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A Learning Theory for Abstract Underlying Phonemes

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1. Introduction

Introduction

Compton & Dresher (2011) propose that in some Inuit dialects there is evidence for a covert contrast between /i/ and /ə/ which is neutralized on the surface to [i].

Mayer, Major, & Yakup (2022) reject this sort of analysis in general, suggesting that the covert contrast is not learnable [*emphasis* added]:

> an underlying featural contrast is used to condition phonological behavior, despite corresponding to no observable phonetic differences *in the conditioning segments themselves* [...] These analyses therefore make strong claims [...] *that there is some learning mechanism* that leads to such a representation. Mayer, Major, & Yakup (2022)

Introduction

Mayer et al. are not the only phonologists who require ‘observable phonetic differences in the conditioning segments themselves’ to diagnose an underlying featural contrast.

In Esimbi (Tivoid), all vowels in roots are high ([i, ɨ, u]) on the surface; however, some roots take prefixes with [i, u], others with [e, o], and others with [ɛ, ɔ].

Archangeli & Pulleyblank (2015) reject the abstract analysis of Hyman (1988) in which root vowels of various heights all neutralize on the surface to high vowels [*emphasis* added]:

Introduction

> Assuming that a phonological difference in the roots is the source of the difference in prefix height requires that height distinctions be encoded in roots even though there is no surface evidence—*in the roots*—for the required distinction. Archangeli & Pulleyblank (2015)

Archangeli & Pulleyblank doubt that abstract underlying height contrasts can be learned because of an ‘opacity problem’.

Since the term ‘opacity’ was introduced by Kiparsky (1973), it has been assumed that opaque rules pose particular learnability problems.

Introduction

This assumption has led to attempts to constrain or completely do away with phonological opacity, or to prefer analyses that do not have it.

I will argue that the learnability problem has been misconceived: rule opacity does not pose a learning problem!

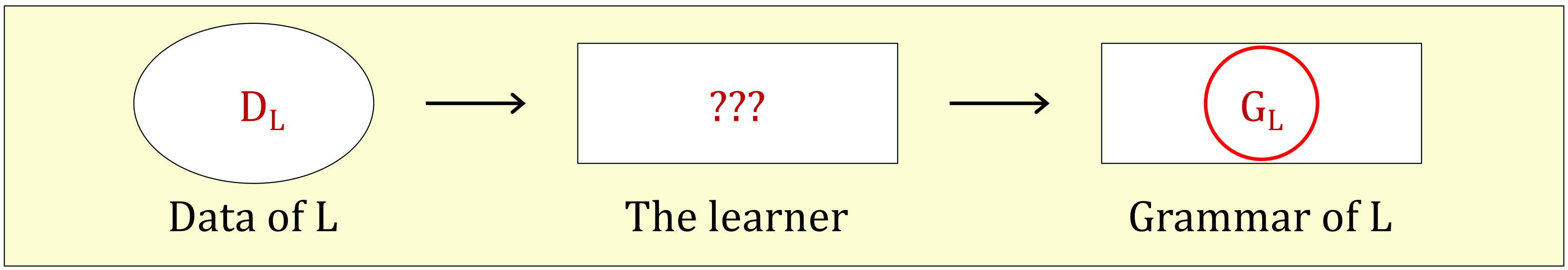
Rather, opacity is a solution within a particular theoretical framework for a learning problem that exists independently of that framework.

I will argue that there is indeed a learning mechanism that leads learners to posit abstract underlying representations and opaque rules.

2. The Learning Problem for Phonology

The learning problem for phonology

Before we get into opacity, I want to emphasize the obvious point that what is easy or hard to learn depends a lot on what learners bring to language acquisition.



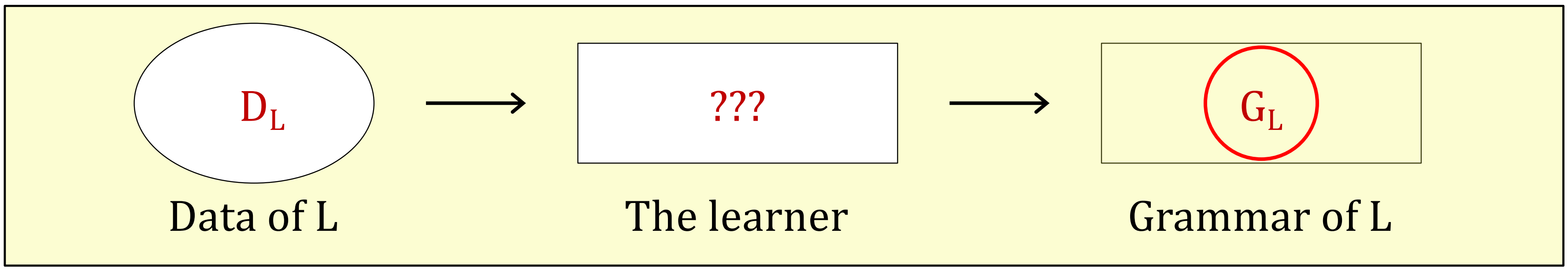
The diagram illustrates a learner born into a community that speaks a language, L, who is exposed to data D_L from L, and somehow arrives at a grammar of L, G_L.

A goal of generative grammar is to determine G_L for each L. A correct grammar of L achieves descriptive adequacy (the term used by Chomsky 1965).

The learning problem for phonology

What are these G_Ls like?

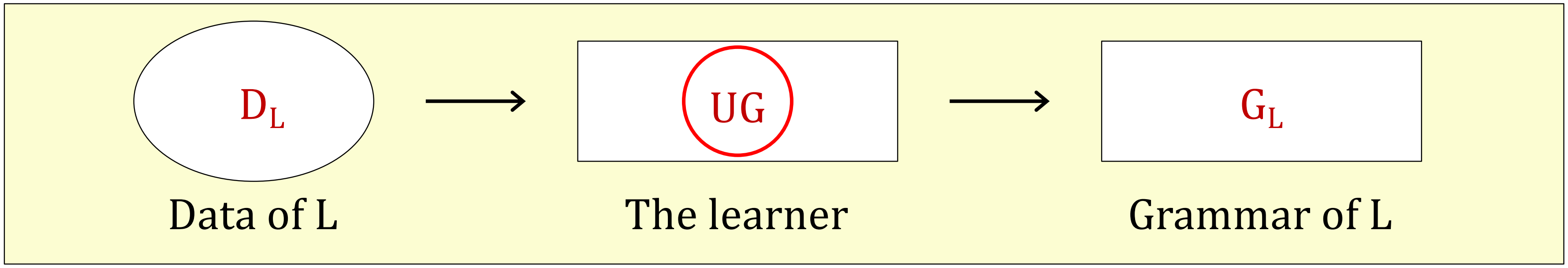
- Do they draw on a set of universal fully-specified features, or do they have language-particular contrastive features?



