Class 9
The Mirror Alignment Principle (Zukoff to appear): Dealing with problems for cyclic concatenation

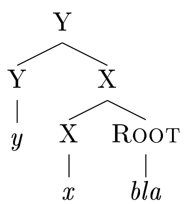
10/22/21

1 Recap: Cyclic concatenation and the Mirror Principle

- **Last time:** Baker (1985) assumed that the Mirror Principle follows from **cyclic concatenation**:
  - Terminal nodes are spelled-out one at time, from the bottom up.
  - This accords with the basic DM approach to spell-out and the interrelationship between syntax and morphology, partly inspired by the Mirror Principle.

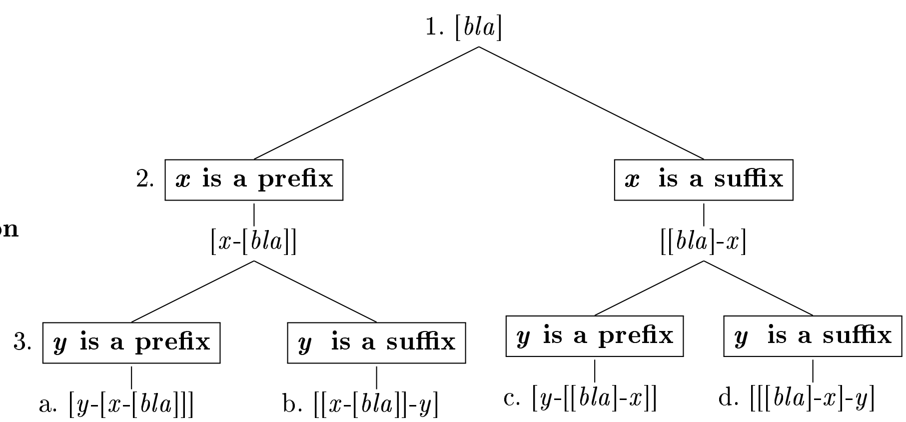
- Cyclic concatenation results in the decision tree in (3), which derives all and only the Mirror Principle-compliant orders; i.e., it correctly rules out *[*x*-*y*-*bla*] and *[*bla*-*y*-*x*].

(1) **Schematic tree**



(2) **Vocabulary insertion**
1. Root ⇔ *bla*
2. X ⇔ *x*
3. Y ⇔ *y*

(3) **Cyclic spellout**



- If the spellout process, or the VI rules themselves, come equipped with a means of determining whether a given affix is a prefix or a suffix, then the decision tree in (3) reduces to a single output.

⋆ **The problem:** perfectly cyclic concatenative spell-out makes the wrong predictions for allomorphy, and a number of other domains.

→ I have a proposal to do things differently, in a way that fixes a lot of these problems.

2 The Mirror Alignment Principle (MAP)

2.1 Generalized Alignment

- McCarthy & Prince (1993) propose a type of OT constraint called an **alignment constraint**.
  - Alignment constraints require that specified edges of phonological and/or morphological constituents coincide in the phonological output.

(4) **Generalized Alignment** [GA] (McCarthy & Prince 1993:80)
Align (Cat[egory]1, Edge1, Cat[egory]2, Edge2) $=_{\text{def}}$
$\forall$ Cat1 $\exists$ Cat2 such that Edge1 of Cat1 and Edge2 of Cat2 coincide.
Where
Cat1, Cat2 $\in$ P[rosodic]Cat $\cup$ G[rammatical]Cat
Edge1, Edge2 $\in$ 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.

- Alignment constraints have been used for all sorts of purposes, with all sorts of combinations of constituents and edges.
- But let's think about what happens if the only kind of alignment is one that relates a specific morpheme to a specific edge of the word.

2.2 Competing alignment constraints

- Given a word that consists of a Root plus three affixes X, Y, and Z, let's make the following assumptions:

(5) **Assumptions**
a. The phonological UR is a *linearly unordered* set of exponents: /Root, X, Y, Z/
b. Each affix is referenced by a single, right-word-edge-oriented alignment constraint:

(6) **Alignment constraints**
a. ALIGN(X, R; PWD, R) [ALIGN-X-R]
Assign one violation 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) [ALIGN-Y-R]
Assign one violation for each segment intervening between the right edge of morpheme Y and the right edge of the prosodic word.
c. ALIGN(Z, R; PWD, R) [ALIGN-Z-R]
Assign one violation for each segment intervening between the right edge of morpheme Z and the right edge of the prosodic word.

