Place and position are computationally different

Charlie O'Hara
charleso@usc.edu

USC University of Southern California

SCIL 2019
January 5, 2019

1. Overview

Voiceless stop inventories can be defined by interactions of **place of articulation** and **syllable position**.

SOFT TYPOLOGY: Patterns differ in relative attestation rates

In a survey of 77 languages (O'Hara 2017):

- patterns defined on just one scale are more common than that need both (27 vs. 7)
- Patterns defined just using syllable position are more common than those using place of articulation (27 vs 0)

Biases present in learning can explain typological skews. (Pater and Moreton 2012, Staubs 2014, Stanton 2016)

Pater and Moreton (2012) demonstrate that a bias exists in MaxEnt learners for **featurally simple patterns.**

- This predicts that **No-Final** and **No-Dorsal** should be well attested, but **No-Dorsal** is unattested.
- Implicational scales exist on both position and place, but prosodic and featural scales have been treated formally differently in constraints.

CLAIM: The difference between attestation of **No-Final** and **No-Dorsal** emerges from learning bias when the two dimensions are treated formally differently.

2. Markedness Hierarchies

Implicational hierarchies have been argued to exist for both position and place of articulation.

Syllable Position

Onset > Coda (Goldsmith 1990)

#C > C#

Place of articulation

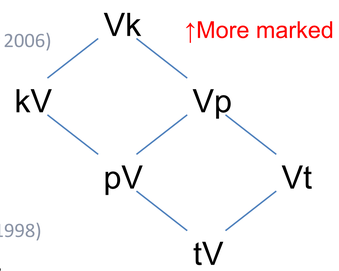
Coronal > Labial > Dorsal

t > p > k

(Lombardi 2001, de Lacy 2006)

- These hierarchies could be defined symmetrically: (Prince 1995, de Lacy 2006)
- Stringently defined markedness:

  *k, and *kp, but no *p
- Faithfulness to less marked structures.
  - **Positional Faithfulness** (Beckman 1998) Ident/Onset, but no Ident/Coda.



The scales are often represented asymmetrically however.

- Harmonic Alignment for prosodic features only. (Prince and Smolensky 1993, de Lacy 2006)
  - Stop/Onset > No Onset, but No Coda > Stop/Coda.
- Preservation of the marked on place scale, but not position: (de Lacy 2006)
  - **Marked-Faithfulness**: Marked places are more faithful than less marked, the opposite of positional faithfulness.
  - Ident-K, Ident-KP, but not Ident-P.

No-Final	*Coda	[pt]-Final	*[Dorsal&Coda]
tV pV kV	1 feature	tV pV kV	2 feature
~~Vt~~ ~~Vp~~ ~~Vk~~	**Common**	Vt Vp ~~Vk~~	*Rare*
All-Final	No restriction	**No-Dorsal**	*Dorsal
tV pV kV	0 features	tV pV ~~kV~~	1 feature
Vt Vp Vk	**Common**	Vt Vp ~~Vk~~	UNATTESTED

3. Learning Model

Generational MaxEnt-learner to uncover learning bias (Staubs 2014, Dowman et al 2006, Hughto 2018)

- Learners initialized with markedness constraints weighted high, faithfulness weighted low.
- Learner exposed to limited amount of training data
- Whatever grammar was learned is used for training the next generation for 20 generations
- The harder a pattern is to learn, the more likely the pattern changes across generations
- The stability of a pattern across 20 generations over 50 runs will be used as a metric of predicted attestation rate.
- Simulations were run using three different constraint sets, to identify the effect of constraints on predicted typology

Observed Results: **No-Final** > **No-Dorsal**

4. Simulations

Unbiased Model: (based on Pater and Moreton 2012)

- Every form violates specific (*k) and general (*kpt) constraints
- All specific constraints exist
- All candidates for each input have same initial probability.

