Morpheme Ordering Happens in the Phonology

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Introduction

Word-building

⋆ **How do languages build their words?**

Introduction

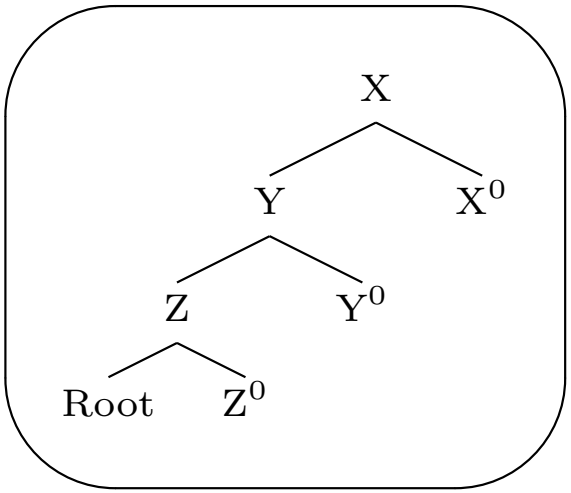
Cyclic Concatenation

- The simplest/standard hypothesis:

(1) **Cyclic concatenation:**

- Add one morpheme at a time (in the morphology).
- Attach it to the left edge (prefix) or the right edge (suffix).

(2) A complex head



(3) Cyclic derivation (if all are suffixes)

Step 1 [Root]
⇓
Step 2 [[Root]-Z]
⇓
Step 3 [[[Root]-Z]-Y]
⇓
Step 4 [[[Root]-Z]-Y]-X]

Introduction

The Mirror Principle

⋆ **Why is this a good model?**

(4) **The Mirror Principle:** "Morphological derivations must directly reflect syntactic derivations (and vice versa)." (Baker 1985)

- Types of evidence for the Mirror Principle:
  - Affix order reflects word order
  - Affix order co-varies with semantic scope (derivational morphology)
  - Affix order can track agreement alternations (inflectional morphology)

  (Abasheikh 1978, Muysken 1979, 1981, 1986, Baker 1985, 1988, Rice 2000, 2011, *a.o.*)

→ Mirror Principle behavior follows naturally from cyclic concatenation, because the order of spell-out matches the constituency.

Introduction

Nonconcatenative Morphology

⋆ **Why is this *not* a good model?**

- Many languages exhibit "**nonconcatenative**" morphological systems:
  → Non-isomorphism between surface constituency and morphosyntactic structure.

(5) *-um-* infixation in Tagalog (Schachter & Otanes 1972, via McCarthy & Prince 1993a:101; see also Orgun & Sprouse 1999, Klein 2005, Zuraw 2007, *a.o.*)

a. V-initial root: /abot/ 'reach for' → [<**um**>abot]
b. C-initial root: /sulat/ 'call' (v.) → [s<**um**>ulat]

- This makes it difficult to reason about the Mirror Principle.

Introduction

Types of Nonconcatenative Morphology

(6) Some types of nonconcatenative morphology [my contributions]

Reduplication	Marantz (1982) Steriade (1982, 1988) McCarthy & Prince (1986, 1995) Inkelas & Zoll (2005)	Zukoff (2017a *MIT diss*, 2017c *LI*) Zukoff (2020, 2023d *under review*) Stanton & Zukoff (2018 *NLLT*) Yates & Zukoff (2018 *IEL*)
Ablaut/mutation	Rose (1994) Zimmermann (2017)	Zukoff & Sandell (2015) Stanton & Zukoff (2016)
Morphological templates	Rice (2000) Hyman (2003) Ryan (2010)	Zukoff (2017b, 2023b *NLLT*) Zukoff (2023a, 2023c)
Root-and-pattern morphology	McCarthy (1979, 1981) Ussishkin (2000a,b, 2003) Bat-El (2003, 2011)	Zukoff (2021a, 2023b *NLLT*)
Infixation	McCarthy & Prince (1993a,b) Yu (2007) Kalin (2022)	Zukoff (2021a, 2023b *NLLT*)
Mobile affixation	Kim (2008, 2010) Jenks & Rose (2011, 2015)	Zukoff (2021b,c)

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Introduction

Illustrating the Problem: Arabic Root-and-Pattern Morphology

- The Arabic verbal system is divided into "Forms": morphosyntactic categories built around consonantal roots.

(7) Kinds of morphemes in the Arabic verb

a. **Roots** (entirely consonantal)
b. ***v*-domain morphemes** (alternate between prefix and infix)
c. **Aspect/Voice morphemes** (entirely vocalic)
d. **Subject agreement morphemes** (suffixal or circumfixal by aspect)

(8) Arabic verbal system (3SG.M of root √ktb 'write'; adapted from McCarthy 1981:385)

Form	**Pf. Act. /a/**	**Pf. Pass /ui/**	**Impf. Act. /var./**	**Impf. Pass. /ua/**
I	**katab-a**	**kutib-a**	**y-aktub-u**	**y-uktab-u**
II	**kat$_c$tab-a**	**kut$_c$tib-a**	**y-ukat$_c$tib-u**	**y-ukat$_c$tab-u**
III	**kaa$_v$tab-a**	**kuu$_v$tib-a**	**y-ukaa$_v$tib-u**	**y-ukaa$_v$tab-u**
IV	**ʔaktab-a**	**ʔuktib-a**	**y-u(ʔa)ktib-u**	**y-u(ʔa)ktab-u**
V	**takat$_c$tab-a**	**tukut$_c$tib-a**	**y-atakat$_c$tab-u**	**y-utakat$_c$tab-u**
VI	**takaa$_v$tab-a**	**tukuu$_v$tib-a**	**y-atakaa$_v$tab-u**	**y-utakaa$_v$tab-u**
VII	**nkatab-a**	**nkutib-a**	**y-ankatib-u**	**y-unkatab-u**
VIII	**ktatab-a**	**ktutib-a**	**y-aktatib-u**	**y-uktatab-u**
X	**staktab-a**	**stuktib-a**	**y-astaktib-u**	**y-ustaktab-u**

Introduction

Arabic Root-and-Pattern Morphology and the Mirror Principle?

- Morphological segmentation is difficult, and changing morphemes can substantially alter the phonological shape of the word.

⇒ **It's not at all obvious how to approach a system like this from the point of view of cyclic concatenation or the Mirror Principle.**

∗ See Zukoff (2023b *NLLT*) for the full analysis.

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I	**katab-a**	**kutib-a**	**y-aktub-u**	**y-uktab-u**
II	**kat$_C$tab-a**	**kut$_C$tib-a**	**y-ukat$_C$tib-u**	**y-ukat$_C$tab-u**
III	**kaa$_V$tab-a**	**kuu$_V$tib-a**	**y-ukaa$_V$tib-u**	**y-ukaa$_V$tab-u**
IV	**ʔaktab-a**	**ʔuktib-a**	**y-u(ʔa)ktib-u**	**y-u(ʔa)ktab-u**
V	**takat$_C$tab-a**	**tukut$_C$tib-a**	**y-atakat$_C$tab-u**	**y-utakat$_C$tab-u**
VI	**takaa$_V$tab-a**	**tukuu$_V$tib-a**	**y-atakaa$_V$tab-u**	**y-utakaa$_V$tab-u**
VII	**nkatab-a**	**nkutib-a**	**y-ankatib-u**	**y-unkatab-u**
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Introduction

Dealing with Nonconcatenative Morphology

⋆ **How do we deal with these languages?**

- Invent *special tools*?
  - CV templates (McCarthy 1979, 1981, Faust 2015, 2023)
  - melodic overwriting (Bat-El 1994, Ussishkin 2000b)
  - morphophonological subcategorization (Yu 2007, Kalin 2022, Kalin & Rolle 2022)
  - ...
- *Give up* on the Mirror Principle?
  - e.g. Baker (1985:400–403)

Introduction

Theoretical Deliverables

- **What does our theory need to do for us?**

⋆ **Theoretical deliverables:**

1. Derive the Mirror Principle for concatenative morphology.
2. Parsimoniously and insightfully analyze nonconcatenative morphology, including its **phonological properties**.
3. Reason about nonconcatenative morphology with respect to the Mirror Principle.

Introduction

Just the Right Theory

⋆ **My theory does exactly this.** It has two components:

(9) **Articulated alignment:** Each morpheme has its own alignment constraint (McCarthy & Prince 1993a), advocating that it surface at a particular word-edge.

⋆ **Transparent interaction between phonology and morphology** lets us explain various kinds of nonconcatenative morphology.

(10) **The Mirror Alignment Principle [MAP]** (preliminary): The ranking of alignment constraints is dynamically determined by morphosyntactic structure.

⋆ This **derives the Mirror Principle**, for both concatenative and nonconcatenative morphology.

Introduction

Case Studies in Morpheme Ordering

- Today: I'll present evidence from morpheme order alternations in two nonconcatenative morphological systems:

  1. **Mobile affixation in Huave** (Huavean)
     - Prefix/suffix alternations conditioned by *phonological and morphological* context.

     ↪ Cyclic concatenation (cf. Kim 2010) misses important generalizations that fall out from articulated alignment.

  2. **Prefix/infix alternations in Arabic** (Semitic)
     - Prefix/infix alternations conditioned by *morphosyntactic* context.

     ↪ The MAP resolves an ordering paradox **and** opens up new lines of analysis/reasoning from multiple perspectives.