- Each alignment constraint is maximally satisfied when its morpheme rightmost within the word.
  - In any candidate output, only one morpheme can be rightmost (full alignment satisfaction).
  - Satisfaction of one of alignment constraint entails increased violation of the others.
  - → These constraints are in *direct competition* for final position.

(7) **Violation profiles**

/Root, X, Y, Z/		ALIGN-X-R	ALIGN-Y-R	ALIGN-Z-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		*	**

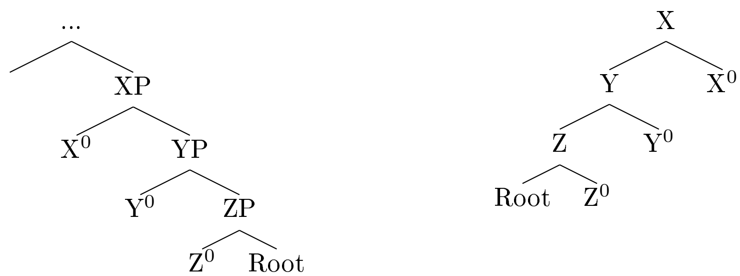
- Each candidate has three alignment violations, distributed across the different constraints:
  - 0 violations for the rightmost morpheme.
  - 1 violation for the morpheme that is second from the right.
  - 2 violations for the morpheme that is third from the right.

→ The six possible rankings each correspond to the selection of one of the six candidate orders.

2.3 Alignment and the Mirror Principle

- Now let's assume that the word we're building is associated with the syntactic structure in (8):

(8) **Syntax of /Root, X, Y, Z/**
a. Base-generated structure → b. Complex head



- If the affixes are all suffixes, we'd expect the Mirror Principle-compliant order to be [Root-Z-Y-X].
  - This is candidate order (7f). We can generate this order with the alignment ranking in (9):

(9) **Generating the Mirror Principle order for (8)**
i. *Ranking*: Align-X-R ≫ Align-Y-R ≫ Align-Z-R
ii. *Tableau*:

/Root, X, Y, Z/	Align-X-R	Align-Y-R	Align-Z-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		*	**

⋆ Notice that there's a relationship between the hierarchical structure in (8) and the ranking in (9):
  - 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.

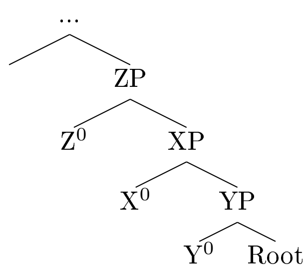
⇒ A formal connection between hierarchical structure (in the form of asymmetric c-command) and alignment ranking can therefore *derive* the Mirror Principle. I call this the **Mirror Alignment Principle**:

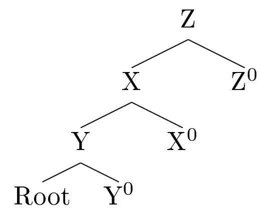
(10) **The Mirror Alignment Principle (The MAP)**
a. If a terminal node α asymmetrically c-commands a terminal node β, then the alignment constraint referencing α dominates the alignment constraint referencing β.
b. *Shorthand*: If α c-commands β → Align-α ≫ Align-β

- The MAP lets us dynamically derive the Mirror Principle for different structures.
  - If the syntax gives us a different structure for the same combination of morphemes (11), then the MAP will provide a different alignment ranking, which will select a different morpheme order (12).

(11) **A different syntactic structure (Z is highest)**

a. Base-generated structure → b. Complex head





(12) **Generating the Mirror Principle order for (11)**

i. *Ranking*: ALIGN-Z-R ≫ ALIGN-X-R ≫ ALIGN-Y-R

ii. *Tableau*:

/Root, X, Y, Z/	ALIGN-Z-R	ALIGN-X-R	ALIGN-Y-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	*!*		*

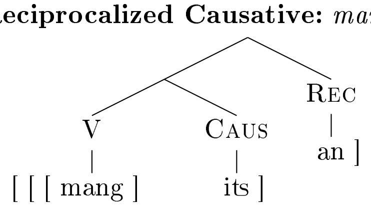
- This approach is thus sensitive to alternations in syntactic structure within a language, of the sort that motivated the Mirror Principle in the first place.
  - It does entail that a language will have different constraint rankings for different syntactic derivations.
  - This is a little unusual in standard OT, but has clear parallels in models like Cophonology Theory (Inkelas & Zoll 2007, Sande, Jenks, & Inkelas 2020).

