MWD » ALIGN-AV-E-MWD:

(19) 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. {[ku*ʔ*itba]}	* (| a)	****! (k | t!,b,a)
e. {*ʔ*[uktiba]}	**! (u! | a)	** (| b,a)

- The tradeoff is now clear:
  - Candidate (e) is ruled out because it has optimally aligned an AV vowel at the expense of a root consonant (*k*).
  - 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.

4.2.2 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*.

(20) 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

- I will treat the prefixal and suffixal parts of the imperfective agreement as distinct entities.[13]
  - The prefixal part controlled by a Left-alignment constraint.
  - The suffixal part controlled by a Right-alignment constraint.
  - Both constraints dominate all other Alignment constraints.

(21) Alignment constraints

a. ALIGN (IMPERFECTIVEPREFIX, L; PROSODICWD, L) [ALIGN-AGR$_{IPFP}$-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.

[13] 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. For a basic overview of the system, see also Schramm (1962:363-4), Ryding (2005:441-3).

b. ALIGN (IMPERFECTIVESUFFIX, R; PROSODICWD, R) [ALIGN- AGR$_{IPFS}$-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.

- When these constraints are ranked above the Root-alignment constraint, we generate the correct imperfective of Form I.

(22) Imperfective passive of Form I: 3SG.MASC *yuktabu*

/y, ktb, ua, u/	C//V	ALIGN-AGR$_{IPFP}$-L-PWD	ALIGN-AGR$_{IPFS}$-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. {[y*u*kutabu]}				*** (y,u | u)	****!* (y,*u*!,k! | b,u)
d. {*ʔu*[ykutabu]}		*!* (ʔ!,u!)		** (y | u)	**** (y,k | b,u)
e. {[ykutabu]}	*!			** (y | u)	**** (y,k | b,u)
f. {[kuytabu]}		*!* (k!,u!)		* (| u)	*** (k | b,u)
g. {[yukatub]}			*! (b!)	*** (y,u | u)	**** (y | t,u,b)

- By ranking the imperfective affixes' Alignment constraints high, we rule out:
  - Candidate (f): it maximally left-aligns the Root at the expense of the imperf prefix.
  - Candidate (g): it maximally right-aligns the Root at the expense of the imperf suffix.
- Candidate (e) shows what would be the optimal segmental makeup purely in terms of the Alignment constraints.
  - However, this has a word-initial cluster (C//V violation), so it is not allowed to surface.
- Candidate (d) repairs this C//V violation with external epenthesis; this is not optimal because it causes increased violation of ALIGN-AGR$_{IPFP}$-L-PWD (see below).

This tableau shows why ALIGN-AGR$_{IPFP}$-L must be defined over the PWD, and not the MWD.

- When optimal alignment between the Root and a verbal derivational morpheme would result in left-edge C//V violation, the syllable well-formedness problem is repaired through prothesis, as in candidate (22)d. But this is not the optimal candidate in this imperfective derivation.

As will be shown below, this requires that the Root and verbal derivational morphemes be aligned to the MWD, and that epenthesis be outside of this domain, i.e. in the PWD.

- If the domain of alignment for ALIGN-AGR$_{IPFP}$-L is the PWD rather than the MWD, then word-initial epenthetic segments would affect the imperfective prefix's alignment calculation.
- If these violations were removed from candidate (d), it would be more optimal than desired candidate (a), since it incurs fewer violations of ALIGN-ROOT-E-MWD.

Aligning this morpheme to the PWD thus prevents prothesis.[14]

[14] Another potential explanation could like in paradigm uniformity. [y] is not a licit coda, so it must be followed by a vowel. If this restriction were transmitted throughout the paradigm, we would require a vowel after the imperfective prefix in all cases. Recruiting the AV vowel for these purposes is always preferable to epenthesis.

- The interaction of ALIGN-AGR$_{IPfP}$-L-PWD and C//V thus prohibits clustering, so a vowel must immediately follow the agreement prefix *y-*.
    - Two options: internal vowel epenthesis (c), or recruit an AV morpheme vowel (a,b).
    - Low-ranked ALIGN-AV-E-MWD prefers using the AV vowel, since this epenthesis would push the AV vowel farther into the word. This rules out (c).

- ALIGN-AV-E-MWD also decides between (a) and (b), but w.r.t. to the right edge.
    - The difference between (a) and (b) is 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 = *k*, right = *b*), the position of the middle radical is irrelevant for Root-alignment.
    - However, its placement can make a crucial difference for AV-alignment.
- In candidate (b), the middle radical *t* follows the second AV vowel.
    - This does not improve Root-alignment, but it does actually worsen AV-alignment:
    - Now both *t* and *b* (and *u*) 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 Local summary

- This section has demonstrated that Alignment constraints can be directly responsible for determining segmental order in the basic verbal forms.
    - No appeal to prosodic templates is required.
    - Syllable well-formedness plays a role, but Alignment constraints do the heavy lifting.
- With this background, we can now examine how Alignment operates in the Forms which have verbal derivational morphemes, which will allow us to investigate the Mirror Principle.

5 Using the MAP to infer the syntax of complex forms

- In this section, we will investigate what the analysis of the more complex Forms, specifically the Alignment rankings, can reveal about syntactic structure.
- As a means of quickly deducing Alignment rankings from surface forms, I will introduce the notion of "edge-precedence" (Section 5.1).
    - ❖ For reasons of time, I will not review the analysis that confirms these rankings. The entire analysis is contained in the Appendix (Section 7).
- Since the MAP makes the connection between Alignment ranking and structure non-arbitrary, I will then use these rankings to infer the syntactic structures of the complex Forms.
    - By thinking about the way that head-movement creates the structures over which the MAP is calculated (Section 5.2), and positing a default preference for Root-alignment in the cases where the MAP does not apply, we can identify two types of rankings:
        - One which indicates that a morpheme expones the first head above the Root.
        - Another which indicates that a morpheme expones the second (or higher) head above the Root.
    - ➢ This distinction will immediately account for the contradictory behavior of Reflexive.

- Based on the syntactic results obtained in this way, we will see that the *v*-domain of Arabic actually looks strikingly similar to that of Bantu (without CARP-like ordering restrictions):
    - Verbal derivational morphemes can be merged in different ways, and these distinct structures are reflected in distinct surface orders that comply with the Mirror Principle.
- Lastly, after taking stock of the structures compiled in this way, I will suggest several further generalizations which may be able to reduce the complexity even further.