- Do they have features at all?
- Or do they have unary elements, or particles, or gestures?
- Ordered rules or parallel constraints?
- Unique representations or exemplar clouds?
- Are the grammars stochastic?
- How much phonetic detail is included in lexical representations?

The learning problem for phonology

These are all questions that phonologists argue about; but presumably these are not issues for learners.

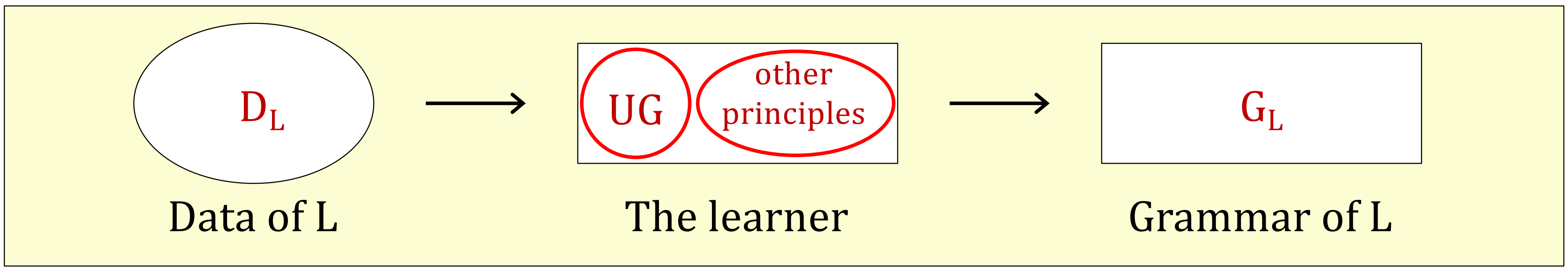


We assume that the basic form of each G_L is determined by the innate set of cognitive principles that learners are equipped with, which can convert D_L into G_L.

In generative grammar these principles have been called Universal Grammar (UG). In Chomsky's terms, a correct theory of UG achieves explanatory adequacy.

The learning problem for phonology

Some understand UG in a narrow sense to mean innate principles exclusive to the language faculty, which have to work together with other cognitive principles.



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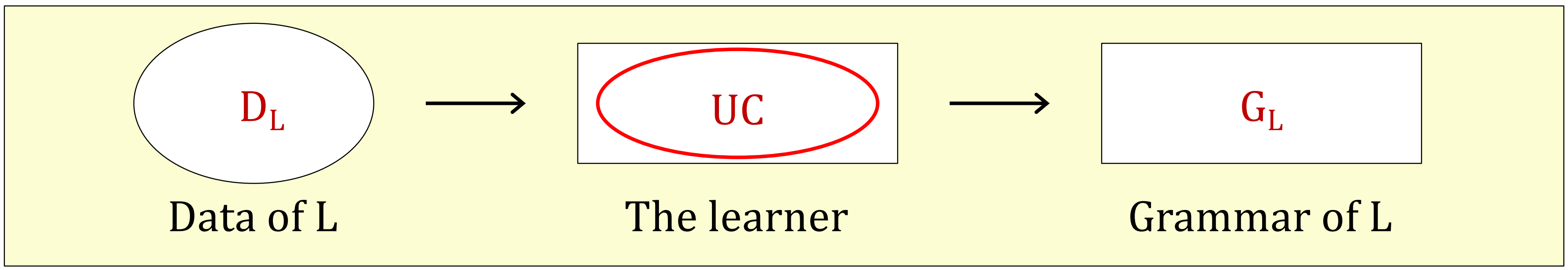
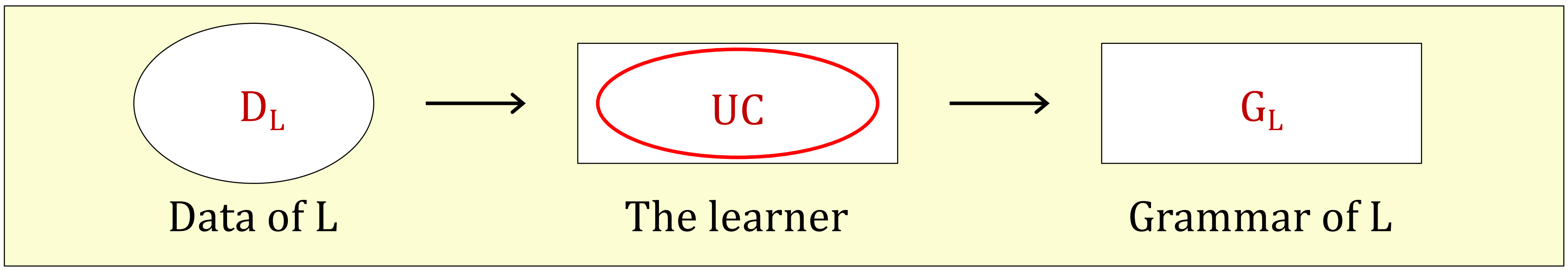


I am not concerned with this issue, so I will use UC to refer to the learner's innate cognitive endowment, whether exclusive to language or more general than that.

By definition, UC is the stuff that learners do not have to learn (for Bayesians, UC is the hypothesis space and the set of priors in the learning scenario).

The learning problem for phonology

Of course, as with UG, we linguists have to arrive at the correct theory of UC: Does it dictate features or elements, single representations or clouds, etc.?