3 The MAP and templatic morphology in Bantu

- Recall the interaction between Causative and Reciprocal in Chichewa (13).
  - When Reciprocal /an/ is further to the right than Causative /its/ (13a), the Reciprocal is interpeted as taking scope over the Causative.
  - When Causative /its/ is further to the right than Reciprocal /an/ (13b), the Causative is interpeted as taking scope over the Reciprocal.

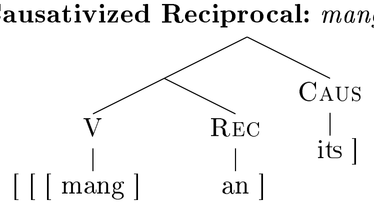
(13) Orders of Causative and Reciprocal in Chichewa (Hyman & Mchombo 1992:350, Hyman 2003:247)

a. **Reciprocalized Causative:** *mang-its-an-* 'cause each other to tie'



[REC: [Z_i cause [*each other*$_i$ tie Y]]]
[Z cause [X tie Y]]
[X tie Y]

b. **Causativized Reciprocal:** *mang-an-its-* 'cause to tie each other'



[Z cause [REC: [X_i tie *each other*$_i$]]]
[REC: [X_i tie *each other*$_i$]]
[X tie Y]

3.1 Deriving Chichewa's Mirror Principle behavior

- As we talked about last time, it would be easy to derive these facts with cyclic concatenation.

⋆ **It is also easy to derive this with the MAP. *Work this out for yourselves!***

- The constraints we need are the following:

(14) **Alignment constraints for Chichewa verbal extensions**

a. ALIGN(RECIPROCAL, R; PWD, R) [ALIGN-REC-R]
Assign one violation for each segment intervening between the right edge of the exponent of Reciprocal and the right edge of the word.

b. ALIGN(CAUSATIVE, R; PWD, R) [ALIGN-CAUS-R]
Assign one violation for each segment intervening between the right edge of the exponent of Causative and the right edge of the word.

∗ **Step 1:** Use the MAP to generate the rankings for the two syntactic structures from (13) in (15):

(15) **Mirror Alignment Principle rankings for the structures in (13)**

a. **Reciprocalized Causative (13a):**

________________ → ________________________

C-command relations *MAP ranking*

b. **Causativized Reciprocal (13b):**

________________ → ________________________

C-command relations *MAP ranking*

∗ **Step 2:** Show how those rankings derive the right outputs in the tableaux in (16) and (17):

(16) **Reciprocalized Causative** *mang-its-an-* (13a)

/$\text{mang}_{\text{ROOT}}$, its_{CAUS}, an_{REC}/		

(17) **Causativized Reciprocal** *mang-an-its-* (13b)

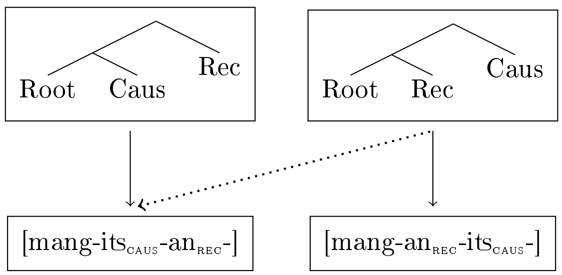
/$\text{mang}_{\text{ROOT}}$, its_{CAUS}, an_{REC}/		

3.2 The CARP template and asymmetric compositionality

- This data can be handled equally well with either approach. But actually, it's not quite so simple:

→ The order *mang-its-an-* (13a) can also mean 'cause to tie each other', the meaning in (13b).
  - Put another way, the order *mang-its-an-* is semantically ambiguous, and the meaning 'cause to tie each other' is linearly ambiguous.
  - **But**, the order *mang-an-its-* (13b) can only mean 'cause to tie each other' (13b).

(18) **Permissible mappings between structure and order**



- This is one component of what Hyman (2003) calls the "CARP template":
  - In most Bantu languages, combinations of Causative [C], Applicative [A], Reciprocal [R], and Passive [P], can always appear in that order [C-A-R-P], regardless of their syntax / semantic interpretation.
  - In some languages, these affixes can *only* appear in this order, regardless of interpretation.
  - In some languages, like Chichewa, some pairs of affixes, like Caus and Rec, can appear in either order, but with the interpretative asymmetry in (18), which Hyman calls "**asymmetric compositionality**".
  - Even in such languages, certain other pairs of affixes, like Caus and Appl, only surface in the CARP order ([CA]).