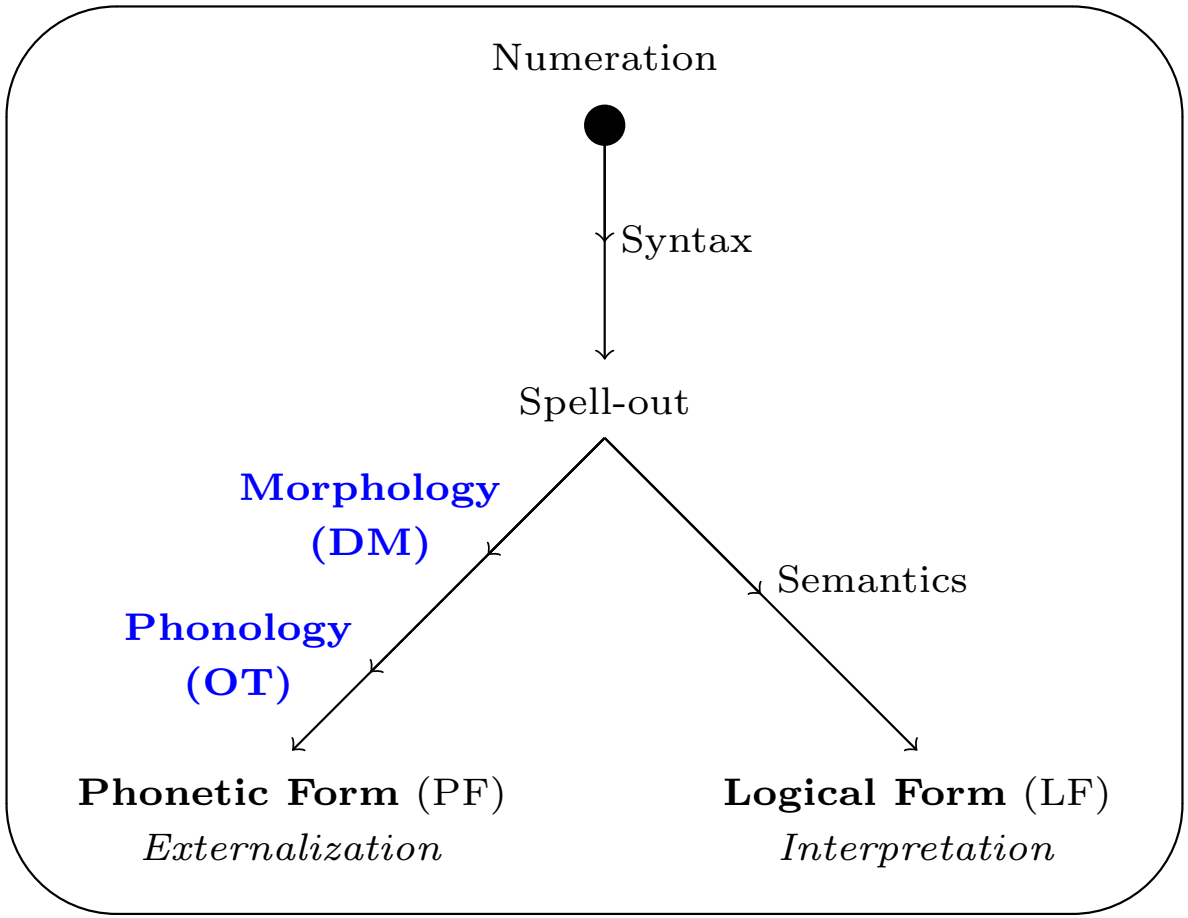
⋆ **Articulated alignment + MAP captures ordering generalizations in these systems better than cyclic concatenation does.**

Introduction

Theoretical Assumptions

- I assume a feed-forward modular architecture:

(11) The Y-Model (Chomsky 1986)



Roadmap

1. Introduction
2. Alignment Constraints
3. **Mobile Affixation in Huave**
4. **The Mirror Alignment Principle**
5. **Prefix/Infix Alternations in Arabic**
6. **Conclusions and Extensions**

Alignment

Generalized Alignment

- The concept of "generalized alignment" was first proposed by McCarthy & Prince (1993a) in the context of early work on Optimality Theory.
  - (See also Prince & Smolensky [1993] 2004, Hyde 2012, *a.o.*)

- **Alignment constraints:** specified edges of phonological and/or morphological constituents **coincide in the output** (McCarthy & Prince 1993a:80).

⋆ As recognized in McCarthy & Prince's original proposal, **alignment constraints can contribute to morpheme order**.
  - (This was subsequently implemented in various ways; cf. Anderson 1996, Potter 1996, Hargus & Tuttle 1997, Trommer 2001, Yu 2007, *a.o.*)

Alignment

Articulated Alignment

- Articulated alignment severely restricts the types of alignment constraints:

(12) **Articulated Alignment**
A designated edge of a **morpheme's exponent** must coincide with the equivalent edge of the word.

- These alignment constraints follow the definition schema in (13):

(13) a. ALIGN-X-R: Assign one violation * for each segment that intervenes between the right edge of the exponent of morpheme X and the right edge of the word. [≈ ***Be a suffix!***]

b. ALIGN-X-L: Assign one violation * for each segment that intervenes between the left edge of the exponent of morpheme X and the left edge of the word. [≈ ***Be a prefix!***]

Alignment

Articulated Alignment and Morpheme Order

- Alignment constraints that specify the same direction **compete** to place their morphemes at that edge (cf. Potter 1996).

(14) Competing alignment constraints

/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		*	**

→ **Competition resolved by relative ranking.**

Alignment

Where we're going

→ Articulated alignment thus recreates various aspects of cyclic concatenation.

* **Later:** Connecting the alignment ranking to the morphosyntactic structure **generates the Mirror Principle**.

* **But first:** Articulated alignment provides a deeper explanation of the morphological and phonological generalizations behind **mobile affixation in Huave**.

Roadmap

1. Introduction

2. Alignment Constraints

3. **Mobile Affixation in Huave**
   - Phonological analysis of basic mobility patterns
   - Articulated alignment analysis of multiple mobility

   ↪ Articulated alignment captures generalizations; cyclic concatenation doesn't

4. **The Mirror Alignment Principle**

5. **Prefix/Infix Alternations in Arabic**

6. **Conclusions and Extensions**

Mobile Affixation in Huave

Overview

- The San Francisco del Mar variety of Huave, as described by Kim (2008), exhibits the typologically unusual behavior known as "mobile affixation".
  - On the San Francisco del Mar variety, see also Kim (2010, 2015a,b), Koopman (2020), Zukoff (2021b).
  - On the San Mateo del Mar variety, where the role of phonology is less clear, see Noyer (1994, 2013), Embick & Noyer (2001, 2007), Koopman (2017).
  - Similar cases of mobile affixation are found in Afar (Fulmer 1991, Rucart 2006), Moro (Jenks & Rose 2011, 2015, Zukoff 2021c, 2022), and Washo (Benz 2018).
- Huave has 5 affixes that can appear on **either side of the root** (15).

  → Importantly, **all of the exponents are single consonants**.

(15) Huave's mobile affixes (Kim 2010:139–141)

/t/	[CP]	Completive
/n/	[ST]	Stative
/m/	[IRR]	Irrealis (/n/ in 1st person [IRR1])
/r/	[2I]	2nd Person Intransitive
/s/	[1]	1st Person

* ***N.B.:*** *Following Salminen (2016), I use "irrealis" in place of "subordinate" (cf. Kim 2008).*

Mobile Affixation in Huave

Distributional Generalizations

(16) Affix mobility (Kim 2010:140, 141, 149)

a.	**V(...)C** bases:	***t***-*uc*	's/he ate'	[**uc*-(*i*)***t***]
b.	**C(...)V** bases:	*mo*^{h}*ko*-***t***	's/he lay face down'	[****t***(*a*)-*mo*^{h}*ko*]
c.	**V(...)V** bases:	*uju*-***m***	'that it spins'	[****m***-*uju*]
d.	**C(...)C** bases:	*ɲ*-*uk*^{w}*al*-*a****s***	'I am pregnant'	[****s***(*a*)-*ɲ*-*uk*^{w}*al*]

∗ Some of the base-edge vowels are "theme vowels" (Kim 2008; Koopman 2020). I treat them as a unit with the root for the purpose of this analysis.

- The analytical generalization behind this distribution (following Kim 2008, 2010) is as follows:

(17) **Huave affix mobility generalization**
A mobile affix surfaces as a **suffix** (the default) unless **prefixation** would uniquely avoid creating a consonant cluster.

Mobile Affixation in Huave

Analysis: Suffixation by default

- Mobile affixes are "underlyingly" **suffixes**:

(18) ALIGN-R: Assign a violation * if the affix does not surface at the right edge of the word. [*Non-articulated version*]

(19) **Suffixation** to V(...)V bases

/uju, m_{IRR}/	*CC	ALIGN-R
a. ☞ uju-**m**		
b. **m**-uju		*!

(20) **Suffixation** to C(...)V bases

/mo^hko, t_{CP}/	*CC	ALIGN-R
a. ☞ mo^hko-**t**		
b. **t**-mo^hko	*!	*!

- Suffixation to C-initial bases also does better on *CC:

(21) *CC: Assign a violation * for each consonant cluster.

↪ *Surface true in Huave*

Mobile Affixation in Huave

Analysis: Prefixation when phonotactically improving

- *CC and ALIGN-R make conflicting demands for V(...)C bases.
- Since we observe **prefixation** (22b), *CC must be more important than ALIGN-R:

(22) ***Prefixation*** to V(...)C bases

/uc, t_{CP}/	*CC	ALIGN-R
a. uc-**t**	*!	
b. ☞ **t**-uc		*

→ Cluster avoidance — **a property of the phonological computation** — is triggering the "movement" of the affix.

Mobile Affixation in Huave

Analysis: Prefixation when phonotactically improving

- **Suffixation** can't be rescued by epenthesis (24c), so DEP must also be more important than ALIGN-R.

(23) DEP: Assign a violation * for each epenthetic segment.

(24) ***Prefixation*** to V(...)C bases

/uc, t_{CP}/	*CC	DEP	ALIGN-R
a. uc-**t**	*!		
b. ☞ **t**-uc			*
c. uc-*i***t**		*!	

∗ Epenthetic segments indicated with *italics*.

Mobile Affixation in Huave

Analysis: Suffixation when phonotactically equivalent

- **Suffixation** for C(...)C bases comes for free.
- Since both **prefixation** and **suffixation** would create a consonant cluster, the mobile affix defaults to **suffix** position so it can satisfy ALIGN-R.

(25) **Suffixation** to C(...)C bases

/CVC, t_{CP}/	*CC	DEP	ALIGN-R
a. CVC-**t**	*!		
b. ☞ CVC-***i*****t**		*	
c. **t**-CVC	*!		*
d. **t*****i***-CVC		*	*!