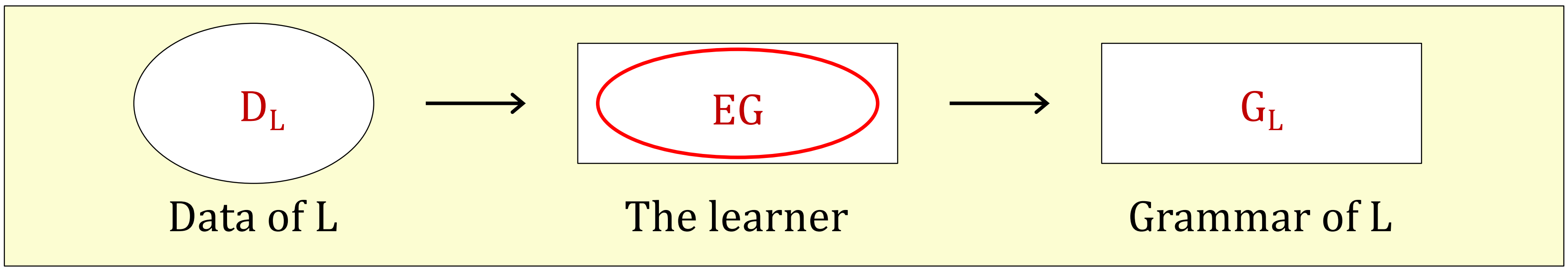


This is a classic poverty of the stimulus problem: the data D_L does not by itself tell the learner what the units of mental represention are.

Therefore, UC must be rich enough to bridge the gap between D_L and G_L.

The learning problem for phonology

Archangeli & Pulleyblank (2015) argue that infants do not learn grammar ‘due to an innate capability specific for language, the Universal Grammar hypothesis’.



They propose that language learners make use of basic cognitive principles not special to language, what they call the Emergent Grammar hypothesis (EG).

The basic principles of EG are the following:

Principles of EG (Archangeli & Pulleyblank 2015)

a. Ability to create categories
b. Ability to attend to frequency
c. Ability to generalize and create a symbolic system

That's it! Recall that these principles have to determine what grammars are like :

Principles (a)–(c) are consistent with any conceivable grammar.

They cannot guide the learner to any particular G_L, whatever it is.

This is not a serious proposal!

- Are features universal and fully-specified, or language-particular and contrastive?
- Do languages have features at all?
- Or do they have unary elements, or particles, or gestures?
- Ordered rules or parallel constraints?
- Unique representations or exemplar clouds?
- Are the grammars stochastic?
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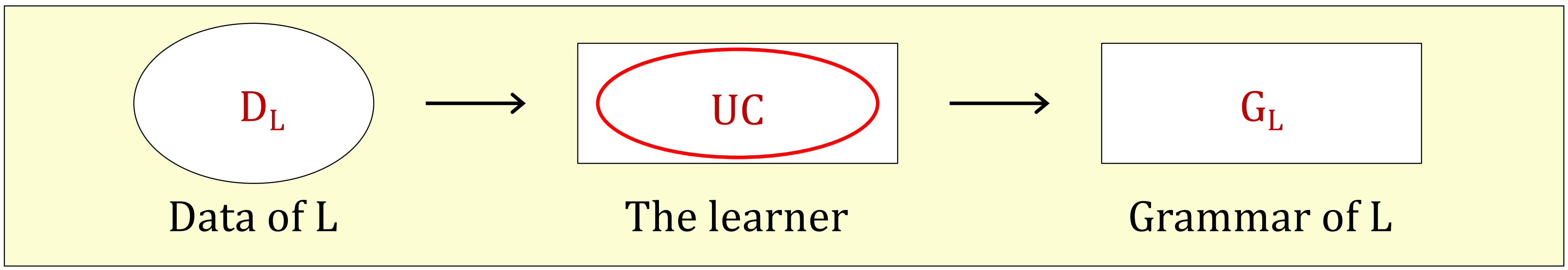
The learning problem for phonology

Whatever the exact nature of the phonological grammar, solving the poverty of the stimulus requires a contentful theory of UC.



Let's now turn to an actual case.

3. Abstract /ə/ in Inuit Dialects

‘Strong *i*’ and ‘weak *i*’ in Inuit dialects

Many Inuit dialects make a distinction between ‘strong i’, which causes palatalization (or assibilation) of some consonants, and ‘weak i’, which doesn’t.

For example, in Barrow North Slope Iñupiaq (Inuit; Kaplan 1981), the suffixes -lu (‘and a N’), -nik (‘N.OBL.PL’), and -tun (‘like a N’) follow a stem whose last vowel is u.

(1)	Stem	Gloss	‘and a N’	‘N-OBL.PL’	‘like a N’
a.	iɣlu	‘house’	iɣlu-lu	iɣlu-nik	iɣlu-tun

‘Strong *i*’ and ‘weak *i*’ in Inuit dialects

These suffixes all begin with an alveolar consonant which is palatalized after some i, as shown in (b). This i is called ‘strong i’ in the literature.

l becomes ʎ, n becomes ɲ, and t becomes s (the usual Inuit palatalization of t).

After other i (‘weak i’) in (c), there is no palatalization, and the suffixes appear as they do after u (and also after a, not shown here).

(1)	Stem	Gloss	‘and a N’	‘N-OBL.PL’	‘like a N’
a.	iɣlu	‘house’	iɣlu-lu	iɣlu-nik	iɣlu-tun
b.	iki	‘wound’	iki-ʎu	iki-ɲik	iki-sun
c.	ini	‘place’	ini-lu	ini-nik	ini-tun

‘Strong *i*’ and ‘weak *i*’ in Inuit dialects

Following Kaplan (1981), Compton & Dresher (2011) propose that weak i derives from an underlying vowel that is distinct from strong i.

Whereas strong i is underlyingly /i/, weak i derives from underlying /ə/.

(1)	Stem	Gloss	‘and a N’	‘N-OBL.PL’	‘like a N’
a.	iɣlu	‘house’	iɣlu-lu	iɣlu-nik	iɣlu-tun
b.	iki	‘wound’	iki-ʎu	iki-ɲik	iki-sun
c.	ini	‘place’	ini-lu	ini-nik	ini-tun

‘Strong *i*’ and ‘weak *i*’ in Inuit dialects

This abstract analysis reflects the historical derivation of strong and weak i from Proto-Eskimo as reconstructed by Fortescue, Jacobson, & Kaplan (1994).