⋆ **What does this tell us about the architecture of the grammar and the Mirror Principle?**

3.3 Proving the syntax

- In Chichewa, Causative and Applicative always surface as [CA].
  - When this order corresponds to an Applicativized Causative interpretation (C < A), and gets passivized, only the Applicative argument can be promoted to subject, as shown in (19).
  - On the other hand, when this order corresponds to a Causativized Applicative interpretation (C > A), and gets passivized, only the Causee can be promoted to subject, as shown in (20).

(19) **Applicativized Causatives in Chichewa** (Hyman 2003:260, ex. 22)
(Caus *-its*, Appl *-il*, Pass *-idw*, 'cry' *líl*, 'children' *aná*, 'stick' *ndodo*)

a. Mchómbó a-ná-líl-**its-il**-a [CAUSEE aná] [APPL ndodo]
'Mchombo made the children cry with a stick'

b. [APPL ndodo] i-ná-líl-**its-il**-idw-á [CAUSEE aná]
'a stick was used to make the children cry'

c. ?*[CAUSEE aná] a-ná-líl-**its-il**-idw-á [APPL ndodo]
'the children were made to cry with a stick'

(20) **Causativized Applicatives in Chichewa** (Hyman 2003:260, ex. 23)
('cultivate' *lím*, 'hoes' *makásu*)

a. Mchómbó a-ná-lím-**its-il**-a [CAUSEE aná] [APPL makásu]
'Mchombo made the children cultivate with hoes'

b. [CAUSEE aná] á-ná-lím-**its-il**-idw-á [APPL makásu]
'the children were made to cultivate with hoes'

c. ?*[APPL makásu] a-ná-lím-**its-il**-idw-á [CAUSEE aná]
'hoes were used to make the children cultivate'

→ Only the argument that is syntactically highest is available for movement to subject.
  - This requires that the arguments, and, correspondingly, the heads that introduce them, be merged in different syntactic orders for the two different scopal interpretations.
  - There must be distinct syntactic structures underlying the ambiguous surface form of the verb word.

⋆ **Take-away:** The CARP template neutralizes underlying syntactic contrasts on the way to linear order.

3.4 Capturing CARP (fixed ordering) with bigram constraints

- Ryan (2010) introduces a way of accounting for templatic morphology with constraints, which he calls "bigram morphotactic constraints".
  - These are constraints that operate in the phonology (or maybe a constraint-based morphological component) that (arbitrarily) penalize certain orders of morphemes.
  - For example, the fact that Applicative can't precede Causative in Chichewa would follow from the constraint in (21):

(21) **Caus-Appl:** Assign one violation for each exponent of Causative which is not immediately followed by an exponent of Applicative.

- If Caus-Appl outranks all the alignment constraints, it can prevent the Mirror Principle order from emerging.

- When the Applicative scopes over the Causative (22), Align-Appl-R will be the highest ranked alignment constraint via the MAP.
  - This advocates for Appl /il/ to surface further to the right than Caus /its/.
  - This is the same order that's preferred by Caus-Appl, so we happen to get a Mirror Principle-compliant order.

(22) **Applicativized Causative** *mang-its-il-* (MP-obeying):
MAP ranking: ALIGN-APPL-R ≫ ALIGN-CAUS-R

[[[Root]Caus]Appl] /mang$_{\text{ROOT}}$, its$_{\text{CAUS}}$, il$_{\text{APPL}}$/	**Bigram 1** CAUS-APPL	**MAP constraints** ALIGN-APPL-R	ALIGN-CAUS-R	**Bigram 2** APPL-CAUS
a. ☞ mang-its-il- [CA]			** (il)	*
b. mang-il-its- [AC]	*!	** (its)		

- But when the Causative scopes over the Applicative (23), ALIGN-CAUS-R will be the highest ranked alignment constraint via the MAP.
  - This advocates for Caus /its/ to surface further to the right than Appl /il/.
  - This contradicts the order preferred by CAUS-APPL.
  - → As long as CAUS-APPL outranks all the alignment constraints, we'll still select the [CA] order, which now violates the Mirror Principle.