5.1 Edge-precedence: how to detect Alignment rankings

- In concatenative languages (like Bantu), it's straightforward to figure out relative rankings of Alignment constraints on different morphemes:
    - If two morphemes look like they're competing for the same edge, whichever morpheme is closer to the edge, its Alignment constraint is higher-ranked.
- In a nonconcatenative language (like Arabic), the same logic applies.
    - But you can't rely on entire morphemes, instead you have to rely on *edges*.[15]
- As a way of describing the *linear ordering of morphemes relative to a word edge*, I introduce the term "edge-precedence":

(23) Edge-precedence

Given two morphemes X and Y, which have surface exponents whose segmental composition are, respectively, $[x_1 \ldots x_n]$ and $[y_1 \ldots y_m]$,

a. X *edge-precedes* Y *with respect to the **Left** Edge* iff the **leftmost** segment of the surface exponent of X, $[x_1]$, **precedes** the **leftmost** segment of the surface exponent of Y, $[y_1]$.
b. X *edge-precedes* Y *w.r.t. the **Right** Edge* iff the **rightmost** segment of the surface exponent of X, $[x_n]$, **follows** the **rightmost** segment of the surface exponent of Y, $[y_m]$.

- By determining edge-precedence relations (which is a simple surface comparison), we have a diagnostic for determining the relative ranking of competing Alignment constraints.
    - Given two Alignment constraints competing for the same edge η:
        - ALIGN-X-η & ALIGN-Y-η
    - If X edge-precedes Y with respect to edge η:
        - ALIGN-X-η » ALIGN-Y-η[16]

❖ Since ranking domination between Alignment constraints depends on c-command relations in the (morpho)syntactic structure via the MAP, this (generally) also means: **X c-commands Y**.

- The table in (24) identifies *Left-edge* edge-precedence relations for Forms II-VIII & X of the active perfective (omitting Agreement suffixes and word-initial epenthetic segments).
    - *Notation*: X edge-precedes Y = "X > Y"
    - 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* (the leftmost segment of the root), and to each other.
- Each edge-precedence relation is coupled with the Alignment ranking it signals.

[15] See McOmber (1995) for a discussion of edges in Arabic.
[16] This might not hold in rare cases where a higher-ranked constraint forces a reversed order.

(24) Left-edge edge-precedence relations → Alignment rankings

	Form	Shape	Edge-precedence	Segments
a.	II	kattab	*root* > *transitive*	*k* > GEMINATION
	RANKING: ALIGN-ROOT » ALIGN-TRANS			
b.	III	kaatab	*root* > *applicative*	*k* > LENGTHENING
	RANKING: ALIGN-ROOT » ALIGN-APPL			
c.	IV	ʔaktab	*causative* > *root*	ʔ > k
	RANKING: ALIGN-CAUS » ALIGN-ROOT			
d.	V	takattab	*reflexive* > *root* > *transitive*	t > k > GEM
	RANKING: ALIGN-REFL » ALIGN-ROOT » ALIGN-TRANS			
e.	VI	takaatab	*reflexive* > *root* > *applicative*	t > k > LENGTH
	RANKING: ALIGN-REFL » ALIGN-ROOT » ALIGN-APPL			
f.	VII	nkatab	*middle* > *root*	n > k
	RANKING: ALIGN-MID » ALIGN-ROOT			
g.	VIII	ktatab	*root* > *reflexive*	k > t
	RANKING: ALIGN-ROOT » ALIGN-REFL			
h.	X	staktab	*causative* > *reflexive* > *root*	s > t > k
	RANKING: ALIGN-CAUS » ALIGN-REFL » ALIGN-ROOT			

- These rankings do indeed generate the phonological forms of each category.
  - This is confirmed in the Appendix (Section 7) with a detailed phonological analysis.
- We will now leverage these rankings, viewed through the lens of the Mirror Alignment Principle, to investigate the syntax.

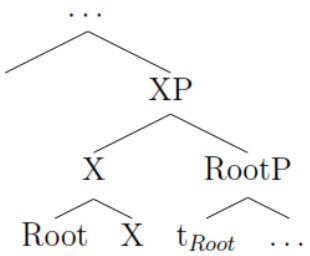
5.2 Interpreting the rankings syntactically

- The MAP imposes Alignment rankings between terminals that stand in a relation of asymmetric c-command.
- If two terminals do not stand in asymmetric c-command (i.e., symmetric c-command or no c-command), then the MAP says nothing about the relative ranking of their Alignment constraints.

➢ There is one position in the complex head-movement structure which invariably lacks asymmetric c-command: the bottom of the tree.

- Assuming that the Root is always the lowest terminal base-generated by the syntax, every time it head-moves to the first head above it, it will enter into a relation of *symmetric* c-command with that first head:

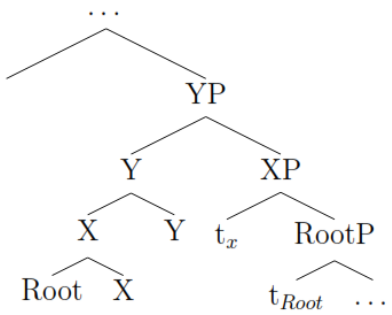
(25) Result of first head movement



- Since Root and X symmetrically c-command one another, the MAP imposes no ranking between ALIGN-ROOT and ALIGN-X, whatever functional head X happens to be.

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

(26) Result of further head movement



- Since Y c-commands X and Root, the MAP asserts the following ranking:

(27) Ranking: ALIGN-Y » ALIGN-X, ALIGN-ROOT

➢ We can thus see that the MAP underdetermines ordering between Root and the first functional head, while still determining the ordering of all higher heads relative to them.

Question: What determines the ranking of ALIGN-X and ALIGN-ROOT?
Claim: In Arabic, in the absence of a MAP-prescribed ranking, ALIGN-ROOT is higher ranked.

- In our schematic example from (26), where X and Root *symmetrically* c-command one another, the MAP asserts no ranking between their Alignment constraints.
- In exactly this case, the default preference for the higher ranking of ALIGN-ROOT kicks in,[18] fixing the ranking as:

[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 (minimal X^0).
[18] The other case where this preference could kick in is when the Root and another head have no c-command relation. This can explain the seemingly problematic ranking of Align-AV (see Section 7.7).

(28) Ranking: ALIGN-ROOT » ALIGN-X

- By transitivity from the ranking in (27), we get the total ranking:

(29) Total ranking: ALIGN-Y » ALIGN-ROOT » ALIGN-X

- This is indeed a general recipe in this language for the treatment of Root and the first two functional heads above it:
  - ALIGN-ROOT always dominates the Alignment constraint on the first functional head.
  - ALIGN-ROOT is always dominated by the Alignment constraint on the second head.
- Therefore, the ranking of an Alignment constraint relative to ALIGN-ROOT tells us where a head is merged in the syntactic structure (at least for VDMs).

(30) Types of rankings

a. Type 1: ALIGN-ROOT » ALIGN-HEAD
   The head merges with RootP

b. Type 2: ALIGN-HEAD » ALIGN-ROOT
   The head merges somewhere higher than RootP
   (usually with the phrase whose head merges with RootP)

5.3 Syntactic structures

- Using the distinction between a Type 1 and a Type 2 ranking, applied to the rankings determined by edge-precedence in (24), we can construct the syntactic structure that underlies each Form.

5.3.1 Forms with Type 1 rankings only

- There are three Forms where only one functional head co-occurs with the Root, and the ranking is of *Type 1*: Form II (Transitive), Form III (Applicative), Form VIII (Reflexive).