[C(...)C bases only arise with complex stems]

- We get epenthesis (25b) rather than the cluster (25a), so *CC must be more important than DEP.

Mobile Affixation in Huave

Interim summary

- Analysis summary:

(26) **Ranking:** *CC ≫ Dep ≫ Align-R

⋆ **Main take-away:**

- Properties of the **phonological computation** — cluster avoidance, epenthesis avoidance — influence affix position.

→ This is an argument for **alignment-based analysis** of morpheme order:

- It is designed to capture transparent phonology-morphology interactions.

- **Next:** words with multiple affixes, including multiple mobile affixes.

Mobile Affixation in Huave

Previewing the Generalizations

- **Preview:** There are two **important generalizations** that articulated alignment captures but cyclic concatenation doesn't:

(27) **Huave mobility-order correlation**
No immobile suffix ever surfaces with a mobile affix to its right.

(28) **Huave affix ordering generalization**
For any two affixes of the same phonological shape, they always appear in the same left/right relative order.

⋆ These generalizations **fall out from the parallel architecture** of articulated alignment, but are not expressible otherwise.

Mobile Affixation in Huave

Articulated Alignment: Overview

- My analysis relies on **articulated alignment**:

(29) **Morpheme-specific alignment constraints** (McCarthy & Prince 1993a)
Each morpheme has its own alignment constraint, which may be either left-oriented or right-oriented.

(30) **A single constraint ranking** (Prince & Smolensky [1993] 2004)
These alignment constraints are ranked with respect to each and with respect to phonological constraints in a single phonological grammar.

(31) **Parallel evaluation** (Prince & Smolensky [1993] 2004)
Morpheme order is determined all at once (i.e., in parallel) according to evaluation of this constraint ranking.

∗ I'm leaving aside the relationship between alignment ranking and morpho-syntax for now, but we'll return to it later.

Mobile Affixation in Huave

Mulitple Mobility

- Consider the example in (32). [Mobile affixes underlined.]

(32) s-i-n-a^{h}ʧ (*ʃina^{h}ʧ*)
1-FUT-IRR1-give
'that I will give' [(Kim 2008:279)]

Actual surface form in italics, reflecting application of "late" phonological processes, e.g. palatalization and diphthongization.

- This example contains three affixes, so we need **three distinct alignment constraints**.

- We know that 1 /s/ and IRR1 /n/ are **mobile affixes**, not prefixes, based on data like (33) and (34):

(33) t-ara^{ŋ}g-*a*s (*tara^{ŋ}gas*)
CP-do-1
'I did (it)' [(Kim 2008:340)]

(34) pa^{h}ka-n (*pa^{h}kan*)
face.up-IRR1
'that I lie face up' [(Kim 2008:338)]

Mobile Affixation in Huave

Articulated Alignment: Alignment Constraints

- Since 1 /s/ and IRR1 /n/ are mobile affixes, their alignment constraints will be right-oriented:

(35) ALIGN-1-R: Assign one violation * for each segment that intervenes between the right edge of the exponent of FIRST PERSON and the right edge of the word.

(36) ALIGN-IRR-R: Assign one violation * for each segment that intervenes between the right edge of the exponent of IRREALIS and the right edge of the word.

- FUT /i/ is a prefix, so its alignment constraint will be left-oriented:

(37) ALIGN-FUT-L: Assign one violation * for each segment that intervenes between the left edge of the exponent of FUTURE and the left edge of the word.

Mobile Affixation in Huave

Articulated Alignment: Example Derivation

- We can capture the target pattern with the ranking in (38):

(38) **Ranking:** *CC ≫ Dep ≫ Align-fut-L ≫ Align-irr-R ≫ Align-1-R

- By ranking *CC and Dep above the alignment constraints, we can select the desired output (39c) using a single (**parallel**) input-output mapping:

(39) Tableau for 1st person Future Irrealis

/a^{h}ʧ, n_{IRR1}, i_{FUT}, s_1/	*CC	Dep	Align-fut-L	Align-irr-R	Align-1-R
a. s-a^{h}ʧ-i-n			**!* (s, a^{h},ʧ)		**** (a^{h},ʧ, i, n)
b. n-a^{h}ʧ-i-s			**!* (n, a^{h},ʧ)	**** (a^{h},ʧ, i, s)	
c. ☞ s-i-n-a^{h}ʧ			* (s)	** (a^{h},ʧ)	**** (i, n, a^{h},ʧ)
d. n-i-s-a^{h}ʧ			* (n)	***!* (i, s, a^{h},ʧ)	** (a^{h},ʧ)
e. i-a^{h}ʧ-*i*s-*a*n		*!*			** (*a*,n)
f. i-a^{h}ʧ-s-n	*!*				* (n)

Mobile Affixation in Huave

Articulated Alignment: Example Derivation

(39) Tableau for 1st person Future Irrealis

/a^{h}ʧ, n_{IRR1}, i_{FUT}, s_1/	*CC	Dep	Align-fut-L	Align-irr-R	Align-1-R
a. s-a^{h}ʧ-i-n			**!* (s, a^{h},ʧ)		**** (a^{h},ʧ, i, n)
b. n-a^{h}ʧ-i-s			**!* (n, a^{h},ʧ)	**** (a^{h},ʧ, i, s)	
c. ☞ s-i-n-a^{h}ʧ			* (s)	** (a^{h},ʧ)	**** (i, n, a^{h},ʧ)
d. n-i-s-a^{h}ʧ			* (n)	***!* (i, s, a^{h},ʧ)	** (a^{h},ʧ)
e. i-a^{h}ʧ-*i*s-*a*n		*!*			** (*a*,n)
f. i-a^{h}ʧ-s-n	*!*				* (n)

Mobile Affixation in Huave

Articulated Alignment: Example Derivation

(39) Tableau for 1st person Future Irrealis

/a^{h}ʧ, n_{IRR1}, i_{FUT}, s_1/	*CC	Dep	Align-fut-L	Align-irr-R	Align-1-R
a. s-a^{h}ʧ-i-n			**!* (s, a^{h},ʧ)		**** (a^{h},ʧ, i, n)
b. n-a^{h}ʧ-i-s			**!* (n, a^{h},ʧ)	**** (a^{h},ʧ, i, s)	
c. ☞ s-i-n-a^{h}ʧ			* (s)	** (a^{h},ʧ)	**** (i, n, a^{h},ʧ)
d. n-i-s-a^{h}ʧ			* (n)	***!* (i, s, a^{h},ʧ)	** (a^{h},ʧ)
e. i-a^{h}ʧ-*i*s-*a*n		*!*			** (*a*,n)
f. i-a^{h}ʧ-s-n	*!*				* (n)

Mobile Affixation in Huave

Articulated Alignment: Example Derivation

(39) Tableau for 1st person Future Irrealis

/a^{h}ʧ, n_{IRR1}, i_{FUT}, s_1/	*CC	Dep	Align-fut-L	Align-irr-R	Align-1-R
a. s-a^{h}ʧ-i-n			**!* (s, a^{h},ʧ)		**** (a^{h},ʧ, i, n)
b. n-a^{h}ʧ-i-s			**!* (n, a^{h},ʧ)	**** (a^{h},ʧ, i, s)	
c. ☞ s-i-n-a^{h}ʧ			* (s)	** (a^{h},ʧ)	**** (i, n, a^{h},ʧ)
d. n-i-s-a^{h}ʧ			* (n)	***!* (i, s, a^{h},ʧ)	** (a^{h},ʧ)
e. i-a^{h}ʧ-*i*s-*a*n		*!*			** (*a*,n)
f. i-a^{h}ʧ-s-n	*!*				* (n)

∗ (39c) and (39d) are identical except in the relative order of the the two mobile affixes.

Mobile Affixation in Huave

Articulated Alignment: Ranking Summary

- In Zukoff (2021b), I consider much more data and motivate the full analysis in greater detail.

- The rankings motivated by that analysis are summarized in (40):

(40) Ranking summary

*CC
|
DEP
|
ALIGN-FUT-L
|
ALIGN-2-L
|
ALIGN-2INTRANS-R
|
ALIGN-IRR-R
|
ALIGN-1-R
|
ALIGN-ASP-R

} mobile affixes

Mobile Affixation in Huave

Articulated Alignment: Analytical Generalizations

Important things to note:

- ⋆ *All* of the language's mobile affixes' alignment constraints are **ranked below *CC and DEP**, which triggers mobility.
- ⋆ The relative order of any two mobile affixes is determined *solely* by the **relative ranking of their alignment constraints**.

(40) Ranking summary

*CC
|
DEP
|
ALIGN-FUT-L
|
ALIGN-2-L
|
ALIGN-2INTRANS-R
|
ALIGN-IRR-R
|
ALIGN-1-R
|
ALIGN-ASP-R

} **mobile affixes**

Mobile Affixation in Huave

Articulated Alignment: Analytical Generalizations

Important things to note:

⋆ *All* of the language's mobile affixes' alignment constraints are **ranked below *CC and DEP**, which triggers mobility.

⋆ The relative order of any two mobile affixes is determined *solely* by the **relative ranking of their alignment constraints**.