(23) **Causativized Applicative** *mang-its-il-* (MP-violating):
MAP ranking: ALIGN-CAUS-R ≫ ALIGN-APPL-R

[[[Root]Appl]Caus] /mang$_{\text{ROOT}}$, its$_{\text{CAUS}}$, il$_{\text{APPL}}$/	**Bigram 1** CAUS-APPL	**MAP constraints** ALIGN-CAUS-R	ALIGN-APPL-R	**Bigram 2** APPL-CAUS
a. ☞ mang-its-il- [CA]		** (il)		*
b. mang-il-its- [AC]	*!		** (its)	

- To capture the full CARP template, we'd need to multiply the set of high-ranked bigram constraints to include all pairwise combinations of CARP elements in that order (to the extent that all combinations are attested independently).

3.5 Capturing asymmetric compositionality with bigrams + MAP

- How can bigram constraints help us capture asymmetric compositionality? *Variable ranking.*
  - → We can characterize cases of asymmetric compositionality as rankings where the CARP bigram constraint stands in an underlyingly *variable* ranking with the MAP constraints.

- Just as in the fixed ordering case, when the MAP ranking prefers the same output as the CARP bigram constraint (Reciprocal scopes over Causative), we get the Mirror Principle-compliant order (24).
  - Since the MAP and the bigram constraint pull in the same direction, it doesn't matter which constraint ranks higher — you'll always get the CARP output.

(24) **Possible rankings and outputs for [[[Root]Caus]Rec]**

i. CAUS-REC ≫ {ALIGN-REC-R ≫ ALIGN-CAUS-R} ⇒ *Output*: CR

[[[Root]Caus]Rec] /mang$_{\text{ROOT}}$, its$_{\text{CAUS}}$, an$_{\text{REC}}$/	**Bigram 1** CAUS-REC	**MAP 1** ALIGN-REC-R	**MAP 2** ALIGN-CAUS-R	**Bigram 2** REC-CAUS
a. ☞ mang-its-an- [CR]			** (an)	*
b. mang-an-its- [RC]	*!	** (its)		

ii. {ALIGN-REC-R ≫ ALIGN-CAUS-R} ≫ CAUS-REC ⇒ *Output*: CR

[[[Root]Caus]Rec] /mang$_{\text{ROOT}}$, its$_{\text{CAUS}}$, an$_{\text{REC}}$/	**MAP 1** ALIGN-REC-R	**MAP 2** ALIGN-CAUS-R	**Bigram 1** CAUS-REC	**Bigram 2** REC-CAUS
a. ☞ mang-its-an- [CR]		** (an)		*
b. mang-an-its- [RC]	*!* (its)		*	

- But when the MAP ranking prefers the *non*-CARP order, as it does when Causative scopes over Reciprocal (25), the MAP and the bigram conflict.
  - If a derivation selects the ranking where the bigram constraint outranks the MAP constraints (25.i), it will select the CARP-obeying order, even though this order violates the Mirror Principle.
  - If a derivation selects the ranking where the MAP constraints outrank the bigram constraint (25.ii), it will not select the Mirror Principle-compliant order, which is CARP-violating.

(25) **Possible rankings and outputs for [[[Root]Rec]Caus]**

i. CAUS-REC ≫ {ALIGN-CAUS-R ≫ ALIGN-REC-R} ⇒ *Output*: CR

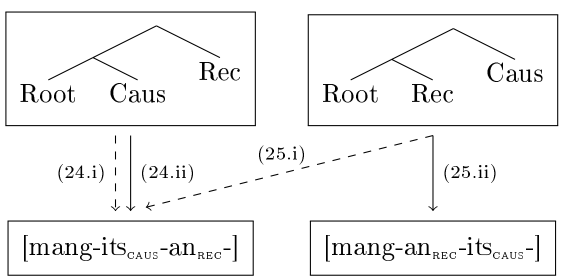
[[[Root]Rec]Caus] /mang$_{\text{ROOT}}$, its$_{\text{CAUS}}$, an$_{\text{REC}}$/	**Bigram 1** CAUS-REC	**MAP 1** ALIGN-CAUS-R	**MAP 2** ALIGN-REC-R	**Bigram 2** REC-CAUS
a. ☞ mang-its-an- [CR]		** (an)		*
b. mang-an-its- [RC]	*!		** (its)	

ii. {ALIGN-CAUS-R ≫ ALIGN-REC-R} ≫ CAUS-REC ⇒ *Output*: RC

[[[Root]Rec]Caus] /mang$_{\text{ROOT}}$, its$_{\text{CAUS}}$, an$_{\text{REC}}$/	**MAP 1** ALIGN-CAUS-R	**MAP 2** ALIGN-REC-R	**Bigram 1** CAUS-REC	**Bigram 2** REC-CAUS
a. mang-its-an- [CR]	*!* (an)			*
b. ☞ mang-an-its- [RC]		** (its)	*	