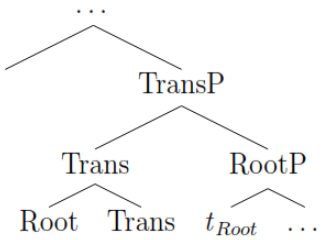
(31) Type 1 rankings only

	Form	Shape	Edge-precedence	Segments
a.	II	kattab	*root* > *transitive*	*k* > GEMINATION
	RANKING: ALIGN-ROOT » ALIGN-TRANS			
b.	III	kaatab	*root* > *applicative*	*k* > LENGTHENING
	RANKING: ALIGN-ROOT » ALIGN-APPL			
c.	VIII	ktatab	*root* > *reflexive*	k > t
	RANKING: ALIGN-ROOT » ALIGN-REFL			

- Since a Type 1 rankings reflects a head that has merged directly with the Root, this gives us the syntactic structures in (32):

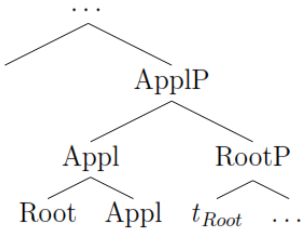
(32) Syntactic structures of Forms II, III, & VIII

a. **Form II:** *transitive*



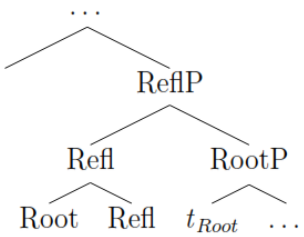
kattab: *ktb* > *GEM*

b. **Form III:** *applicative*



kaatab: *ktb* > *LENGTH*

c. **Form VIII:** *reflexive*



ktatab: *ktb* > *t*

5.3.2 Type 1 + Type 2

- There are two Forms where we find two functional heads co-occurring with Root, with one in a Type 1 ranking, and the other in a Type 2 ranking: Form V (Reflexive of Transitive) and Form VI (Reflexive of Applicative).

(33) Type 1 and Type 2 rankings

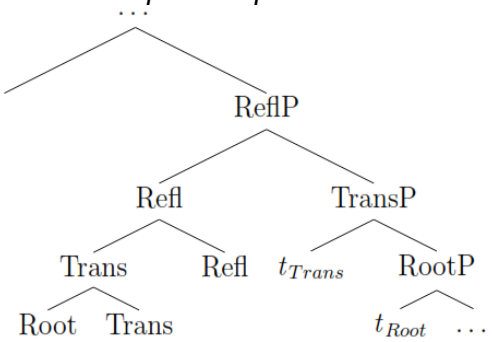
	Form	Shape	Edge-precedence	Segments
a.	V	takattab	*reflexive* > *root* > *transitive*	t > k > GEM
	RANKING: ALIGN-REFL » ALIGN-ROOT » ALIGN-TRANS			
b.	VI	takaatab	*reflexive* > *root* > *applicative*	t > k > LENGTH
	RANKING: ALIGN-REFL » ALIGN-ROOT » ALIGN-APPL			

- These Forms are transparently the reflexivized versions of Form II (Transitive) & Form III (Applicative), respectively.

- In translating the rankings into syntactic structures, we see that this is exactly what the syntactic structure should represent:

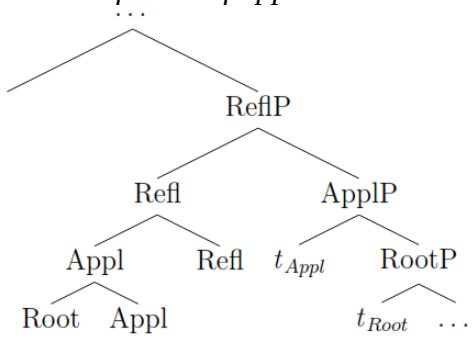
(34) Syntactic structures of Forms V & VI

a. **Form V:** *reflexive of transitive*



takattab: [*ktb* > *GEM*] < *t*

b. **Form VI:** *reflexive of applicative*



takaatab: [*ktb* > *LENGTH*] < *t*

❖ Comparing Forms V & VI (Reflexive of Transitive/Applicative) (and also Form X – see below) to Form VIII (simple Reflexive), we can now see more clearly that the inconsistent ordering properties of the Reflexive *t* correlate with a difference in syntactic structure.
  - When Reflexive merges with the Root (Form VIII), it enters into a Type 1 ranking, and surfaces as an "infix".
  - When Reflexive merges higher (with TransP in Form V, with ApplP in Form VI, with *v*P in Form X), it enters into a Type 2 ranking, and surfaces as a prefix.

- Ideally we could adduce additional syntactic/semantic evidence for these distinctions, but this already provides the outline of an explanation for the inconsistent behavior which had to be stipulated in all prior accounts.

5.3.3 Type 2 ranking only: positing a null head

- There are two Forms where only one functional head co-occurs with the Root, and the ranking is of *Type 2*: Form IV (Causative) and Form VII (Middle).

(35) Type 2 ranking only

	Form	Shape	Edge-precedence	Segments
a.	IV	ʔaktab	*causative* > *root*	ʔ > k
	RANKING: ALIGN-CAUS » ALIGN-ROOT			
b.	VII	nkatab	*middle* > *root*	n > k
	RANKING: ALIGN-MID » ALIGN-ROOT			

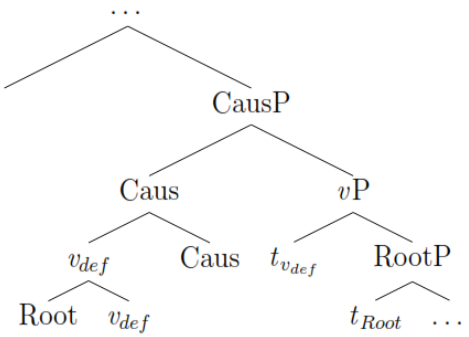
❖ **Problem:** Every Form should have a Type 1 ranking, since some head must be the first to merge with the Root.

➢ **Solution:** If we posit a null head which is merged between Root and the head in the Type 2 ranking, then we generate the Type 2 ranking.

- Therefore, I suggest that Form IV and Form VII (and also Form X) contain the default verbal categorizing head $v_{default}$ immediately above the Root.
    - This seems to be a reasonable addition to the system, since all of the VDMs under discussion could indeed be identified as some flavor of little *v*: v_{caus} , v_{refl} , etc.
    - Furthermore, this element must be present in Form I, in order to verbalize the Root.
- If $v_{default}$ 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.
    - Its Alignment constraint could be included in the ranking (as a Type 1 ranking), and always vacuously satisfied.