Of course, child learners of modern Inuit dialects have no access to the Proto-Eskimo origins of these words.

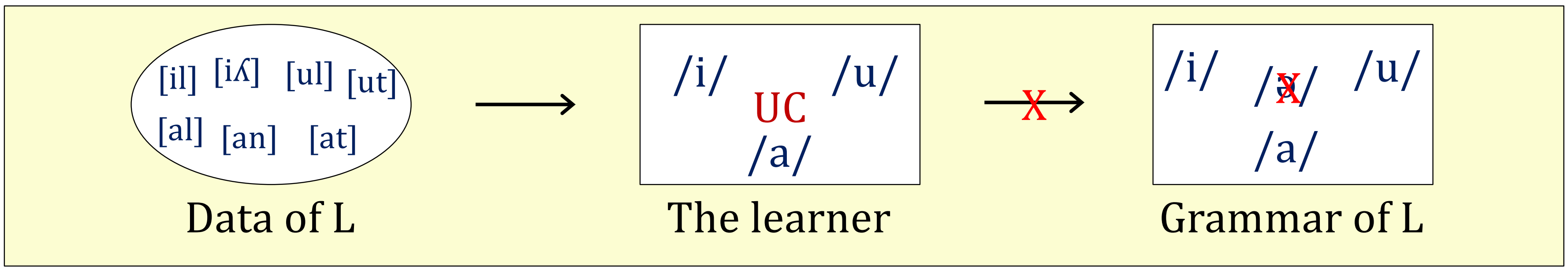
The abstract analysis is not motivated by Proto-Eskimo, but by the synchronic data that learners have access to.

(1)	Stem	Gloss	‘and a N’	‘N-OBL.PL’	‘like a N’	Proto-Eskimo
a.	iɣlu	‘house’	iɣlu-lu	iɣlu-nik	iɣlu-tun	*əŋlu
b.	iki	‘wound’	iki-ʎu	iki-ɲik	iki-sun	*əki
c.	ini	‘place’	ini-lu	ini-nik	ini-tun	*ənə

4. A Learning Theory for Abstract Phonemes

A learning theory for phonology: Some assumptions

How hard is it to learn an underlying phoneme that never exists as such at the phonetic surface? In our case, to acquire an underlying /ə/ in Inuit dialects?



It depends on the contents of UC. If UC limits the learner to underlying representations that exist at the surface, then there is no path to acquiring /ə/ in Inuit.

A learning theory for phonology: Some assumptions

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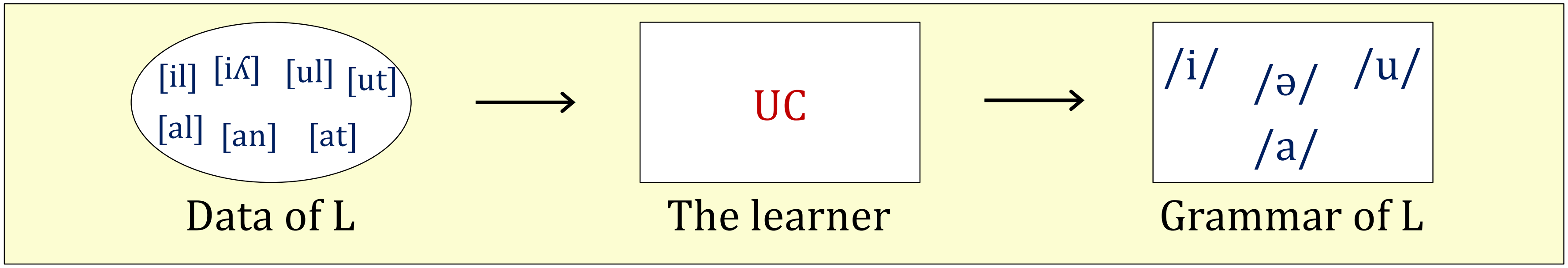
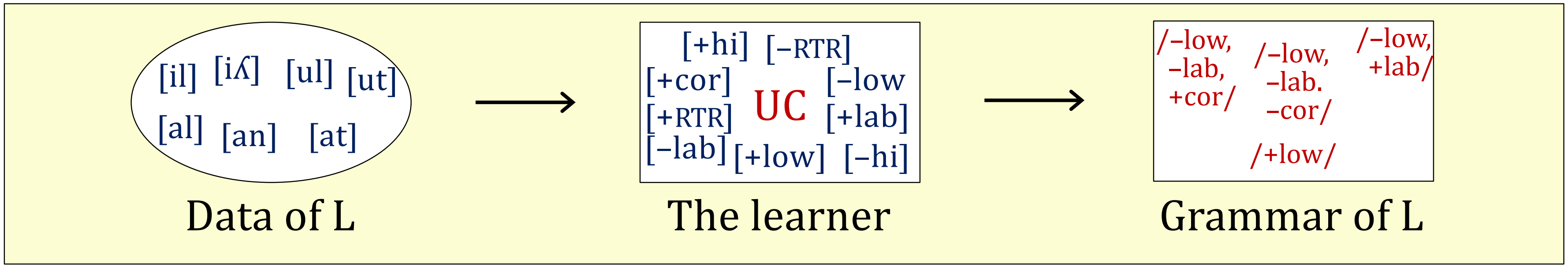


It depends on the contents of UC. If UC limits the learner to underlying represent-ations that exist at the surface, then there is no path to acquiring /ə/ in Inuit.

But I know of no evidence for this limitation, which would perhaps have some rationale if UC treated phonemes as undecomposable primes.

A learning theory for phonology: Some assumptions

Most theories of phonology, however, assume that phonemes and segments are composed of smaller units, i.e., features or elements of some kind.



If so, then it is these primes that are the material of phonological computation, not unanalyzed segments.

I will argue that this kind of computation can easily lead to abstract phonemes.