- We can summarize the tableaux in (25) and (24) by returning to the possible mappings between structure and order from (18).
  - The dashed lines represent the cases where the CARP bigram constraint (CAUS-REC) is selected as the higher-ranked constraint. Regardless of syntactic input, this maps to the CARP order.
  - The solid lines represent the cases where the MAP constraint is selected as the higher-ranked constraint. This selects the order that complies with the Mirror Principle.
  - → This is the only way to get the CARP-violating order (25.ii).

(26) **Permissible mappings between structure and order**



3.6 Local conclusions

- "Morphological templates" like CARP are a problem for the Mirror Principle, because they allow (or, in some instances, require) violating it.
- Trying to capture these kinds of morphological templates with a cyclic concatenation approach to the Mirror Principle is inelegant at best.
  - You'd have to posit that the morphology puts together the wrong order by cyclic concatenation.
  - Then something comes in later to clean things up (maybe Local Dislocation; Embick & Noyer 2001).
- Using a constraint-based analysis at a late stage of the derivation allows us to derive both fixed ordering and asymmetric compositionality in a direct way.

4 The MAP and root-and-pattern morphology

- Another kind of morphology that sometimes gets called "templatic" is the root-and-pattern nonconcatenative morphology in the Semitic languages.
  - In these languages, morphological word building frequently does not consist of sequential affixation to a fixed base of derivation.
  - Rather, morphemes may be interspersed, and adding new morphemes often significantly alters the segmental order and/or larger prosodic organization of the word.

⋆ Because Baker was thinking about the Mirror Principle in terms of cyclic morphological concatenation (Baker 1985:378ff.), he didn't see a clear way to reason about thoroughly nonconcatenative morphological processes/systems with respect to the Mirror Principle (Baker 1985:400–403, LeTourneau 1997).

→ The MAP let's us explain these kinds of root-and-pattern systems in a way that *does* let us reason about the Mirror Principle.

4.1 A MAP-Based Analysis of the Arabic Reflexive

- Arabic verbs are built around a consonantal root, proto-typically three consonants (see McCarthy 1979).
  - I'll exemplify forms using the root /ktb/ 'write' .
- The verbal system is divided into "Forms", built to these roots.
  - Forms are morphosyntactic categories associated with a particular phonological shape (traditionally described in terms of a CV "template") and a range of morphosemantics (often highly idiomatized).
- Within this system, Reflexive /t/ recurs across multiple Forms:
  - Sometimes as an *"infix"* (Table 1a)
  - Sometimes as a *"prefix"* (Table 1b)

Table 1: Forms with Reflexive /t/ (for example root $\sqrt{ktb}$ 'write'; data from McCarthy 1981:384)

Position		Form	Proposed morphosyntax	Example form	Translation
a.	*Infixal*	VIII	Reflexive	***kt̲**ataba*	'write, be registered'
b.	*Prefixal*	V	Reflexive of the Causative	***t̲ak**attaba*	(*constructed form*)
		VI	Reflexive of the Applicative	***t̲ak**aataba*	'write to each other'
		X	Causative of the Reflexive	***st̲ak**taba*	'write, make write'

- Recent accounts (Tucker 2010, 2011; cf. Ussishkin 2003) have used alignment constraints to help derive the ordering alternation.
  - However, an alignment-based analysis of the Reflexive leads to the ranking paradox in (27).
  - That these paradoxical rankings properly derive the distribution is confirmed in (28).

(27) **Ranking paradox**

a. Infixal Form (VIII): ALIGN-ROOT-L ≫ ALIGN-REFLEXIVE-L

b. Prefixal Forms (V,VI,X): ALIGN-REFLEXIVE-L ≫ ALIGN-ROOT-L

(28) **Alignment-based derivation of the Reflexive alternation**

(/t/ ⇔ REFL, /μ_c/ ⇔ CAUS, /a/ ⇔ PERF.ACT, /a/ ⇔ 3SG.MASC)

i. Infixal order: Form VIII Reflexive ***kṯ**ataba* [= (27a)]

/t, ktb, a, a/	ALIGN-ROOT-L	ALIGN-REFL-L
a. **ṯ**a**k**taba	*!*	
b. ☞ **kṯ**ataba		*

ii. Prefixal order: Form V Reflexive of Causative ***ṯ**a**k**at$_c$taba* [= (27b)]

/t, μ_c, ktb, a, a/	ALIGN-REFL-L	ALIGN-ROOT-L
a. ☞ **ṯ**a**k**at$_c$taba		**
b. **kṯ**at$_c$taba	*!	