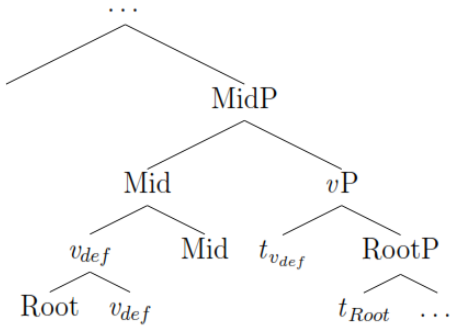
(36) Syntactic structures of Forms IV & VII

a. **Form IV:** *causative*



ʔaktab: [*ktb* (>) *Ø*] < *ʔ*

b. **Form VII**: *middle*



nkatab: [*ktb* (>) *Ø*] < *n*

5.3.4 Two Type 2 rankings

- The one remaining Form is Form X (Causative of Reflexive). It has two overt heads (Reflexive and Causative), and both stand in a Type 2 ranking with the Root.

(37) Two Type 2 rankings

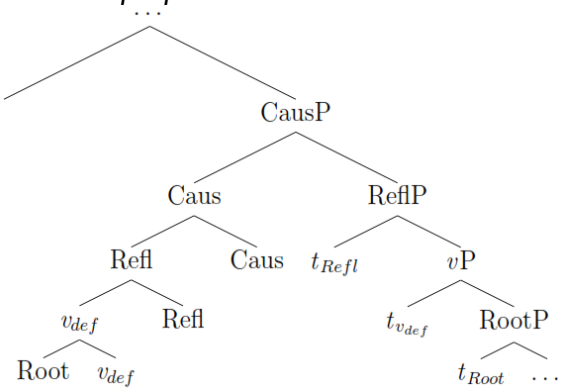
	Form	**Shape**	**Edge-precedence**	**Segments**
a.	X	staktab	*causative* > *reflexive* > *root*	s > t > k
	RANKING: ALIGN-CAUS » ALIGN-REFL » ALIGN-ROOT			

- This means that Form X must also include $v_{default}$ to fill in the missing Type 1 ranking.
- This should be expected, since Form X is essentially the reflexivized version of Form IV (the simple Causative), which itself has a $v_{default}$.
    - [We might have expected *reflexive* > *causative* here…]

- The combined rankings point to the following syntactic structure:

(38) Syntactic structure of Form X

Form X: *causative of reflexive*



staktab: [[*ktb* (>) *Ø*] < *t*] < *s*

5.3.5 Local summary

- Reviewing the structures, we now have a system where one or two verbal derivational morphemes (or three, in the case of Form X) can be merged with the Root.
  - One very clearly can recur across forms: the Reflexive (V,VI,VIII,X).
  - If we do indeed identify the /ʔ/ of Form IV and the /s/ of Form X as allomorphs of Causative, then Causative can also recur across Forms.
- In the next subsection, I will suggest a few ways in which we might reduce the complexity even further, such that this system looks even more like Bantu.

5.4 Reducing the morphosyntactic complexity

- I have thus far been fairly conservative in doing morphological segmentation.
  - This gives the impression that there are a wide variety of morphosyntactic elements involved in the Arabic *v*-domain.
- I will make two suggestions, one which is very reasonable, the other much more speculative, that will reduce the complexity considerably.

5.4.1 Transitive is actually Causative

- Both the Transitive and the Causative have the basic function of increasing valency.
  - In the Causative Forms (IV & X), this almost always carries the semantics of causation.
  - In the Transitive Forms (II & V), there appears to be a wider range of interpretations.[19]

- We can now observe a correlated structural difference between the two types:
  - Transitive *always* surfaces as sister to Root (Form II (32)a & Form V (34)a).
  - Causative *never* surfaces as sister to Root (Form IV (36)a & Form X (38)).
  - Also, the two never co-occur.

[19] Consult again the following sources for discussions regarding the meaning of the various Forms: Wright (1896:29-46), Schramm (1962:361-2), Fischer (2002:99-100), Ratcliffe (2005), Ryding (2005).

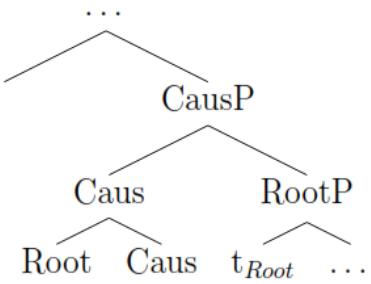
- If we encountered a head which could either merge directly with the Root or merge higher, we would likely expect the Root-local configuration to display a wider range of interpretation, i.e. more lexicalized/idiomatic meanings, than the non-local configuration.
    - This would be consistent with the Transitive ~ Causative situation.

- Taken together, these observations suggest that Transitive and Causative may represent the *same morphosyntactic terminal*, which I will call Causative.
- Under this proposal, this unitary Causative head would yield (slightly) different interpretations, and also different allomorphs (see below), depending on whether it is merged high or low.

- The structures that result if we conflate Transitive and Causative are shown in (39).

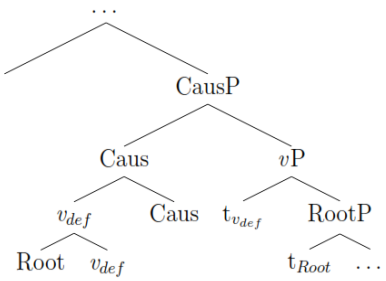
(39) Conflating Transitive and Causative

a. **Form II**: ~~transitive~~ → low causative



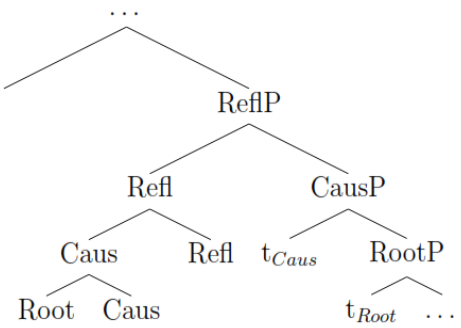
kattab: *ktb* > *GEM*

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



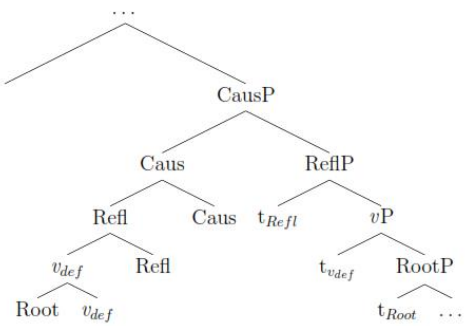
ʔaktab: [*ktb* (>) *Ø*] < *ʔ*

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



takattab: [*ktb* > *GEM*] < *t*

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



staktab: [[*ktb* (>) *Ø*] < *t*] < *s*

- The allomorphy exhibited between the different versions of Causative can be locally conditioned:

(40) Vocabulary entries

a. CAUSATIVE ↔ *consonantal mora* / sister to ROOT

b. CAUSATIVE ↔ ʔ ~ s [20]

[20] There is comparative evidence indicating that the [ʔ] that expones *Causative* in Form IV derives historically from /s/ (Yushmanov 1961:49). Synchronically, the alternation between [s] and [ʔ] could be, in some sense, (morpho)phonologically conditioned: [s] surfaces before consonants and [ʔ] surfaces before vowels.