∗ **What would happen if a right-oriented consonantal affix's alignment constraint ranked above DEP?**

(40) Ranking summary

*CC
|
DEP
|
ALIGN-FUT-L
|
ALIGN-2-L
|
ALIGN-2INTRANS-R
|
ALIGN-IRR-R
|
ALIGN-1-R
|
ALIGN-ASP-R

} mobile affixes

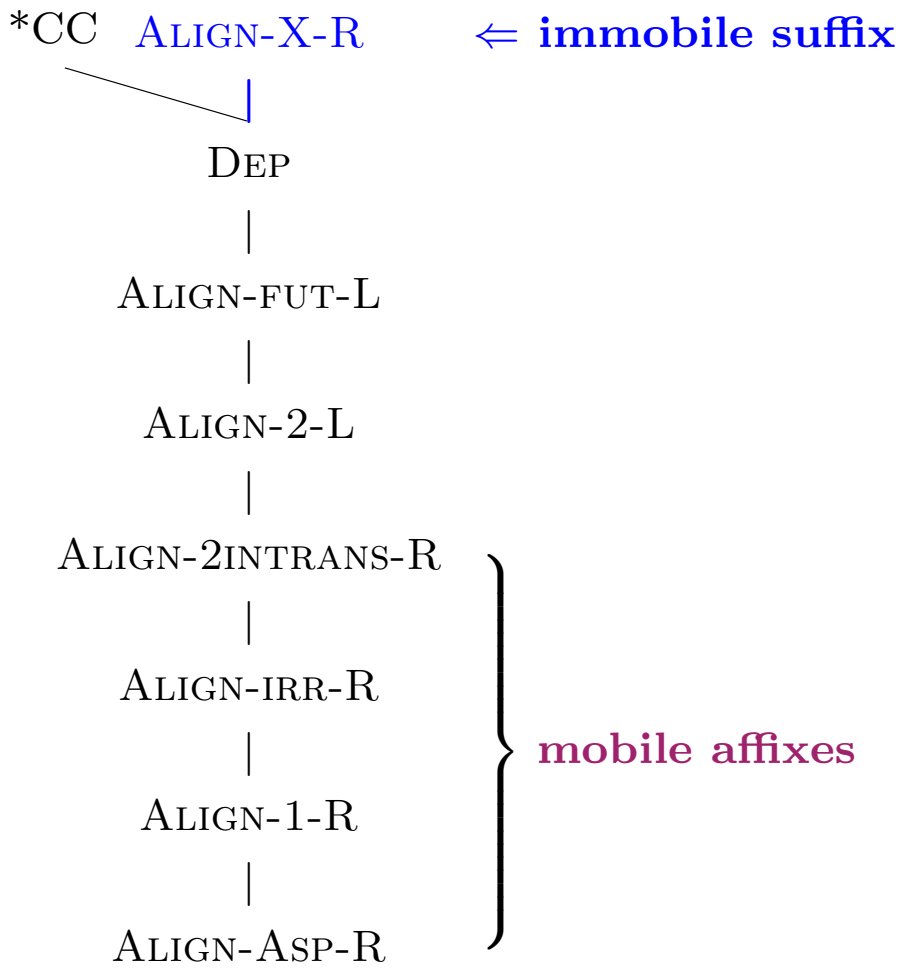
Mobile Affixation in Huave

Articulated Alignment: Predictions

1. Would not be mobile
It would be an **immobile suffix** because its alignment constraint outranks DEP (the mobility trigger).

2. Would be rightmost
It would always be the **rightmost morpheme**, because its right-oriented alignment constraint outranks all of the mobile affixes' alignment constraints by transitivity.

(41) Ranking summary: predictions



Mobile Affixation in Huave

Plural /n/ is a Suffix, not a Mobile Affix

⋆ **All of Huave's plural agreement markers work exactly this way.**

- **Plural /n/**, 3rd plural /^{h}w/, 1st inclusive /r/ and /$^{(h)}$ʦ/ (Kim 2008:47)

- As expected, when there is a stem-final vowel, it surfaces as a **suffix**:

(42) i-m-e-wici-r-u-**n** (*imewicjorun*)
FUT-IRR-2-rise-2I-ITR-PL
'you (pl.) will get up' [(Kim 2008:280)]

- But it also **suffixes** to V(...)C bases, even though this triggers **epenthesis**.
  → Mobile affixes would have **prefixed** here to avoid epenthesis.

(43) i-m-e-^{h}ʧ-**in** (*ime^{h}ʧjon*) (*n-i-m-e-^{h}ʧ, *m-i-n-e-^{h}ʧ)
FUT-IRR-2-give-PL
'you (pl.) will give' [(Kim 2008:279)]

Mobile Affixation in Huave

Articulated Alignment: Immobility of the Plural

- Crucial interactions are represented in (44):

(44) Tableau for 2nd person plural Future Irrealis (abbreviated)

/(a)^{h}ʧ, m_{IRR}, i_{FUT}, e_2, n_{PL}/	ALN-PL-R	DEP	...	ALN-IRR-R
a. ☞ i-m-e-^{h}ʧ-*i*n		*		**** (e,^{h}ʧ,*i*,n)
b. m-i-n-e-^{h}ʧ	*!* (e,^{h}ʧ)			**** (i,n,e,^{h}ʧ)
c. n-i-m-e-^{h}ʧ	*!*** (i,m,e,^{h}ʧ)			** (e,^{h}ʧ)

→ **The mobility trigger serves as a pivot between immobile and mobile affixes.**

Mobile Affixation in Huave

The Mobility-Order Correlation

- This interaction doesn't just account for the immobility of Plural /n/, it derives the **Huave mobility-order correlation** (27):

(27) **Huave mobility-order correlation**
No immobile suffix ever surfaces with a mobile affix to its right.

- (27) follows from the **parallelism** of the articulated alignment approach:
  → In a parallel mapping, constraint ranking is subject to transitivity.

⋆ (27) is **not derivable with cyclic concatenation**.
  → There is no inherent connection between the behavior of one affix and the behavior of any other affix.

Mobile Affixation in Huave

Cyclic Concatenation + Cophonologies

- Kim's cyclic concatenation model (Kim 2008, 2010) derives the distinct behavior of different affixes using "cophonologies" (Inkelas 1998 et seq.):
  → Each affix is indexed to its own constraint ranking.

- Some affixes *happen* to be indexed to (45) [phonotactics ≫ alignment]:

(45) **Mobile cophonology:** {*CC ≫ Dep} ≫ Align-R

- Other affixes *happen* to be indexed to (46) or (47) [alignment ≫ phonotactics]:

(46) **Suffix cophonology:** Align-R ≫ {*CC ≫ Dep}

(47) **Prefix cophonology:** Align-L ≫ {*CC ≫ Dep}

Mobile Affixation in Huave

The Problem with Cyclic Concatenation + Cophonologies

- The cyclic concatenation + cophonologies approach **misses the mobility-order correlation:**

(27) **Huave mobility-order correlation**
No immobile suffix ever surfaces with a mobile affix to its right.

→ Whether an affix is or is not mobile is an arbitrary property of the lexicon, so they could have been distributed in a different way.

- This is **not expressible** in a cophonology theory analysis:
  → No (meta-)property governs the distribution of rankings across morphemes.

Mobile Affixation in Huave

The Affix Order Generalization

- Articulated alignment derives a second striking generalization, which is also missed with cyclic concatenation + cophonologies:

(28) **Huave affix ordering generalization**
For any two affixes of the same phonological shape, they always appear in the same left/right relative order.

Same side *vs.* **Opposite sides**

(48) s-i-n-a^{h}ʧ (*ʃina^{h}ʧ*) [= (32)]
1-FUT-IRR1-give
'that I will give' [(Kim 2008:279)]

(49) s-i-ʧutu-n (*ʃiʧutun*)
1-FUT-sit-IRR1
'that I will sit' [(Kim 2008:333)]

(50) ʧutu-t-u-s (*ʧututus*)
sit-CP-ITR-1
'I sat down' [(Kim 2008:334)]

(51) t-araŋg-as (*taraŋgas*)
CP-do-1
'I did (it)' [(Kim 2008:340)]

Mobile Affixation in Huave

Deriving the Affix Order Generalization

- Articulated alignment derives a second striking generalization, which is also missed with cyclic concatenation + cophonologies:

(28) **Huave affix ordering generalization**
For any two affixes of the same phonological shape, they always appear in the same left/right relative order.

- Nothing guarantees this in the cophonology approach.

⋆ **This automatically follows from the articulated alignment approach:**

- Movement around the verb word is conditioned only by consonant/vowel phonotactics.
- Reversing the order of same-shape affixes will not improve phonotactics.

∗ This generalization may be compatible with Koopman's (2017, 2020) leftward movement-based approach, as long as "mobile" affixes never move over each other.

Mobile Affixation in Huave

Why should we care about these generalizations?

Mobile Affixation in Huave

Why should we care about these generalizations?

Question

Why should we care about these generalizations?

Mobile Affixation in Huave

Why should we care about these generalizations?

QUESTION

Why should we care about these generalizations?

⇒ **Answer: Restrictiveness**

- These generalizations were **necessary consequences of the architecture** of the theory.
  - ↪ Articulated alignment makes **falsifiable predictions** about affix mobility.

Mobile Affixation in Huave

Generalizing

⋆ We should find general avatars of the generalizations we found in Huave:

(52) **Generalized mobility-order correlation**
Any language with a mobile/immobile affix distinction will distribute them according to exteriority.

(53) **Generalized affix ordering generalization**
Affix mobility never changes relative order between affixes with the same phonological properties.

- This gives us something to test when we encounter a new language with affix mobility.

∗ Cyclic cophonologies doesn't make any such predictions.

→ No amount of new evidence will ever lead us to reject the theory.

Mobile Affixation in Huave

Local Conclusions

The view from Huave:

1. Phonological factors (e.g. cluster avoidance, epenthesis avoidance) can influence the surface order of morphemes.
   ↪ Transparent interaction between phonology and morphology.

2. Cyclic concatenation + cophonologies fails to capture generalizations about the relative order of morphemes and the possibility/distribution of mobility.
   ↪ Lack of transparency leads to loss of generalization.