A learning theory for phonology: Some basic assumptions

I make the following basic assumptions, which are standard in most theories of phonology:

- Learners analyze segments into features.
- Interactions between segments involve features.
- Learners have access to the morphological make-up and paradigmatic membership of lexical items.
- Learners attempt to arrive at a single underlying form for each lexical item.
- Where possible, rules and representations formulated in phonological terms are preferred to those that mention non-phonological terms (e.g., diacritics or morphosyntactic terms).

Some further assumptions about features

There are various views as to the nature of the features or elements that constitute segments. For concreteness, I will assume the following:

- Features are binary and language particular.
- Each feature has a marked and an unmarked value, determined on a language-specific basis (Rice 2003, 2007, building on Trubetzkoy 1939).
- On a language-specific basis, either both values of a feature may be active, or marked values may be more active than unmarked values, which can serve as defaults and may be more or less inert.

An assumption about rules

Dresher (1981) suggests that 'the most common phonetic rules involve the assimilation of one feature to a feature in its environment'.

I proposed that a rule of the general form in (2) is a highly-valued rule that learners would be drawn to construct:

(2) Template for a highly-valued rule

$$\begin{bmatrix} \beta G \\ \gamma H \\ . \\ . \\ \varphi P \end{bmatrix} \longrightarrow [\alpha F] \;/\; \begin{array}{l} \_\_\_\_ X\ [\alpha F] \\ \\ [\alpha F]\ X \_\_\_\_ \end{array}$$

If a segment S = [βG, γH, ... φP] takes on a feature [αF] in the presence of another segment T, i.e.

$S \rightarrow [\alpha F] / \_\_\_\_ T$ *or* $S \rightarrow [\alpha F] / T \_\_\_\_$

the learner will suppose that T also bears [αF].

An assumption about rules

A similar constraint has recently been proposed by Danesi (2022) under the name of the No Ex Nihilo Hypothesis (3).

(2) Template for a highly-valued rule

$$\begin{bmatrix} \beta G \\ \gamma H \\ . \\ . \\ \varphi P \end{bmatrix} \longrightarrow [\alpha F] \;/\; \begin{matrix} \_\_\_\_ X\ [\alpha F] \\ \\ [\alpha F]\ X \_\_\_\_ \end{matrix}$$

(3) No Ex Nihilo Hypothesis (Danesi 2022: 192)

Phonological computation cannot manipulate primes that are absent from the representation of the target and the trigger.

A learning theory for weak *i*

Returning to the question of strong and weak i in Inuit dialects, it is clear in (1b) that stem-final i is what causes palatalization of the suffix-initial consonants.

It is not so obvious what the palatalizing feature is; for now, let's call it [P].

(1)	Stem	Gloss	'and a N'	'N-OBL.PL'	'like a N'
a.	iɣlu	'house'	iɣlu-lu	iɣlu-nik	iɣlu-tun
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By our assumptions, the learner posits that i and the palatalized consonants carry this feature, and that stem-final u does not.

(1)	Stem	Gloss	'and a N'	'N-OBL.PL'	'like a N'
a.	iɣlu	'house'	iɣlu-lu	iɣlu-nik	iɣlu-tun
b.	$iki_{[P]}$	'wound'	$iki_{[P]}$-$ʎ_{[P]}$ u	$iki_{[P]}$-$ɲ_{[P]}$ik	$iki_{[P]}$-$s_{[P]}$un

A learning theory for weak *i*

But (1c) presents conflicting signals: stem-final i is phonetically the same as i in (1b), hence [P]; but the suffixes that follow it suggest that it is not [P].

The learning theory tells the learner how to resolve this conflict.

In classical generative phonology, the resolution occurs via a derivation: stem-final i in (1c) has [P] at the surface but lacks it underlyingly.

(1)	Stem	Gloss	'and a N'	'N-OBL.PL'	'like a N'
a.	iɣlu	'house'	iɣlu-lu	iɣlu-nik	iɣlu-tun
b.	iki$_{[P]}$	'wound'	iki$_{[P]}$-ʎ$_{[P]}$ u	iki$_{[P]}$-ɲ$_{[P]}$ik	iki$_{[P]}$-s$_{[P]}$un
c.	ini$_{[P]}$	'place'	ini$_{[P]}$-lu	ini$_{[P]}$-nik	ini$_{[P]}$-tun

5. Assigning Features to Abstract Phonemes

A learning theory for phonological features

So how does a learner assign features to weak i? The same way that features are assigned to every other phoneme.

Compton & Dresher's analysis is couched in terms of Contrastive Hierarchy Theory (CHT), whose main tenets are shown in (4):

(4) a. The Successive Division Algorithm (SDA; Dresher 1998, 2003, 2009): Contrastive features are assigned by successively dividing the inventory until every phoneme has been distinguished.

b. Variability of feature ordering: Features and feature ordering are language particular and thus can vary over space and time.

c. The Contrastivist Hypothesis (Hall 2007): The phonological component of a language L operates only on the contrastive features derived by the SDA.

A learning theory for phonological features

Since the ordering of features is language particular, learners need a way to determine which features are contrastive and how they are ordered.

According to the Contrastivist Hypothesis, only contrastive features can be active; therefore, by hypothesis, a feature that is found to be active must be contrastive.

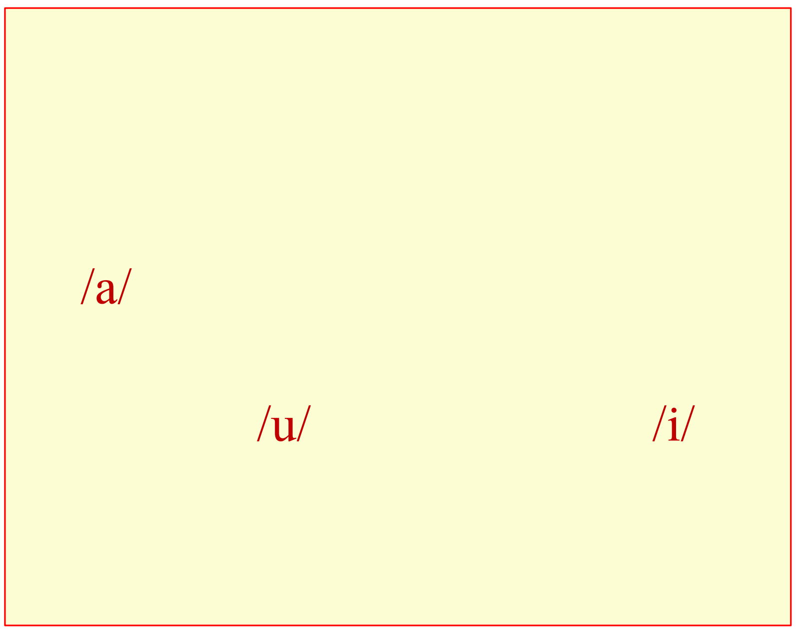
In CHT, then, an important source of evidence for learners is phonological activity, which can be defined as in (5):