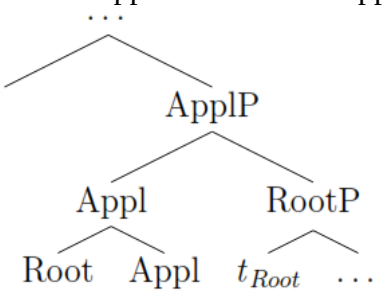
5.4.2 Middle is actually Applicative (???)

- There are two remaining morphemes which are unpaired:
  - Applicative (Form III/VI) and Middle (Form VII).
- The meanings and functions of the two morphemes don't go as well together as Transitive and Causative do, but the details of both are fairly difficult to pin down.
- They are in exactly the same structurally complementary distribution as Transitive and Causative are, and never co-occur.

- I will thus (very tentatively) suggest that we conflate these two morphemes in the same way as Transitive and Causative, and I'll call this unitary head *Applicative*.
- The revised structures involving this head are shown in (41).

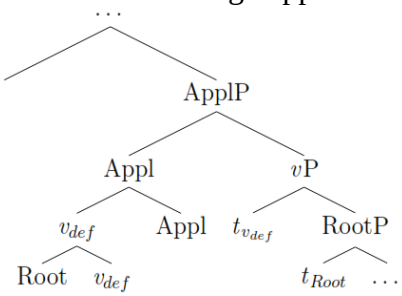
(41) Conflating Applicative and Middle

a. **Form III**: ~~applicative~~ → low applicative



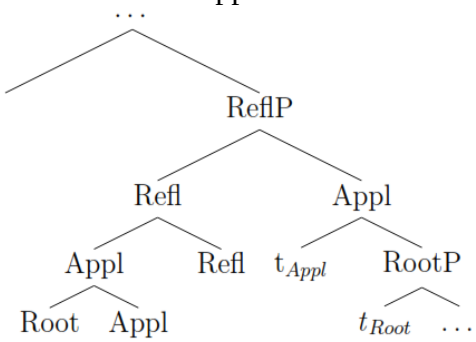
kaatab: *ktb* > *LENGTH*

b. **Form VII**: ~~middle~~ → high applicative



nkatab: [*ktb* (>) *Ø*] < *n*

c. **Form VI**: reflexive of ~~applicative~~ → reflexive of low applicative



takaatab: [*ktb* > *LENGTH*] < *t*

- The allomorphy can again be locally conditioned (in exactly the same way):

(42) Vocabulary entries

a. APPLICATIVE ↔ *vocalic mora* / sister to ROOT
b. APPLICATIVE ↔ n

5.5 The Arabic *v*-domain

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

(43) Combinations of terminals

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

(44) Semantic structure of Forms

Form	**Perf. Pass.**	**Semantic structure**	**Relations between Forms**
I	*kataba*	[v_{def} [Root]]	--
II	*kattaba*	[Caus [Root]]	Root-merged
III	*kaataba*	[Appl [Root]]	Root-merged
IV	*ʔaktaba*	[Caus [v_{def} [Root]]]	High merge of Form II
V	*takattaba*	[Refl [Caus [Root]]]	Refl of Form II
VI	*takaataba*	[Refl [Appl [Root]]]	Refl of Form III
VII	*ʔinkataba*	[Appl [v_{def} [Root]]]	High merge of Form III
VIII	*ʔiktataba*	[Refl [Root]]	Root-merged
X	*ʔistaktaba*	[Caus [Refl [v_{def} [Root]]]]	Refl merged between elements of Form IV

- While some possible combinations appear to still be lacking, most combinations are attested.
  - Perhaps the gaps are based on syntactic restrictions; e.g., maybe having both Causative and Applicative would create too many argument positions (case filter?).
  - Or maybe there are a few CARP-like templatic effects hiding in here…

- We seem to have evidence for mirror-image-like ordering of Causative and Reflexive:
  - Form V: Reflexive scopes over Causative → Reflexive is outside of Causative
  - Form X: Causative scopes over Reflexive → Causative is outside of Reflexive
  - ❖ A fuller examination of the lexical semantics of the two Forms is required in order to see if this actually correlates to consistent semantic differences.

➢ This picture of the Arabic *v*-domain comes to look a lot like what is shown by Bantu languages that allow mirror-image orders:
  - Heads can be merged in different orders by the syntax/semantics.
  - This is reflected in the surface order of those morphemes.

6 Conclusion

- This paper has shown that the Mirror Alignment Principle approach to morpheme ordering (Zukoff 2016), whereby asymmetric c-command relations in the (morpho)syntax map directly onto rankings of Alignment constraints in the phonology, leads to a comprehensive phonological and morphosyntactic analysis of the verbal domain in Arabic.
    - Nonconcatenative morphological/phonological behavior can be attributed to the interaction of Alignment constraints with one another and with other phonological constraints.
    - The ranking of Alignment constraints determined through phonological analysis directly translates to syntactic structures.
- The resulting syntactic structures comprise a verbal system that is generally unremarkable from a typological perspective.
    - Verbal derivational morphemes like Causative, Reflexive, and Applicative combine with one another in various ways to generate various meanings.
    - These semantic differences correlate with differences in the surface order of their morphemes, as predicted by the Mirror Principle (Baker 1985).
    - The Arabic verbal system thus looks very similar to more familiar verbal systems, like that of Bantu, which display overt Mirror Principle effects.
- Therefore, using the Mirror Alignment Principle approach to morpheme ordering allows us to view nonconcatenative morphological processes as no different than concatenative ones for the purposes of the mapping between surface form and syntactic representation.

➢ While further investigation into the lexical semantics is required in order to validate some of the assertions in Section 5, and the phonological details of additional root types (biliteral roots, quadriliteral roots, roots with glides) remain to be worked out fully, this paper provides the most complete integrated phonological and syntactic account of the Arabic verbal system.

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7 Appendix: Phonological analysis of complex Forms

This appendix confirms each of the Alignment rankings, deduced from edge-precedence in Section 5.1, through detailed phonological analysis. There are several phonological issues that arise, including the treatment of mora affixation and morpheme-specific phonotactic requirements; but, overall, the total analysis follows with relatively few additional considerations. This Appendix abides by the conservative morpheme segmentations proposed in Section 3, and thus does not adhere to the morphosyntactic conflations proposed in Section 5.4. The final two subsections of this Appendix discuss, respectively, how the particular underlying representations of various morphemes in Arabic make nonconcatenative behavior inevitable (Section 7.6), and how to resolve the unexpectedly low ranking of ALIGN-AV (Section 7.7).