3. Articulated alignment directly captures these generalizations as a consequence of its architecture.
   ↪ **Parallelism, transparency, and constraint interaction yields a uniquely insightful and restrictive analysis in this domain.**

Roadmap

1. **Introduction**
2. **Alignment Constraints**
3. **Mobile Affixation in Huave**
4. **The Mirror Alignment Principle**
   - Motivate and formalize a connection between alignment ranking and morphosyntactic structure that can derive the Mirror Principle.
   - ∗ We'll revisit Huave in this context at the end of the Section 5.
5. **Prefix/Infix Alternations in Arabic**
6. **Conclusions and Extensions**

The Mirror Alignment Principle

Deriving Order

- So far, I've shown you two ways to derive an order [Root-Z-Y-X]:

The Mirror Alignment Principle

Deriving Order

- So far, I've shown you two ways to derive an order [Root-Z-Y-X]:

  1. A ranking of articulated alignment constraints:

(14) **Articulated alignment**

/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		*	**

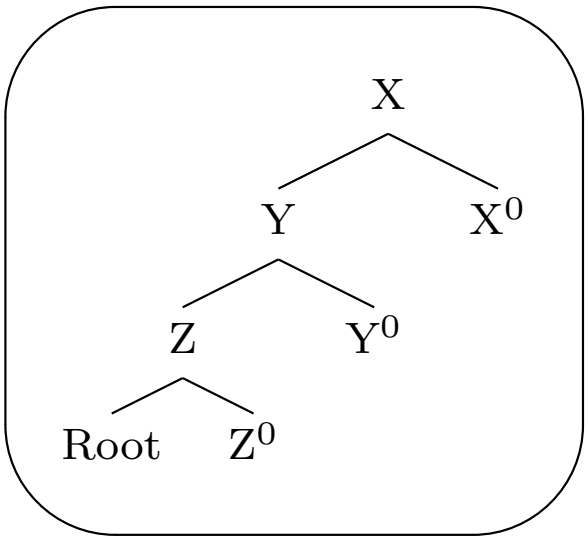
The Mirror Alignment Principle

Deriving Order

- So far, I've shown you two schematic ways to derive an order [Root-Z-Y-X]:

  2. Applying cyclic concatenation (3) to the structure in (2):

(2) A complex head



(3) Cyclic derivation (if all are suffixes)

Step 1 [Root]
⇓
Step 2 [Root]-Z
⇓
Step 3 [[Root]-Z]-Y
⇓
Step 4 [[Root]-Z]-Y]-X

The Mirror Alignment Principle

A Correlation between Ranking and Structure

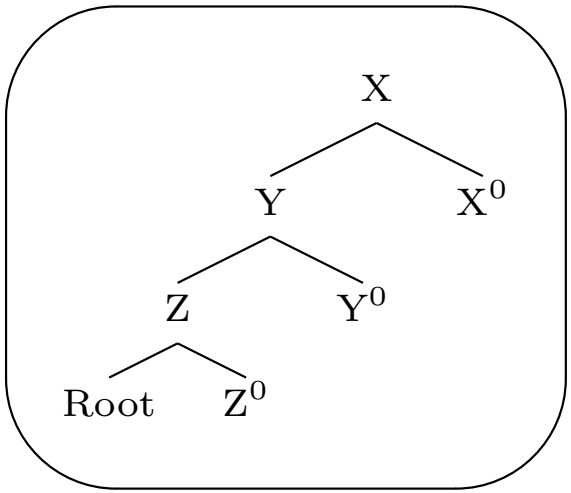
- There's a correlation between the alignment ranking and the morpho-syntactic structure:

(54) Ranking: ALIGN-X-R ≫ ALIGN-Y-R ≫ ALIGN-Z-R

(55) How ranking relates to structure

Alignment Ranking	**Structural Height**
ALIGN-X-R	X
ALIGN-Y-R	Y
ALIGN-Z-R	Z

Highest ↕ Lowest



(56) **The higher the head in the structure, the higher its alignment constraint in the ranking.**

The Mirror Alignment Principle

Alignment and the Mirror Principle

- This correlation is not just a quirk of this example:
  → It is a way to consistently **derive the Mirror Principle using articulated alignment constraints**.

⋆ This interaction **flips the Mirror Principle** on its head:

- Cyclic concatenation: morphemes "compete" for closeness to the **root**:
  – Competition is resolved via **sequential application, tied to the structure (bottom to top)**.

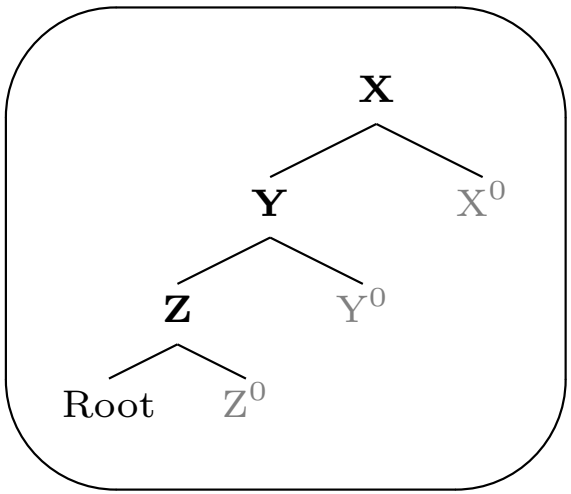
- Articulated alignment: morphemes compete for closeness to a **word edge**:
  → Competition is resolved via **constraint interaction, tied to the structure (top to bottom)**.

The Mirror Alignment Principle

Structural Height

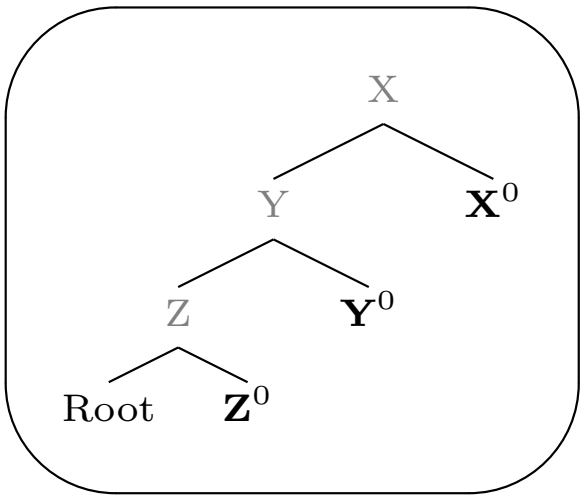
- There are (at least) two ways to characterize structural height in this scenario:

(57) Dominance



- X is higher than Y because the highest segment of X dominates the highest segment of Y and not vice versa.

(58) Asymmetric "c-command"



- X is higher than Y because the lowest segment of X is sister to the constituent containing the lowest segment of Y and not vice versa.

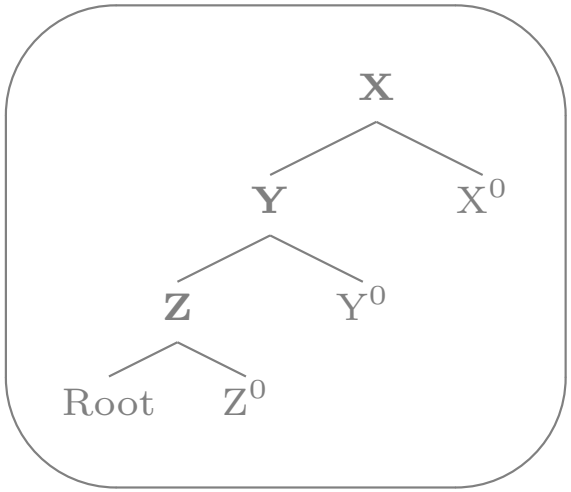
∗ It's not exactly the same asymmetric c-command that's relevant for syntactic computation, because that definition includes a non-dominance condition (cf., e.g., Kayne 1994).

The Mirror Alignment Principle

Structural Height: Asymmetric C-Command

- There are (at least) two ways to characterize structural height in this scenario:

(57) Dominance



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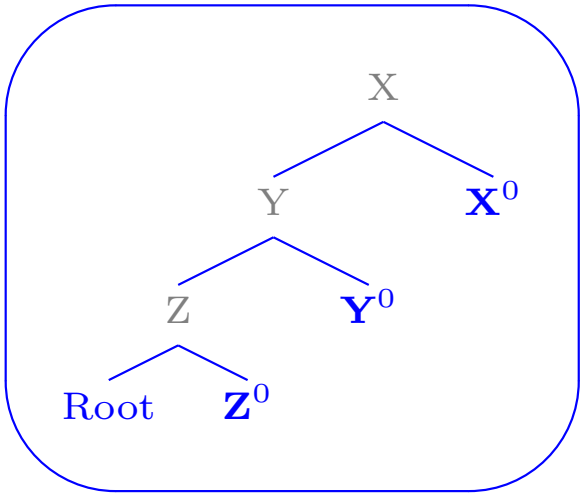
(58) Asymmetric "c-command"



- X is higher than Y because the lowest segment of X is sister to the constituent containing the lowest segment of Y and not vice versa.

⋆ **Claim:** It needs to be **asymmetric "c-command"**.

The Mirror Alignment Principle

The Mirror Alignment Principle

(56) **The higher the head is in the structure, the higher its alignment constraint is in the ranking.**

⋆ Asymmetric c-command can capture the generalization in (56).

→ I formalize this as the **"Mirror Alignment Principle":**

(59) **The Mirror Alignment Principle [MAP]** (Zukoff 2023b *NLLT*)
If a terminal node α ASYMMETRICALLY "C-COMMANDS" a terminal node β, then the alignment constraint referencing α DOMINATES the alignment constraint referencing β.

The Mirror Alignment Principle

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Shorthand

If α c-commands β → ALIGN-α ≫ ALIGN-β

The Mirror Alignment Principle

The Mirror Alignment Principle and Linearization

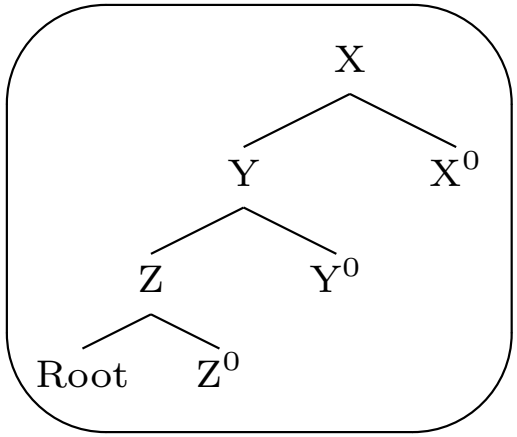
⋆ **Proposal:** The MAP is a **causal link** between morphosyntax and phonology.

- Under this approach:
  - Ordering *preferences* are **determined** by morphosyntactic structure.
  - These preferences are **transmitted** to the phonological component as a *ranking of alignment constraints*.
  - Ordering is **implemented** via articulated alignment in the phonological component.