(5) Phonological activity (adapted from Clements 2001: 77): A feature can be said to be active if it plays a role in the phonological computation; that is, if it is required for the expression of phonological regularities in a language, including both static phonotactic patterns and patterns of alternation.

Inuit-Yupik contrastive hierarchy (Compton and Dresher 2011)

There are Inuit dialects which have 3 underlying vowels, /i, a, u/.

(6) Three-vowel Dialects



These dialects have completely lost any contrast between P-E *i and *ə.

Interestingly, none of these dialects have palatalization after /i/.

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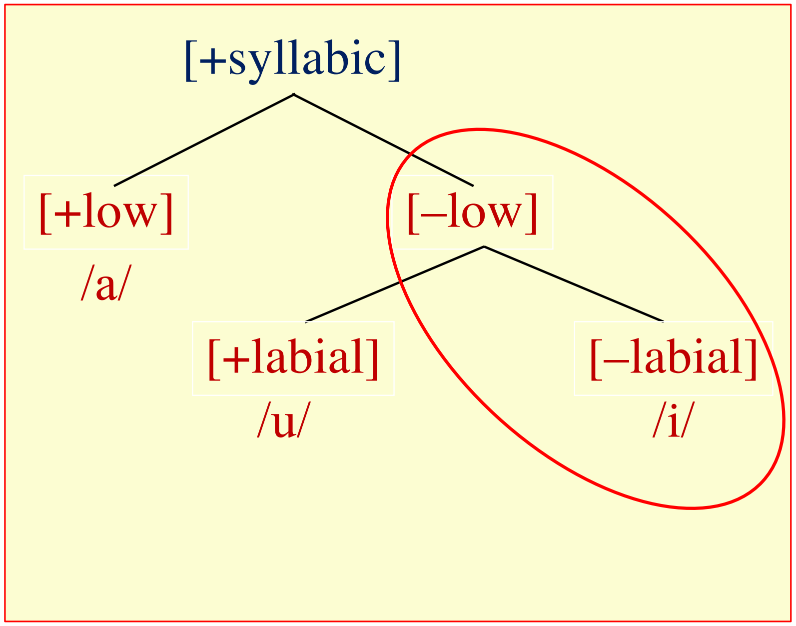

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Interestingly, none of these dialects have palatalization after /i/.

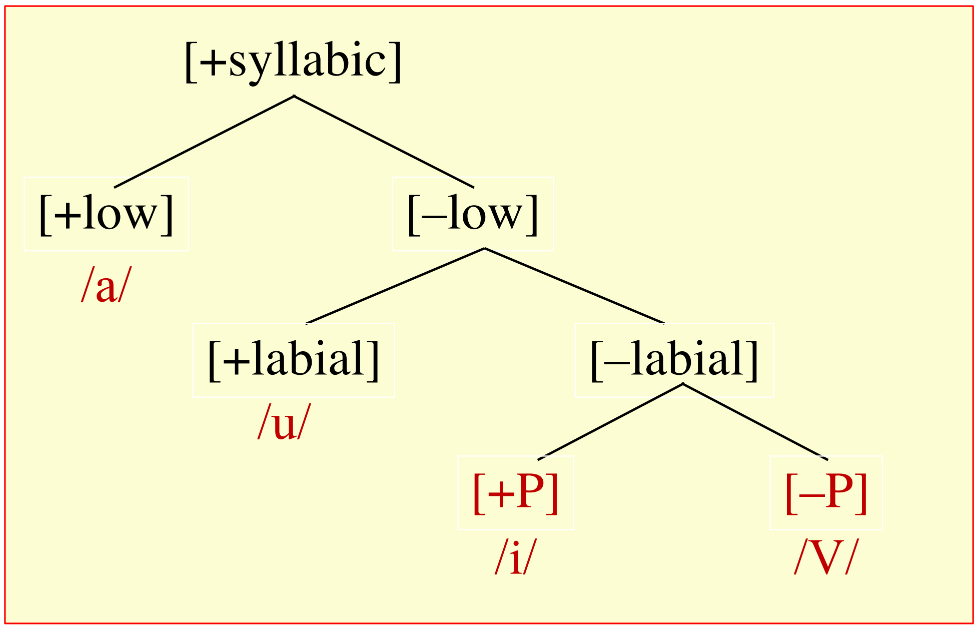
Compton & Dresher (2011) propose that this is because the Inuit-Yupik contrastive hierarchy has: [low] > [labial] at the top.

Thus, /i/ in these dialects has no contrastive palatalizing feature; it's the unmarked vowel.

Inuit-Yupik contrastive hierarchy (Compton and Dresher 2011)

Now consider dialects which have retained 4 underlying vowels.

(7) Four-vowel Dialects



These dialects have a contrast between strong i and weak i; i.e., between /i/ and a fourth vowel, which for now we can call /V/.