- The MAP will let us take advantage of a syntactic generalization (29) to deliver an explanation.

(29) **Syntactic generalization about Reflexive /t/**

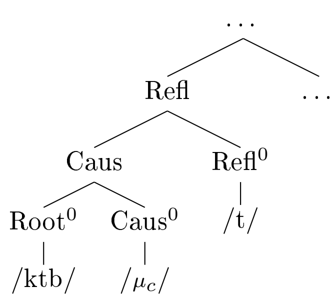
a. When Reflexive co-occurs with (and scopes over/c-commands) another verbal derivational morpheme (e.g. Causative or Applicative), its exponent is *prefixal*.

b. When Reflexive is the only verbal derivational morpheme, its exponent is *infixal*.

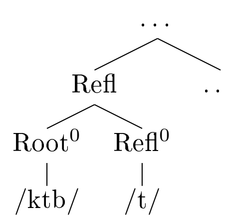
- The difference can be illustrated by comparing the syntactic structures of Form V (the reflexive of the causative) and Form VIII (the simple reflexive), as shown in (30).

(30) **Syntactic structures with Reflexive**

a. Form V ***ṯ**a**k**at$_c$taba*



b. Form VIII ***kṯ**ataba*



- In Form V (30a), Refl *asymmetrically c-commands* Root, since it adjoins to the complex head containing Root and Caus.
  → The MAP produces ALIGN-REFL-L ≫ ALIGN-ROOT-L, which generates prefixal /t/ (28.ii).
- In Form VIII (30b), Refl and Root stand in *symmetric c-command*, because Refl is the first head to adjoin with Root.
  → Since the MAP only establishes rankings based on asymmetric c-command, the ranking between ALIGN-REFL-L and ALIGN-ROOT-L is underdetermined.

(31) **MAP-governed rankings with Reflexive**

a. Form VIII (infixal order): ALIGN-ROOT-L, ALIGN-REFLEXIVE-L

b. Form V (prefixal order): ALIGN-REFLEXIVE-L ≫ ALIGN-ROOT-L

- While we've now identified a distinction between the two types of structures' alignment behavior, the MAP itself doesn't explain why Reflexive /t/ is infixal in Form VIII. Now observe one further generalization:

(32) **Root-alignment generalization**

The Root's left edge always surfaces further to the left than the first head which adjoins to it.

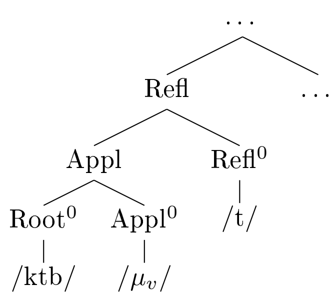
- This holds in all of the following Forms:

(33) **Forms exemplifying (32)**

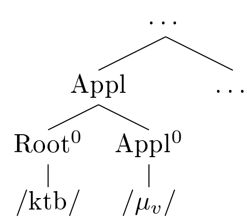
Root and Reflexive:	a.	Form VIII	***kṯ**ataba*	(30b)
Root and Causative:	b.	Form V	*ta**k**a**ṯ**$_c$**taba***	(30a)
	c.	Form II	***ka**ṯ$_c$**taba***	(§4.2)
Root and Applicative:	d.	Form VI	*ta**k**a**a̲**$_v$**taba***	(34a)
	e.	Form III	***k**a**a̲**$_v$**taba***	(34b)

(34) **Syntactic structures with Applicative**

a. Form VI *takaa$_v$taba*



b. Form III *kaa$_v$taba*



- We can understand the generalization in (32) in terms of alignment.
  - In each of the relevant cases, the constraint Align-Root-L outranks the left-oriented alignment constraint of the verbal derivational morpheme.
  - Note crucially that these are exactly the cases where the MAP does not establish a ranking, because the two heads stand in symmetric c-command.

- If we assume that there is a language-specific default ranking that emerges in the absence of contradictory instructions from the MAP, we can account for these cases by positing the default ranking in (35):

(35) **Language-specific default ranking for Arabic**
Align-Root-L ≫ all the other alignment constraints

- For the infixal Reflexive in Form VIII ***kṯ**ataba* (30b), the default ranking in (35) steps in to resolve the indeterminacy (cf. (31)) in favor of Align-Root-L. This now yields the ranking in (36a).