The Mirror Alignment Principle

Architecture

Morphosyntax



⇓

Interface

MAP ranking: ALIGN-X-R ≫ ALIGN-Y-R ≫ ALIGN-Z-R

⇓

Phonology

/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		*	**

The Mirror Alignment Principle

The MAP Delivers

⋆ **Theoretical deliverables:**

1. Derive the Mirror Principle for concatenative morphology. ✓
2. Parsimoniously and insightfully analyze nonconcatenative morphology, including its **phonological properties**. ✓ **(Huave)**

- What I will show next is that it also delivers on the third:

3. **Reason about nonconcatenative morphology with respect to the Mirror Principle.**

Roadmap

1. **Introduction**
2. **Alignment Constraints**
3. **Mobile Affixation in Huave**
4. **The Mirror Alignment Principle**
5. **Prefix/Infix Alternations in Arabic**
   - Explain a thoroughgoing prefix/infix alternation by probing the dynamic interaction between the MAP, morphosyntactic structure, and articulated alignment.
   - ∗ Revisit Huave from the perspective of the MAP.
6. **Conclusions and Extensions**

Prefix/Infix Alternations in Arabic

Background: Arabic Root-and-Pattern Morphology

- The Arabic verbal system is divided into "Forms":
  - Morphosyntactic categories built around consonantal roots.
  - – A particular phonological shape: CV "template" (cf. McCarthy 1979, 1981).
  - – A range of morphosemantics, often highly idiomatized.

⋆ **Focus:** the relative order of the **Form morphemes** and the **Root**.

(60) Arabic verbal system (3SG.M of root √ktb 'write'; adapted from McCarthy 1981:385)

Form	Pf. Act. /a/	Pf. Pass /ui/	Impf. Act. /var./	Impf. Pass. /ua/
I	katab-a	kutib-a	y-aktub-u	y-uktab-u
II	kat$_C$tab-a	kut$_C$tib-a	y-ukat$_C$tib-u	y-ukat$_C$tab-u
III	kaa$_V$tab-a	kuu$_V$tib-a	y-ukaa$_V$tib-u	y-ukaa$_V$tab-u
IV	ʔaktab-a	ʔuktib-a	y-u(ʔa)ktib-u	y-u(ʔa)ktab-u
V	takat$_C$tab-a	tukut$_C$tib-a	y-atakat$_C$tab-u	y-utakat$_C$tab-u
VI	takaa$_V$tab-a	tukuu$_V$tib-a	y-atakaa$_V$tab-u	y-utakaa$_V$tab-u
VII	nkatab-a	nkutib-a	y-ankatib-u	y-unkatab-u
VIII	ktatab-a	ktutib-a	y-aktatib-u	y-uktatab-u
X	staktab-a	stuktib-a	y-astaktib-u	y-ustaktab-u

Prefix/Infix Alternations in Arabic

Morphological Analysis of the Form Morphemes

(61) Form morphemes

Syntactic Heads		**Exponents**		**Forms**
Reflexive		/t/		V, VI, VIII, X
Applicative		/μ_v/		III, VI
Middle		/n/		VII
v		/$\emptyset$/		I, IV, VII, X
Causative	i.	/μ_c/	(sister to Root)	II, V
	ii.	/ʔ/	(sister to v)	IV
	iii.	/s/	(sister to Refl)	X

⋆ I assume that these are all "**flavors of v**" (Folli & Harley 2005), i.e. verbal categorizing heads.

Prefix/Infix Alternations in Arabic

Reflexive

- Within this system, Reflexive /t/ recurs across multiple Forms:
  - Sometimes as an infix (62a)
  - Sometimes as a prefix (62b)

(62) Forms with Reflexive /t/ (√*ktb* 'write'; data from McCarthy 1981:384)

Position	**Form**	**Proposed morphosyntax**	**Example**	**Translation**
a. *Infixal*	VIII	Reflexive	*ktataba*	'write, be registered'
b. *Prefixal*	V	Reflexive of Causative	*takattaba*	(*constructed form*)
	VI	Reflexive of Applicative	*takaataba*	'write to each other'
	X	Causative of Reflexive	*staktaba*	'write, make write'

Prefix/Infix Alternations in Arabic

An Alignment Paradox

- An alignment-based analysis leads to **a ranking paradox** (63).

(Tucker 2010a,b, 2011; cf. Ussishkin 2003)

(63) a. Infixal Form (VIII): ALIGN-ROOT-L ≫ ALIGN-REFLEXIVE-L
b. Prefixal Forms (V,VI,X): ALIGN-REFLEXIVE-L ≫ ALIGN-ROOT-L

(64) Infixal order: Form VIII Reflexive ***kt****ataba* [= (63a)]

/t, **k**tb, a, a/	ALIGN-ROOT-L	ALIGN-REFL-L
a. t**k**taba	*!*	
b. ☞ **kt**ataba		*

(65) Prefixal order: Form V Reflexive of Causative ***t****a****k****a****t*$_c$*taba* [= (63b)]

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

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

Prefix/Infix Alternations in Arabic

Resolving the Paradox with Syntactic Structure

(66) Morphosyntactic generalization about Reflexive /t/

a. When Refl scopes over another v morpheme (e.g. Caus or Appl), its exponent is *prefixal* (62b).

b. When Refl is the only v morpheme, its exponent is *infixal* (62a).

(62) Forms with Reflexive /t/ ($\sqrt{ktb}$ 'write'; data from McCarthy 1981:384)

	Position	**Form**	**Proposed morphosyntax**	**Example**	**Translation**
a.	*Infixal*	VIII	Reflexive	*k**t**ataba*	'write, be registered'
b.	*Prefixal*	V	Reflexive of Causative	*t**a**k**a**t$_c$taba*	(*constructed form*)
		VI	Reflexive of Applicative	*t**a**k**a**a$_v$taba*	'write to each other'
		X	Causative of Reflexive	*st**a**k**t**aba*	'write, make write'

∗ In order for this to be an accurate generalization, it must be the case that there is a null v below Reflexive in Form X. There is independent evidence to suggest that this is reasonable, which will be discussed below.

Prefix/Infix Alternations in Arabic

Resolving the Paradox with the MAP

- Consistent structural differences ⇒ **MAP can produce an explanation**.

Prefix/Infix Alternations in Arabic

Resolving the Paradox with the MAP

- Consistent structural differences ⇒ **MAP can produce an explanation**.

Mirror Alignment Principle (shorthand)

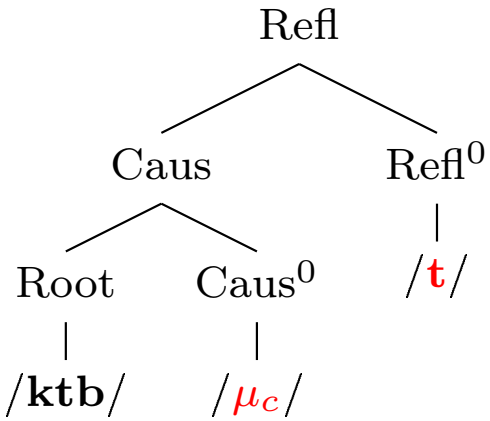
If α c-commands β → Align-α ≫ Align-β

Prefix/Infix Alternations in Arabic

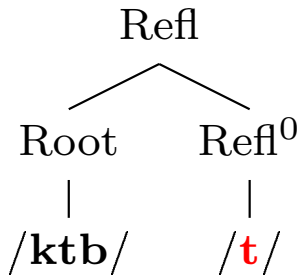
Reflexive Structures and the MAP

- Compare Form V (reflexive of causative) and Form VIII (simple reflexive):

(67) Form V *t**a**k**a**t$_c$**t**aba*



(68) Form VIII *k**t**ataba*



- Form V: **asymmetric** c-command $\xrightarrow{\text{MAP}}$ ALIGN-REFL-L $\gg$ ALIGN-ROOT-L (69b)
- Form VIII: **symmetric** c-command $\longrightarrow$ no MAP ranking (69a)

  $\hookrightarrow$ *Remember: the MAP only kicks in when there is asymmetric c-command*

(69) MAP-governed rankings with Reflexive

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

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

Prefix/Infix Alternations in Arabic

So then what?

(69) MAP-governed rankings with Reflexive

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

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

⋆ How do we derive the ranking ALIGN-ROOT-L $\gg$ ALIGN-REFLEXIVE-L for the infixal cases?

Prefix/Infix Alternations in Arabic

Root-alignment

(70) **Root-alignment generalization:** The Root's left edge always surfaces further to the left than the first head which adjoins to it.

(71) Forms exemplifying the root-alignment generalization

Root and Reflexive (/t/):	a.	Form VIII	***k*t*ataba***	Refl Root Refl
Root and Causative (/μ_c/):	b.	Form II	***ka*t$_c$*taba***	Caus Root Caus
	c.	Form V	*ta**k**a*t$_c$*taba*	
Root and Applicative (/μ_v/):	d.	Form III	***ka*a$_v$*taba***	Appl Root Appl
	e.	Form VI	*ta**k**a*a$_v$*taba*	

- These are exactly the cases where asymmetric c-command is absent.
  - ⋆ Since we've defined the MAP using asymmetric c-command (and not *dominance*), the **MAP does not provide a ranking.**

Prefix/Infix Alternations in Arabic

Resolving the Paradox

- **Assumption:** A default ranking takes over when the MAP is moot:

(72) **Language-specific(?) default ranking for Arabic**
ALIGN-ROOT-L ≫ all the other alignment constraints

⋆ **This fixes the ranking in (73a):**

(73) 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

Prefix/Infix Alternations in Arabic

Interim Conclusions

- We have found an explanation for the apparent paradox:
  - ⋆ **The dynamic interaction of the MAP and Arabic's default ranking as mediated by the morphosyntactic structure**

- There are consistently two types of interactions:

---

(74) **α asymmetrically c-commands Root** (it's *not* the first head to attach)

↪ **MAP:** Align-α ≫ Align-Root ⇒ **Default Ranking has no effect**

⋆ This explains the prefixal cases.

---

(75) **β doesn't asymmetrically c-command Root** (it *is* the first head to attach)

↪ **MAP is moot** ⇒ **Default Ranking:** Align-Root ≫Align-β

⋆ This explains the infixal cases.

Prefix/Infix Alternations in Arabic

Drawing Predictions from the MAP

→ This interaction works across **the entire Form system**.