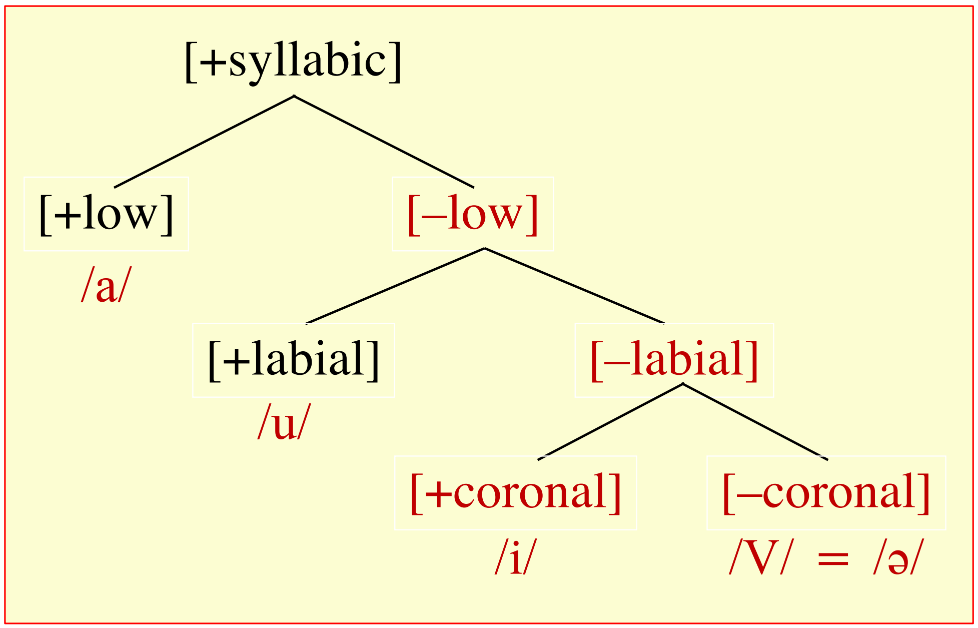
The contrast between /i/ and the fourth vowel /V/ requires a third feature, which must be the palatal-izing feature [+P].

What is [P]?

Inuit-Yupik contrastive hierarchy (Compton and Dresher 2011)

Compton & Dresher (2011) proposed that [P] is [coronal].

(7) Four-vowel Dialects

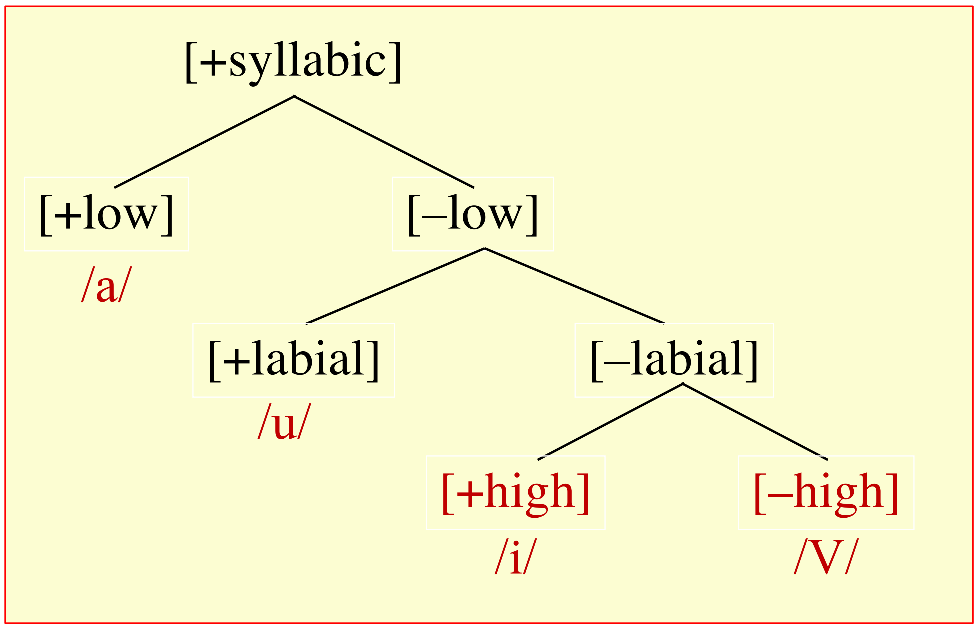


This followed studies that argued that V-place [coronal] causes palatalization of consonants (Clements 1976, 1991; Hume 1994), even those with C-place [coronal] (see Kochetov to appear for a review).

If strong /i/ is [+coronal], then weak /i/ must be: [–low, –labial, –coronal] , i.e., a central vowel we could call /ə/.

Inuit-Yupik contrastive hierarchy (Compton and Dresher 2011)

(7) Four-vowel Dialects



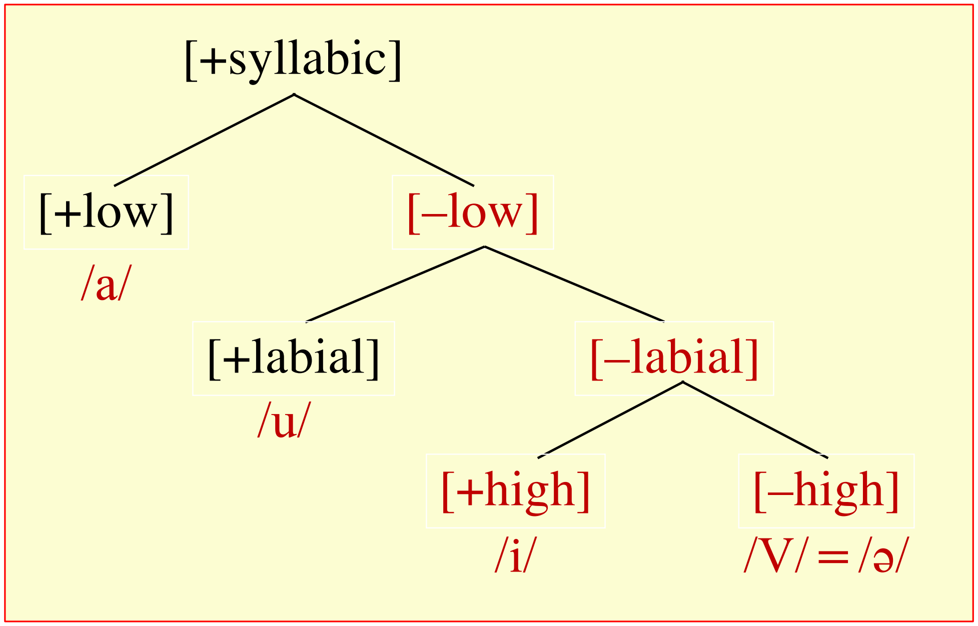
Kaplan (1981) followed Chomsky & Halle (1968) (SPE) in proposing that the palatalizing feature is [high].