7.1 Phonological Analysis of Form II (Transitive) & Form III (Applicative)

- The phonological forms of Form II (Transitive) and & Form III (Applicative) are shown in the table in (45):

(45) Forms II & III

	Perfective		Imperfective	
	Active	Passive	Active	Passive
Form I	kataba	kutiba	yaktubu	yuktabu
Form II (Transitive)	ka**tt**aba	ku**tt**iba	yuka**tt**ibu	yuka**tt**abu
Form III (Applicative)	k**aa**taba	k**uu**tiba	yuk**aa**tibu	yuk**aa**tabu

- Forms II & III share similar phonological properties – they both double a stem segment:
  - Form II lengthens a (Root) consonant – gemination:
    - Form I *kataba* ↔ Form II *ka**tt**aba*
  - Form III lengthens a (AV) vowel – vowel lengthening:
    - Form I *kataba* ↔ Form II *k**aa**taba*
- Both types of doubling are internal to the first root consonant.
  - Vowel lengthening affects the first AV vowel in the perfective, but the second AV vowel in the imperfective (because of position relative to Root).
- Both could be derived by affixing a mora.
  - Ussishkin (2003) employs this approach, but requires ranked IDENT_{μ}-C & IDENT_{μ}-V, plus an Antihomophony constraint to generate distinct realizations as gemination in one case but vowel lengthening in the other.

- These distinctions could alternatively be built into the underlyingly representation: consonantal mora (or timing slot) for Transitive, vocalic mora (or timing slot) for Applicative.
    - Transitive = /μ_C/
    - Applicative = /μ_V/
  - The moras are required to dock to a segment with the right specification for C or V.
    - /μ_C/ cannot surface in the environment {#,V}_{#,V}
    - /μ_V/ cannot surface in the environment {#,C}_{#,C}

- The rankings deduced from edge-precedence in (24) (repeated in (46) with ranking arguments), coupled with a few assumptions about the calculation of Alignment constraints, properly generates the Forms.

(46) Rankings

a. Form II: ALIGN-ROOT-E-MWD » ALIGN-TRANS-L-MWD *kuutiba > *ʔuuktiba*

b. Form III: ALIGN-ROOT-E-MWD » ALIGN-APPL-L-MWD *kuttiba > *ʔukkutiba*

7.1.1 Form III in the perfective

- For vowel lengthening in the perfective of Form III, it is unnecessary to make a distinction about which moraic position of the long vowel corresponds to the Applicative mora and which to the AV mora.
    - In this tableau, I will mark the long vowel in bold and treat it as a single position for Alignment (though nothing would change if we treated it as two positions).

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

/ktb, ui, μ_v, a/	ALIGN-ROOT-E-MWD	ALIGN-APPL-L-MWD
a. ☞ {[k**uu**tiba]}	* (| a)	* (k)
b. {[kut**ii**ba]}	* (| a)	**!* (k,u!,t!)
c. {ʔ[**uu**ktiba]}	**! (uu! | a)	
d. {ʔ[**uu**kitba]}	**! (uu! | a)	

- If ALIGN-ROOT-E-MWD » ALIGN-APPL-L-MWD, then the long vowel cannot surface to the leftmost Root consonant, as in candidates (c) and (d).
- The Applicative mora will therefore dock on the leftmost vowel interior to the Root, i.e. the first AV vowel, candidate (a), rather than the second AV vowel, candidate (b).

7.1.2 Form III in the imperfective

- The imperfective, which surfaces as *yukaatabu*, requires that the Alignment constraints must be calculated over timing slots rather than segments.
    - The imperfective prefix requires a vowel after it, and this results in the AV vowel getting pulled to the left of the first Root consonant: Form I *yaktubu*.
    - If a short vowel counted the same as a long vowel, we would expect the Applicative mora to be able to dock on that first AV vowel: **yuukatbu* or **yuuktabu*.
- With ALIGN-ROOT » ALIGN-APPL, increasing the Alignment-relevant material before the Root in favor of the Applicative mora is suboptimal.
    - This forces the long vowel once again into post-Root-initial position.
- In this tableau, I mark distinct positions for the Applicative mora and AV vowel it attaches to (subscript v indicates the Applicative's position).[21]

[21] I assume that candidates like {[y*i*$_v$kutabu]}, where the Applicative mora obtains segmental material through epenthesis, or {[yu$_v$kutabu]} (or something similar), where the Applicative mora takes segmental material form the

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

/y, ktb, ua, μ_v, u/	ALIGN-ROOT-E-MWD	ALIGN-APPL-L-MWD	ALIGN-AV-E-MWD[22]
a. {[yu$_v$uktabu]}	****! (y,u$_v$,u | u)	* (y)	**** (y,u$_v$ | b,u)
b. {[yuu$_v$ktabu]}	****! (y,u,u$_v$ | u)	** (y,u)	*** (y | b,u)
c. {[yuka$_v$atbu]}	*** (y,u | u)	*** (y,u,k)	****! (y | t!,b,u)
d. {[yukaa$_v$tbu]}	*** (y,u | u)	****! (y,u,k,a!)	**** (y | t,b,u)
e. ☞ {[yuka$_v$atabu]}	*** (y,u | u)	*** (y,u,k)	*** (y | b,u)
f. {[yukaa$_v$tabu]}	*** (y,u | u)	****! (y,u,k,a!)	*** (y | b,u)
g. {[yukata$_v$abu]}	*** (y,u | u)	****!* (y,u,k,a!,t!)	*** (y | b,u)

7.1.3 Form II in the perfective

- Calculating Alignment over timing slots is also necessary in order to locate gemination in the right place in Form II.
- Form II surfaces as: *ku**tt**iba* (perfective passive); *yuka**tt**abu* (imperfective passive)

- Gemination always affects the second Root consonant, not the first.
  - Since Transitive is a consonantal mora, it is necessarily restricted to coda position.
  - If it were to dock on the first Root consonant, it would precede the Root for the purposes of Alignment calculation, since it is in coda while the Root consonant is in onset.
- Given the ranking ALIGN-ROOT-E-MWD » ALIGN-TRANS-L-MWD, this configuration will never be optimal.
  - The Transitive mora will thus have to retract move inward to the next consonant, which is the Root-medial consonant.

(49) Perfective passive of Form II: 3SG.MASC *kuttiba*

/ktb, ui, μ_c, a/	ALIGN-ROOT-E-MWD	ALIGN-TRANS-L-MWD
a. {*ʔu*[k$_c$kutiba]}	**! (k$_c$! | a)	
b. ☞ {[kut$_c$tiba]}	* (| a)	** (k,u)
c. {[kutib$_c$ba]}	* (| a)	***!* (k,u,t!,i!)

- The same factors lead to imperfective *yuka**tt**abu* > **yu**kk**atabu*.

➢ Once we account for the restrictions on mora association, the edge-precedence-based Alignment ranking is fully confirmed.

AV morpheme but does not result in a two-vocalic-mora sequence, to not be made available by Gen. Both would be beat the desired output if allowed.

[22] No ranking between ALIGN-APPL and ALIGN-AV is actually required here, nor is one determined by the MAP based on the operation posited in (66) below.