RESULTS: All-Final>**No-Dorsal**>**No-Final** >[pt]-Final

Unbiased: *k, ****p, *t,*** *kpt, ***+k, +p, +t, +kpt***, NoCoda, ***+Coda, NoOnset***, Onset, Max, Ident

Symmetric Model

- Minimal set of markedness constraints to capture implication
- Specific Ident constraints protect unmarked segments on both dimensions.

***RESULTS*:** **No-Dorsal**>All-Final>[pt]-Final>**No-Final**

Symmetric: *k, *kp, *kpt, NoCoda, Max, Ident-KPT, **Ident-PT, Ident-T,** Ident/Ons

Asymmetric Model

- Including **Onset** and **Marked Faithfulness** constraints

RESULTS: **No-Final**>All-Final>[pt]-Final>**No-Dorsal**

Asymmetric: *k, *kp, *kpt, NoCoda, **Onset**, Max, Ident-KPT, **Ident-KP, Ident-K,** Ident/Ons

	No-Final	No-Dorsal	All-Final	[pt]-Final
Typological Skew	27	0	43	3
Unbiased Model	**80%**	**86%**	**94%**	*36%*
Symmetric Model	*0%*	**94%**	60%	*48%*
Asymmetric Model	**98%**	*32%*	**84%**	68%

5. Discussion

The structure of the constraint set can cause significant changes to the predicted soft typology.

- The learnability of a pattern is dependent on how long it takes to learn the last learned form of the pattern.
- A form's learning time is dependent on **Distance** and **Speed**.

Distance:

- Difference in harmony scores between the target from and a competing candidate
- Initially, mostly from difference on markedness constraints

Speed:

- How fast are the harmony scores expected to change.
- Markedness *and faithfulness* constraints contribute to speed
- Speed of forms depends on training pattern.

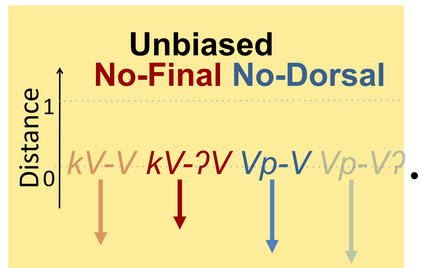
In all three conditions, initial [k] and final [p] have the same initial distance; and are the last learned forms.

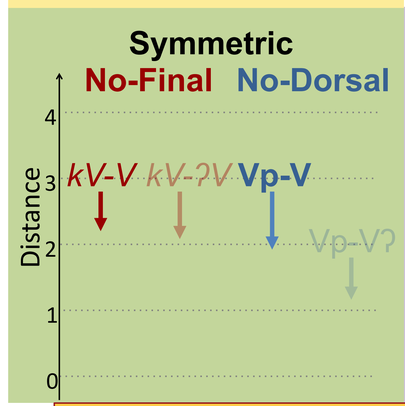
For **No-Final** to be more stable than **No-Dorsal**, initial [k] must have a higher speed in **No-Final** than final [p] has in **No-Dorsal**.

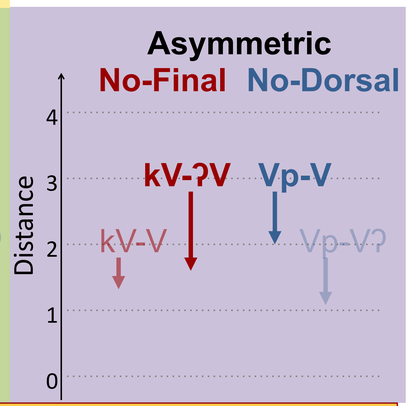
- In the unbiased model, **No-Final** and **No-Dorsal** are largely similar, capturing simplicity bias.
- (However, **No-Final** is slightly slower because debuccalization errors do not update general position constraints.)

The symmetric and asymmetric models differ in how the **No-Final** pattern is learned:

- The addition of Onset makes kV-V closer to 0, making debuccalization the preferred repair for initial stops, increasing the speed of the Ident family.
- The addition of specific Ident constraints further speeds the learning of initial kV-ʔV.







CONCLUSION:

Typological skew of positional place of articulation restrictions comes out of asymmetries in how place and position are encoded in the constraints.