- First head is infixal
- Higher heads are prefixal

⋆ Because the MAP directly connects surface ordering properties to morpho-syntactic structure, ordering distinctions make **predictions about morpho-syntactic structure**.

- **Next:** The **ordering properties** of the Causative shed light on the **(morpho)syntax and (morpho)semantics**.

Prefix/Infix Alternations in Arabic

Ordering in Causatives

- Two basic types of morphological causatives (cf. Wright 1896:31–36, Ryding 2005:491, 515, Arbaoui 2010a,b, *a.o.*) with **distinct ordering properties**:

(76) **Form II:** exponed by infixal /μ_c/
e.g. $\sqrt{\text{ʕlm}}$ 'know' → ʕa**l**$_c$*lama* 'teach'

(77) **Form IV:** exponed by prefixal /ʔ/
e.g. $\sqrt{\text{ʕlm}}$ 'know' → **ʔ***a*ʕ*lama* 'inform'

- This is another prefix/infix alternation:
  - Infixal in Form II ⇒ Caus must be the **first head** to combine w/ Root.
  - Prefixal in Form IV ⇒ Caus must be **higher** than the first head.

∗ We have to posit a null head ($v \Leftrightarrow$ /Ø/) btw. Caus and Root in Form IV.

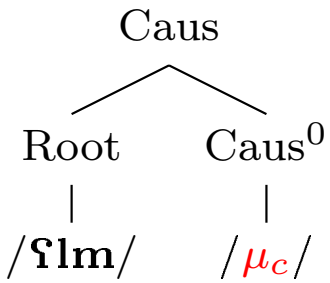
Prefix/Infix Alternations in Arabic

The MAP: Predictions about Morphosyntax

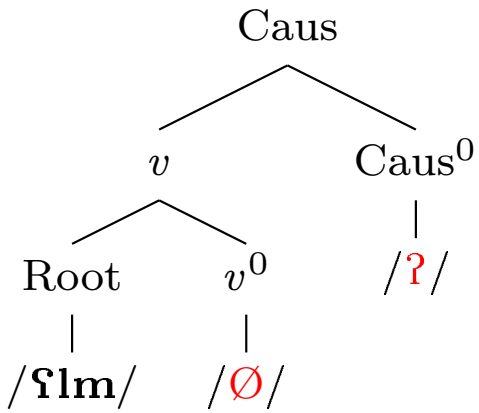
→ The MAP pushes us to **make a claim about the morphosyntax** of these categories:

- Form II is a Root-selecting causative (78)
- Form IV is a vP-selecting causative (79)

(78) Form II ʕa**l**$_c$*lama* 'teach'



(79) Form IV **ʔ**a**ʕ***lama* 'inform'

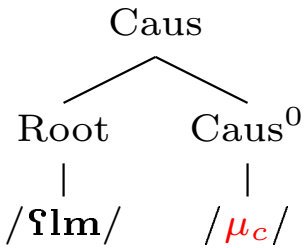


Prefix/Infix Alternations in Arabic

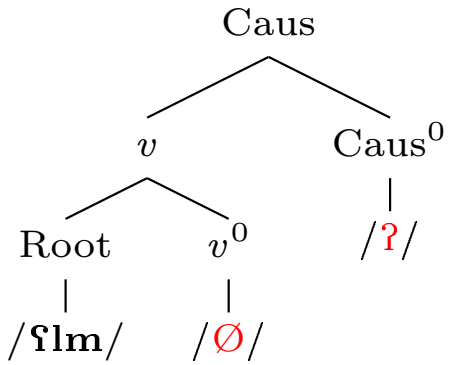
The MAP: Predictions about Morphosemantics

- If morphosyntactic locality is a prerequisite for idiomatic semantics (Marantz 1997, Arad 2003), this morphosyntactic distinction **makes a prediction about the semantics:**
  - → Idiomatic semantics with Form II (Caus and Root are local)
  - → Transparent semantics with Form IV (Caus and Root are not local)

(78) Form II ʕa*l*$_c$*lama* 'teach'



(79) Form IV ʔaʕlama 'inform'



⋆ **This prediction is borne out!** Consider the minimal pair in (78, 79):

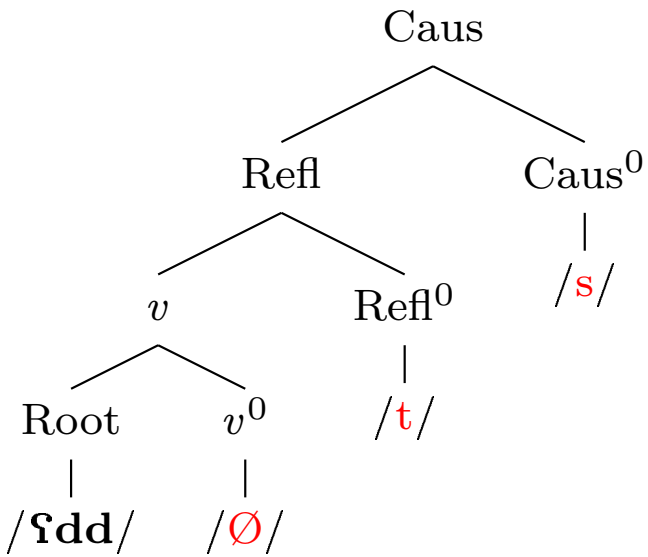
- Form II 'teach' (idiomatic) vs. Form IV 'inform' [≈ 'make know'] (transparent)
- Also generally true throughout the language (Wright 1896:31–36).

Prefix/Infix Alternations in Arabic

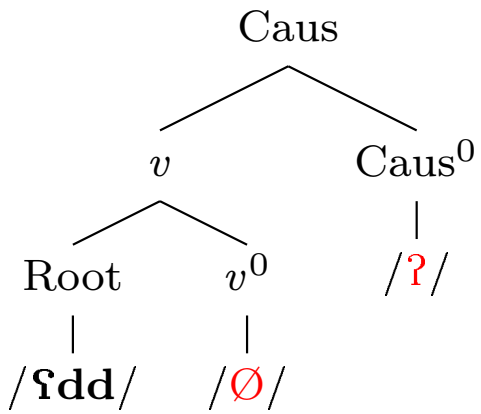
The MAP: Predictions about the Relationship between Forms

- The MAP also pushes us to posit a null v is in Form X (80):

(80) Form X ***st****aʕadda* 'prepare oneself'



(81) Form IV ***ʔ****aʕadda* 'prepare (s.t.)'



$\sqrt{}$*ʕdd* 'be ready(?)'

(data from Ryding 2005:516,584)

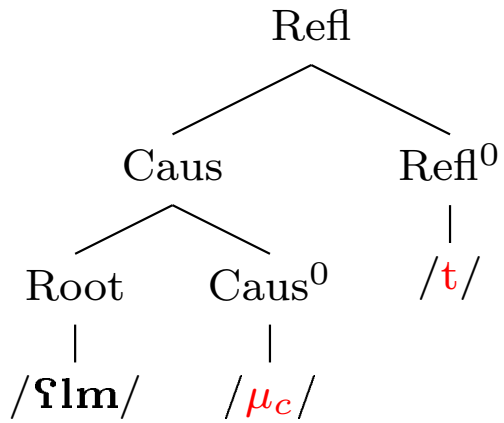
→ Form X often functions as the reflexive of Form IV (81) (Wright 1896:44, Ryding 2005:584), where we also must posit null v.

Prefix/Infix Alternations in Arabic

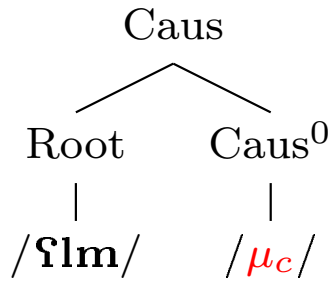
The MAP: Predictions about the Relationship between Forms

- Form V (82) is the reflexive of the Form II causative (78) (Wright 1896:36–37).

(82) Form V *t*a**ʕ**a*l*$_c$*lama* 'teach oneself'



(78) Form II **ʕ**a*l*$_c$*lama* 'teach'



(Fischer 2002:99, Ryding 2005:515)

→ In this case, it even retains the idiomatic semantics.

⋆ In both cases of combinations of reflexive and causative, the **ordering facts align with the structural facts and the semantics**.

Prefix/Infix Alternations in Arabic

The MAP: Causative Allomorphy

⋆ The MAP analysis also helps make sense of **Causative allomorphy:**

- There are 3 different allomorphs of Causative.
- MAP analysis requires 3 different structural configurations for Causative.

(83) a. CAUS ⇔ μ_C / _[Root] (Forms II,V)
b. CAUS ⇔ ʔ / _[v] (Form IV)
c. CAUS ⇔ s / _[Refl] (Form X)

→ We can interpret this entirely as structurally-conditioned allomorphy (Halle & Marantz 1993 et seq.).

Prefix/Infix Alternations in Arabic

Local Conclusions

The view from Arabic

- Articulated alignment + MAP delivers on our third theoretical requirement:

  3. **Can reason about nonconcatenative morphology with respect to the Mirror Principle.**

⋆ **Infixation** (a nonconcatenative process) reveals various properties of Arabic verbal morphosyntax, including:

- **Structural alternations** of Reflexive
- **Morphosemantic differences** between Causatives
- **Structure-conditioned allomorphy** of Causative

→ These are exactly the sorts of correlations and discoveries that the **Mirror Principle** is meant to reveal. **The MAP can do this even on nonconcatenative structures.**

Prefix/Infix Alternations in Arabic

The Morphophonology of Semitic Root-and-pattern Morphology

- The morphophonology of Semitic root-and-pattern morphology is well-trod ground:
  - Here's just a partial list: McCarthy (1979, 1981, 1993), Yip (1988), McCarthy & Prince (1990a,b), Guerssel & Lowenstamm (1991), Bat-El (1994, 2003, 2011), Golston (1996), LeTourneau (1997), Gafos (1998, 2018), Ussishkin (2000a,b, 2003, 2005), Lowenstamm (2005), Arbaoui (2010a,b), Tucker (2010a,b, 2011), Wallace (2013), Faust (2015, 2023), Kastner (2016, 2019, 2020, 2023), Kusmer (2019), Zukoff (2021a, 2023b)

- Many of these analyses have appealed to purpose-built, otherwise unmotivated machinery, like "prosodic templates" (McCarthy 1979, 1981; cf. Faust 2015).