7.2 Form V (Reflexive of Transitive) & Form VI (Reflexive of Applicative)

- Form V and Form VI transparently represent the Reflexive version of Forms II & III, respectively.
    - Their phonological forms are essentially the basic Form prefixed with *tV-*:

(50) Reflexives: Form II ~ Form V; Form III ~ Form VI

	Perfective		Imperfective	
	Active	Passive	Active	Passive
Form II	kattaba	kuttiba	yukattibu	yukattabu
Form V	**t**akattaba	**t**ukuttiba	ya**t**akattabu	yu**t**akattabu
Form II	kattaba	kuttiba	yukattibu	yukattabu
Form VI	**t**akaataba	**t**ukuutiba	ya**t**akaatabu	yu**t**akaatabu

- If we again take the rankings from (24), we very nearly derive the surface forms.

(51) Rankings

a. Form V: ALIGN-REFL-L-MWD » ALIGN-ROOT-E-MWD » ALIGN-TRANS-L-MWD
tukuttiba > **ʔuktuttiba*

b. Form VI: ALIGN-REFL-L-MWD » ALIGN-ROOT-E-MWD » ALIGN-APPL-L-MWD
tukuutiba > **ʔuktuutiba*

- In conjunction with the assumptions developed in Section 7.1, this ranking would predict clustering of the Reflexive /t/ with the Root-initial consonant:
    - e.g., perfective active of Form V: **ʔitkattaba* (cf. Form VII)

- One approach would be to say that Reflexive is actually aligned to the prosodic word.
    - This would allow the same interaction with C//V that forces a vowel to follow the imperfective prefix (cf. Section 4.2.2).
- But this cannot be correct, as it makes the wrong predictions for Form VIII (it would predict **kuTtiba* instead of *ʔuktiba* – see below).

- 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 Forms V & VI were to show clustering (**ʔitkattaba*), then the Reflexive /t/ would surface in coda position, and thus be subject to place assimilation.
    - The lack of clustering could be a way to avoid changing the place of the Reflexive morpheme.[23]

[23] This also makes sense from a realizational and/or processing perspective, as place assimilation would make the result of affixing the Reflexive basically homophonous with the Transitive morpheme, both of which would surface as geminates (since there is also voicing assimilation in obstruent clusters).

(52) *t_{REFL}C: Assign a violation * if Reflexive /t/ surfaces as before a consonant.[24]

- This generalization is surface true (i.e. the constraint is undominated):
  - All Forms with the Reflexive (V,VI,VIII,X) position the *t* before a vowel.
- As long as *t_{REFL}C outranks ALIGN-ROOT, we now derive the correct output for Forms V & VI: (I represent the Reflexive marker as *T* to avoid confusion with the Root-medial consonant *t*.)

(53) Perfective passive of Form V (reflexive of transitive): 3SG.MASC *tukuttiba*

/T, ktb, μ_c, ui, a/	*t_{REFL}C	ALIGN-REFL-L-MWD	ALIGN-ROOT-E-MWD	ALIGN-TRANS-L-MWD
a. {*ʔu*[Tkut$_c$tiba]}	*!		** (T | a)	*** (T,k,u)
b. {*ʔu*[kTut$_c$tiba]}		*! (k)	* (| a)	*** (k,T,u)
c. ☞ {[Tukut$_c$tiba]}			*** (T,u | a)	**** (T,u,k,u)
d. {[Tuk$_c$kutiba]}			****! (T,u,k$_c$! | a)	** (T,u)

(54) Perfective passive of Form VI (reflexive of applicative): 3SG.MASC *tukuutiba*

/T, ktb, μ_v, ui, a/	*t_{REFL}C	ALIGN-REFL-L-MWD	ALIGN-ROOT-E-MWD	ALIGN-APPL-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)

- In both cases, *t_{REFL}C blocks the clustering candidate, which would be optimal based on the Alignment constraints.
- Among the candidates where Reflexive /t/ is pre-vocalic, the (c) candidates – where the /t/ is initial followed by the first AV vowel and the other VDM is in its normal position – does the best on the top two Alignment constraints (ALIGN-REFL & ALIGN-ROOT), and is selected.

➢ Once we include the morpheme-specific markedness constraint *t_{REFL}C, the edge-precedence-based Alignment ranking is fully confirmed.

7.3 Form VIII: the simple reflexive

- The Reflexive /t/ also appears in Form VIII, where it is the only verbal derivational morpheme.
- In this category, unlike Forms V & VI, the Reflexive *t* always appears *immediately after* the Root-initial consonant: perfect passive *ʔukTutiba*.[25]
- The ranking from (24), repeated here, properly generates the form, as long as we permit morphological-word-external epenthesis to support the initial cluster:

[24] A precisely parallel constraint, with parallel motivation, will be employed to account for the non-clustering behavior of the Causative in Form IV.

[25] The *t* exponing Reflexive is the post-root-initial *t*, not the medial *t*: e.g. *ksb* → *ʔikt**t**asaba* 'earn' (Ryding 2005:568).

(55) Ranking (Form VIII): ALIGN-ROOT-E-MWD » ALIGN-REFL-L-MWD » ALIGN-AV-E-MWD[26]
*ʔuktutiba > *tuktiba*

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

/T, ktb, ui, a/	*t_{REFL}C[27]	ALIGN-ROOT-E-MWD	ALIGN-REFL-L-MWD	ALIGN-AV-E-MWD
a. {[Tuktiba]}		**!* (T!,u! | a)		*** (T | b,a)
b. {*ʔu*[Tkutiba]}	*!	** (T | a)		**** (T,k | b,a)
c. ☞ {*ʔu*[kTutiba]}		* (| a)	* (k)	**** (k,T | b,a)
d. {[kuTtiba]}	*!	* (| a)	** (k,u)	*** (k | b,a)
e. {[kutTiba]}		* (| a)	**!* (k,u!,t!)	*** (k | b,a)

This is the first Form we've seen where initial-clustering + initial-epenthesis is optimal. These sorts of forms motivate identifying epenthesis as external to the morphological word.

- If we treated it as internal to the morphological word, the desired string in candidate (c) would have the phonological representation {[*ʔu*ktutiba]}.
- This would add two violations to ALIGN-REFL-L-MWD. These violations would cause a tie with (e), which will be resolved in favor of (e) by ALIGN-AV.

Therefore, identifying *ʔu-*/*ʔi-*epenthesis as internal to the domain of Alignment is incompatible with the analysis. This is even more directly observable in Form VII (immediately below).

➢ Once we allow for initial-clustering in these types of Forms, the edge-precedence-based Alignment ranking is fully confirmed.

7.4 Form VII ("Middle")

- The *n* morpheme that marks Form VII ("Middle") is straightforwardly prefixal:
  - Perfective passive: *ʔu**n**kutiba* (*ʔu* is epenthetic); imperfective passive: *yu**n**katabu*
  - This *n* surfaces before the first Root consonant in all categories.

- The ranking obtained from edge-precedence in (24) is again completely sufficient.