(36) **MAP-governed rankings supplemented by Arabic default ranking**
a. Form VIII (infixal order): Align-Root-L ≫ Align-Reflexive-L
b. Form V (prefixal order): Align-Reflexive-L ≫ Align-Root-L

- The two distinct rankings in (36) are the paradoxical rankings from (27) above which generate the contrasting prefixal vs. infixal behavior of the Reflexive detailed in Table 1 above.

→ We have found an explanation for the apparent paradox: the dynamic interaction of the MAP and Arabic's default ranking as mediated by the syntactic structure.

4.2 A MAP-Based Analysis of the Causative

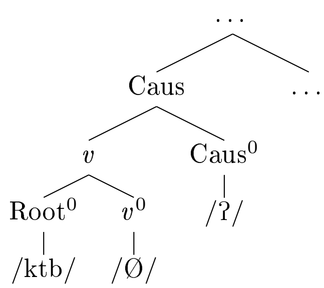
- Arabic has two basic types of morphological causatives (cf. Wright 1896:31–36, Ryding 2005:491, 515, Arbaoui 2010a,b, *a.o.*):
  - Form II, which is marked by an infixal consonantal mora (/μ_c/), as in *kat$_c$taba*
  - Form IV, which is marked by a prefixal /ʔ/, as in ***ʔ**aktaba*

- The analysis of the Reflexive in the previous subsection gives us a roadmap for understanding this infix vs. prefix alternation.
  - An infixal morpheme should be the first head to attach to the Root, such that the default high ranking of ALIGN-ROOT-L can emerge in the absence of a MAP-determined ranking.
  - A prefixal morpheme should be a higher head, such that it asymmetrically c-commands Root, and the MAP can rank its alignment constraint above ALIGN-ROOT-L.

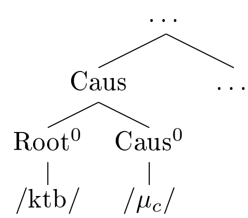
- If we reverse engineer the syntax in this way, we come up with the structures in (37).
  - ∗ Note that we must posit a null v head in Form IV (37a) in order to create the necessary structures.

(37) **Syntactic structures with Causative**

a. Form IV *ʔaktaba*



b. Form II *kat$_c$taba*



- The MAP-based phonological analysis predicts distinct syntactic structures for the two types of causatives.
  - *Does this supposed syntactic distinction correlate with other observable differences?*
  - → **Yes:** we can observe a difference in the semantics of the two categories.

- Both Forms can contribute causative or factitive semantics (Wright 1896:31–36).
  - Most Form IV forms have a canonically causative or factitive interpretation (ibid.:34).
  - → On the other hand, Form II forms have a substantially wider range of interpretations relating to causation or transitivity, such as (in Wright's parlance): intensive, extensive, iterative/frequentative, declarative, and estimative (ibid.:31–32).

- The root $\sqrt{\text{ʕlm}}$ 'know' provides a minimal pair that illustrates this distinction clearly (ibid.:34):
  - It has a Form II causative *ʕa**l̲**$_c$lama* which means 'teach'.
  - It also has a Form IV causative ***ʔ̲**aʕlama*, which means 'inform' (≈ 'make someone know').

- Taking this distinction to be general, consider now the nature of the syntactic difference posited in (37).
  - In Form IV, the Causative head selects a vP.
  - In Form II, the Causative head directly selects the Root.

- Cross-linguistically, root-selecting heads allow more idiomatic semantics than non-root-selecting heads (Marantz 1997, Arad 2003).

→ This is exactly what we observe in the semantics of these two Forms.
  - The one which selects for Root (Form II) has a wide range of semantics.
  - The one which selects for vP has more consistent semantics.

4.3 Local conclusions

- We therefore have exactly the sort of correlation between ordering, syntactic structure, and semantics that we would expect in the MAP framework.
- Because the MAP generates morpheme order using a feed-forward modular architecture, syntactic differences should lead to ordering differences at PF the same way they lead to interpretative differences at LF.
- Furthermore, the MAP, unlike cyclic concatenation, allows us to use nonconcatenative morphophonological patterning to make falsifiable hypotheses about syntactic structure (and thus semantics), exactly as the Mirror Principle envisions.

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