⋆ The articulated alignment + MAP approach opens up an avenue for a **more complete morphophonological analysis** of Arabic root-and-pattern morphology than was previously possible.

Prefix/Infix Alternations in Arabic

Huave and Morphosyntactic Structure

* ***So what about the MAP in Huave?***

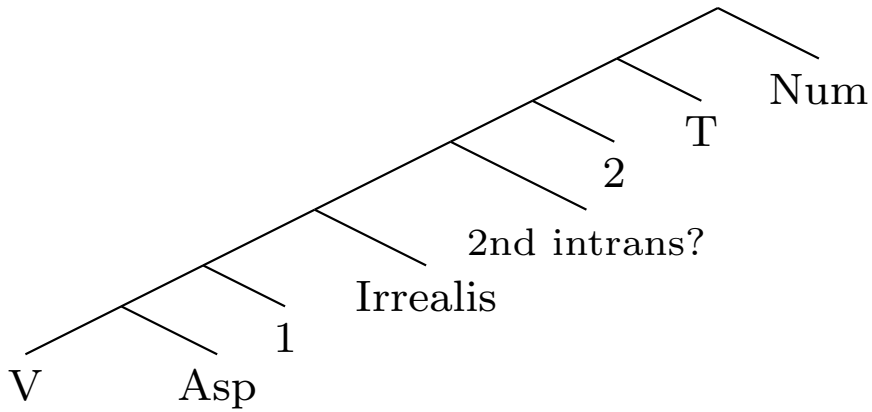
Prefix/Infix Alternations in Arabic

Huave and Morphosyntactic Structure

- We can (provisionally) **reverse-engineer the morphosyntax** (85) from the alignment ranking (84).

(84) Huave alignment ranking ⇔ (85) Reverse-engineered structure

ALIGN-PL-R
|
ALIGN-FUT-L
|
ALIGN-2-L
|
ALIGN-2INTRANS-R
|
ALIGN-IRR-R
|
ALIGN-1-R
|
ALIGN-ASP-R



∗ **Caveat:** This is only a hypothesis, because the MAP is not bidirectional (as we saw in Arabic).

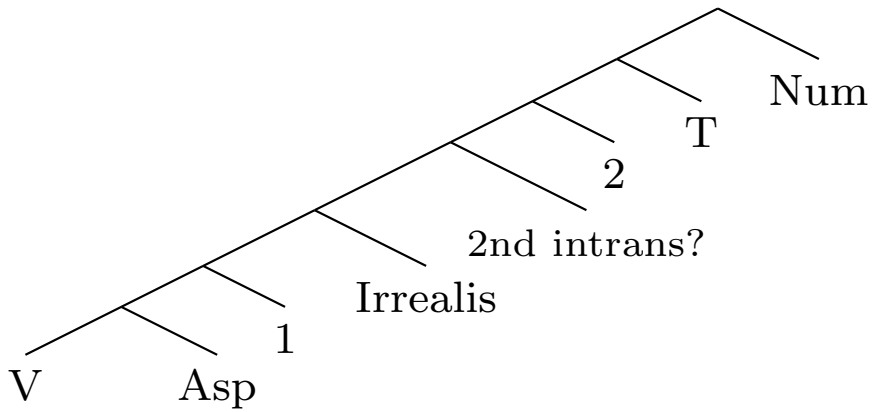
Prefix/Infix Alternations in Arabic

Huave and Morphosyntactic Structure

- We can (provisionally) **reverse-engineer the morphosyntax** (85) from the alignment ranking (84).

∗ See Koopman (2020) for very different conclusions about the morphosyntactic structure of this language.

(85) Reverse-engineered structure



⋆ **Take-away:**
Articulated alignment + MAP gives us the ability to make **falsifiable predictions about the morphosyntax** based on **phonological *analysis***.

Roadmap

1. Introduction
2. Alignment Constraints
3. Mobile Affixation in Huave
4. The Mirror Alignment Principle
5. Prefix/Infix Alternations in Arabic
6. **Conclusions and Extensions**

Conclusions

Summary: Articulated Alignment

⋆ My theory of morpheme ordering centers on **articulated alignment:**

(86) **Morpheme-specific alignment constraints** (McCarthy & Prince 1993a)
Each morpheme is related to its own alignment constraint, which may be either left-oriented or right-oriented.

(87) **A single constraint ranking** (Prince & Smolensky [1993] 2004)
These alignment constraints are ranked with respect to each and with respect to phonological constraints in a single phonological grammar.
↪ **Ranking influenced dynamically by the MAP.**

(88) **Parallel evaluation** (Prince & Smolensky [1993] 2004)
Morpheme order is determined all at once (i.e., in parallel) according to evaluation of this constraint ranking.

Conclusions

Summary: The Mirror Alignment Principle

⋆ This theory derives the **Mirror Principle** (Baker 1985) by tying the alignment ranking to morphosyntactic structure via the **Mirror Alignment Principle** at the **phonology-morphology interface**.

(89) **The Mirror Alignment Principle [The MAP]** (Zukoff 2023b *NLLT*)
If a terminal node α ASYMMETRICALLY C-COMMANDS a terminal node β, then the alignment constraint referencing α DOMINATES the alignment constraint referencing β.

Conclusions

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If a terminal node α ASYMMETRICALLY C-COMMANDS a terminal node β, then the alignment constraint referencing α DOMINATES the alignment constraint referencing β.

Shorthand

If α c-commands β → ALIGN-α ≫ ALIGN-β

- It also can explain ranking inconsistencies (as in Arabic):

  → **Changes in morphosyntactic structure lead to changes in ranking**.

Conclusions

Results

1. Articulated alignment successfully analyzes **Huave mobile affixation**.
   → **Captures substantive generalizations** that are missed by cyclic concatenation + cophonologies.

2. **Arabic prefix/infix alternations** can be derived by tying the ranking of the articulated alignment constraints to morphosyntactic structure via the MAP.
   → Brings root-and-pattern morphology into the fold of **Mirror Principle reasoning**.

Conclusion

Theoretical Deliverables

⋆ **Theoretical deliverables:**

1. Derive the Mirror Principle for concatenative morphology. ✓
2. Parsimoniously and insightfully analyze nonconcatenative morphology, including its **phonological properties**. ✓
3. Reason about nonconcatenative morphology with respect to the Mirror Principle. ✓

Conclusions

The Phonology-Morphology Interface

⋆ **Claims about the phonology-morphology interface:**

(90) The morphological component does not do linearization.

- Phonology does.

(91) Phonology and morphology are not interleaved.

- The morphology transmits its information to the phonology just once.

(92) The phonological component is not serial or cyclic.

- It runs a single (parallel) input-output mapping.

(93) The phonological component has constraints that include morphological information:

- Alignment constraints that relate morphemes to word edges.
  - ∗ Lexically-indexed constraints (for deriving Arabic "templates")
  - ∗ Base-Derivative faithfulness constraints (for suffix doubling in Chichewa)

Conclusions

Extensions: Reduplication

- **Areas where this approach translates directly into similar results:**

1. **Reduplication:** Articulated alignment constraints act as "size restrictor" constraints (Spaelti 1997, Hendricks 1999, Riggle 2006, Zukoff 2017a) in partial reduplication, following Hendricks's (1999) compression model.

(94) Hendricks's compression model (exemplified for prefixes)

a. MAX-IO, ALIGN-AFFIX-L ≫ ALIGN-ROOT-L *no compression*
b. MAX-IO, ALIGN-RED-L ≫ ALIGN-ROOT-L *compression*
   ↪ Reduplicant will be as small as possible

→ The morpheme ordering process uniquely compresses reduplicative morphemes, because they aren't protected by input-output faithfulness (McCarthy & Prince 1995, 1999; Zukoff 2016, 2017a,c, 2020, 2023d).

Conclusions

Extensions: Infixation

- **Areas where this approach translates directly into similar results:**

2. **Infixation:** Articulated alignment (+ MAP) opens up new analytical possibilities for infixation.

   - Infix placement traditionally derived exclusively by interaction btw. alignment and purely phonological factors (McCarthy & Prince 1993a, Yu 2007).
     - Banner case: Tagalog *-um-* infixation (Schachter & Otanes 1972; McCarthy & Prince 1993a, Orgun & Sprouse 1999, Klein 2005, Zuraw 2007, *a.o.*)
   - This approach additionally recognizes *morphologically-driven* infixation, via interaction among articulated alignment constraints, à la Arabic.

     → Could explain **"non-optimizing"** cases of infixation, which otherwise argue against accounting for infixation in the phonology (cf. Yu 2003, 2007, Paster 2006, 2009, Kalin 2022).

Conclusions

Extensions: Templatic Morphology

- **Areas where this approach translates directly into similar results:**

3. **Morphological templates:** The interaction between MAP-based alignment and bigram morphotactic constraints (Ryan 2010) explains aspects of templatic morphology (Zukoff 2023b:§3):
   - "Asymmetric compositionality" and fixed ordering in the Bantu CARP template (Hyman 2003).

◦ Supplementing MAP with Base-Derivative Correspondence constraints (Benua 1997) can also account for (Zukoff 2023a,c):
   - Suffix doubling in Chichewa (Mchombo 2004; Hyman & Mchombo 1992, Hyman 2003)
   - Phonological opacity in Nyakyusa (Persohn 2017; Hyman 2000, Myler 2017)

Conclusions

Broader Conclusions

⋆ **These are exactly the domains that Baker couldn't comport with the Mirror Principle!** (Baker 1985:400–403)

- Articulated alignment + MAP brings these systems back into the Mirror Principle fold.

→ These morphological systems derive from **the same kinds of morpho-syntactic systems as concatenative languages.**

Conclusions

Lessons from the MAP

- **To sum up:**
  - This approach allows us to capture more generalizations in a number of domains.
  - It makes even stronger connections between phonology and morpho-syntax than in traditional cyclic approaches to morpheme order and the phonology-morphology interface.

Conclusions

Thank you!

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