(57) Ranking (Form VII): ALIGN-MID-L-MWD » ALIGN-ROOT-E-MWD *ʔu**n**kutiba > *ʔuk**n**utiba*

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

[26] The ranking ALIGN-REFL » ALIGN-AV is crucial here. The ranking is consistent with, but not predicted by, the MAP, so something else must be at play in determining this ranking. Saying that ALIGN-AV is always the lowest ranked Alignment constraint (in the absence of a MAP-prescribed ranking) would be consistent with the data.
[27] The candidates eliminated by this constraint would also have been eliminated by the Alignment constraints.

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

/n, ktb, ui, a/	C//V	ALIGN-MID-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. {[nkutiba]}	*!		** (n | a)	**** (n,k | b,a)
d. ☞ {*ʔu*[nkutiba]}			** (n | a)	**** (n,k | b,a)
e. {*ʔu*[knutiba]}		*! (k!)	* (| a)	**** (k,n | b,a)

7.5 Form IV (Causative) & Form X (Reflexive of Causative)

7.5.1 Form IV

- In the perfective, Form IV surfaces as *ʔuktiba*, where this time the [ʔ] is phonemic, and indeed the marker of the category.
  - The imperfective is opaque: //*yuʔaktabu*// → [yuktabu] with deletion of the /ʔ/.[28]

- Form IV again needs a (morpho)phonotactic constraint that requires its exponent to be pre-vocalic, just like the Reflexive /t/.
  - /ʔ/ has an even more restricted distribution than /t/, so such a constraint is again well-motivated.

(59) *ʔ$_{CAUS}$C: Assign a violation * if Causative /ʔ/ surfaces as before a consonant.[29]

- As long as this constraint is highly-ranked, the Alignment ranking deduced from edge-precedence does generate the perfective.
  - Further investigation will be needed in order to resolve the opacity effect in the imperfective.

(60) Ranking (Form IV): ALIGN-CAUS-L-MWD » ALIGN-ROOT-E-MWD *ʔuktiba* > **ʔukʔutiba*

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

/ʔ, ktb, ui, a/	*ʔ$_{CAUS}$C	ALIGN-CAUS-L-MWD	ALIGN-ROOT-E-MWD
a. ☞ {[ʔuktiba]}			*** (ʔ,u | a)
b. {[kuʔtiba]}	*!	** (k,u)	* (| a)
c. {*ʔ*[ukʔitba]}		*!* (u!,k!)	** (u | a)

[28] In the active, *yuktibu*, there is perhaps also deletion of an AV vowel (/a/), though it is difficult to identify the underlying representation of the *active imperfective* morpheme in general.

[29] If the phonotactic restriction was not just *ʔ$_{CAUS}$C, but also *Vʔ$_{CAUS}$, and both constraints ranked below ALIGN-AGR$_{IPFP}$-L-PWD, but above REALIZE MORPHEME(CAUS) and/or MAX(ʔ), then we would predict deletion/non-occurrence of the /ʔ/.

7.5.2 Form X (Reflexive of Causative)

- Form X surfaces as:
  - Perfective passive: *ʔu**st**uktiba*; Imperfective passive: *yustaktabu*
  - Causative /s/, Reflexive /t/

- The ranking obtained from edge-precedence in (24) is again completely sufficient:

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

(63) 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. {[kustitba]}	*!* (k!,u!)	*** (k,u,s)	* (| a)

(64) 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
a. ☞ {[yustaktabu]}		** (y,u)	*** (y,u,s)
b. {[yuskattabu]}		** (y,u)	****!* (y,u,s,k!,a!)
c. {[yutsaktabu]}		***! (y,u,t!)	** (y,u)
d. {[yuksattabu]}		***! (y,u,k!)	***** (y,u,k,s,a)
e. {[suytaktabu]}	*!* (s!,u!)		*** (s,u,y)

7.6 CONTIGUITY (or lack thereof) in Arabic

- In Section 2.2, I suggested that Arabic was a language where the faithfulness constraint CONTIGUITY could not help but be violated in the course of word formation.

(65) CONTIGUITY-I(→)O (repeated from (6) 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.

- This fact stems from the unusual distribution of segments in underlying representations:
  - Roots are comprised of a string of consonants (such as *ktb*),
  - 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 these circumstances in this language), there are two ways that the string could be made phonotactically licit.

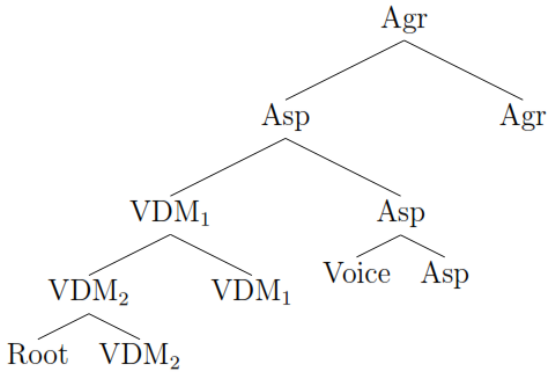
- One is epenthesis. At the expense of DEP violations, epenthesis would allow for a concatenative structure: /ktb, ui/ → [k*i*tb-u*ʔ*i], [*ʔ*ikt*i*b-u*ʔ*i], etc.
  - However, this sort of epenthesis itself creates a CONTIGUITY violation, as it separates segments which were adjacent in underlying representation:
  - [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 URs of these morphemes, having the AV morpheme intrude on the Root – /ktb, ui/ → [k-u-t-i-b] – provides
    - vowels to avoid C//V violations for the Root, and
    - consonants to avoid ONSET violations for the AV morpheme.
  - This results in three CONTIGUITY violations (*k*↔*t*, *t*↔*b*, and *u*↔*i*), but avoids 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 can avoid DEP violations altogether, the intrusion strategy would be preferred, and we are left with the nonconcatenative system we observe for Arabic.

7.7 ALIGN-AV, the MAP, and a morphological operation

The ranking ALIGN-ROOT » ALIGN-AV, which is required throughout the phonological analysis, does not seem to follow from the MAP, since the Aspect and Voice heads would be expected to merge higher in the syntactic structure than Root. However, we already have at hand a reason why ALIGN-ROOT might be ranked higher than expected: the default preference for Root-alignment which surfaces in the absence of asymmetric c-command. Since this ranking holds throughout the grammar, not just in forms without intervening VDMs, we cannot appeal to *symmetric* c-command to reach this point. Instead, we should notice something about Aspect and Voice: they always appear together as a portmanteau morpheme. This is a morphological generalization, so it should be encoded with a morphological operation. If we assume that whatever morphological operation joins Aspect and Voice creates a counter-cyclic structure within the complex head, then that will remove all c-command relations (asymmetric or otherwise) between these heads and the Root:

(66) Aspect + Voice in the complex head



A structure of this sort would leave Voice and Aspect out of the MAP calculation entirely. The default preference for Root-alignment would apply, fixing the ranking ALIGN-ROOT » ALIGN-AV. ALIGN-AV would then be subordinated to all other functional heads' Alignment constraints by transitivity.