This view is supported by Lahiri & Evers (1991) and Lahiri (2018), who argue that the palatalization of /l/ to [ʎ] and /n/ to [ɲ] amounts to the change of [–high] to [+high].

Inuit-Yupik contrastive hierarchy (Compton and Dresher 2011)

In our case, it doesn't matter that much what we call the palatalizing feature.

(7) Four-vowel Dialects



Whether feature theory has C-place and V-place tiers is determined by UC; it's not something the learner has to figure out.

Suppose we assume that the third feature is [high]. On this view:

Weak /i/ must be: [–low, –labial, –high], which again = /ə/.

What about /t/ to [s]?

As to /t/ to [s], Kaplan proposes that adding [+high] to /t/ gives [tʃ], which then becomes [s].

The palatalization of /t/ is [s] in many Inuit dialects, presumably by a similar mechanism as proposed by Kaplan for Iñupiaq.

(1)	Stem	Gloss	'and a N'	'N-OBL.PL'	'like a N'
a.	iɣlu	'house'	iɣlu-lu	iɣlu-nik	iɣlu-tun
b.	iki	'wound'	iki-ʎu	iki-ɲik	/iki-tʃun/ → iki-sun
c.	ini	'place'	ini-lu	ini-nik	ini-tun

6. Derivations and Rule Opacity

Derivations with strong and weak *i*: opacity

I have now presented the outline of a learning theory that can lead an Inuit learner to identify weak i with an underlying set of features that amount to /ə/.

To complete the story, let's consider sample derivations with strong and weak i.

In (8a), Palatalization applies to /l/ that follows underlying ('strong') /i/.

(8)	a. 'and a wound'
UR	/iki+lu/
Palatalization	ikiʎu
SR	[ikiʎu]

Derivations with strong and weak *i*: opacity

In (8b), Palatalization does not apply to /l/ that follows underlying /ə/ (weak i).

The neutralization of /ə/ to [i] must follow the application of Palatalization.

The relative ordering of Palatalization and /ə/ → [i] makes the former opaque.

(8)	a. 'and a wound'	b. 'and a place'
UR	/iki+lu/	/inə+lu/
Palatalization	ikiʎu	—
/ə/ → [i]	—	inilu
SR	[ikiʎu]	[inilu]

Rule opacity

Opacity is a term introduced by Kiparsky (1973) to describe a phonological rule whose structural description is contradicted at the surface.

Kiparsky's formulation is given in (9):

Our case is type (a): Palatalization is opaque because at the surface there exists unpalatalized [l] (= A) in environment i_____ (= C_____).

> (9) A rule A → B/C____D is opaque to the extent that
>
> a. there exists A in environment C____D (apparent underapplication);
>
> b. there exists B (derived from A) in environment other than C____D (apparent overapplication).

Rule opacity and learnability

Does this opacity thereby make Palatalization hard to learn?

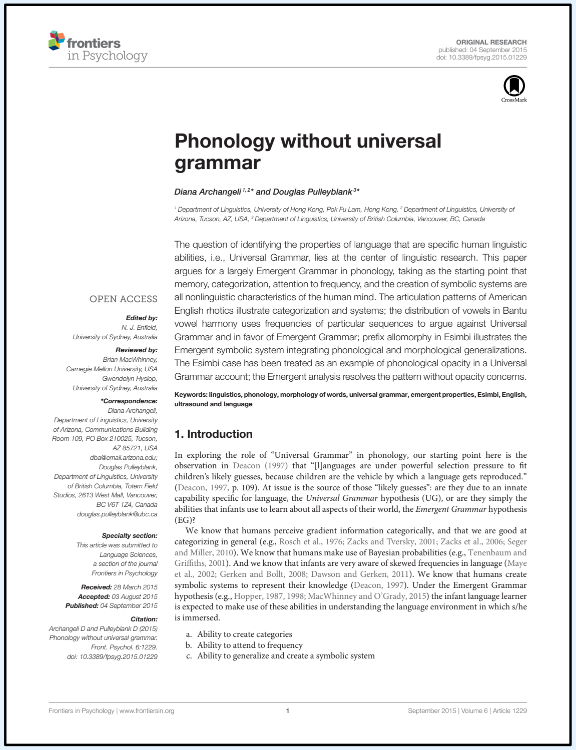
No! In our learning scenario, learners have *already* acquired the rule of Palatalization, as well as the underlying contrast between /i/ and /ə/.

Ordering Palatalization before /ə/ → [i]—i.e, creating opacity—is a solution to the problem of conflicting signals sent by weak i.

(8)	a. ‘and a wound’	b. ‘and a place’
UR	/iki+lu/	/inə+lu/
Palatalization	ikiʎu	—
/ə/ → [i]	—	inilu
SR	[ikiʎu]	[inilu]

7. UG vs. EG
in Esimbi

Emergent Grammar versus Universal Grammar



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Phonology without universal grammar

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The question of identifying the properties of language that are specific human linguistic abilities, i.e., Universal Grammar, lies at the center of linguistic research. This paper argues for a largely Emergent Grammar in phonology, taking as the starting point that memory, categorization, attention to frequency, and the creation of symbolic systems are all nonlinguistic characteristics of the human mind. The articulation patterns of American English rhotics illustrate categorization and systems; the distribution of vowels in Bantu vowel harmony uses frequencies of particular sequences to argue against Universal Grammar and in favor of Emergent Grammar; prefix allomorphy in Esimbi illustrates the Emergent symbolic system integrating phonological and morphological generalizations. The Esimbi case has been treated as an example of phonological opacity in a Universal Grammar account; the Emergent analysis resolves the pattern without opacity concerns.

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1. Introduction

In exploring the role of "Universal Grammar" in phonology, our starting point here is the observation in Deacon (1997) that "[l]anguages are under powerful selection pressure to fit children's likely guesses, because children are the vehicle by which a language gets reproduced." (Deacon, 1997, p. 109). At issue is the source of those "likely guesses": are they due to an innate capability specific for language, the *Universal Grammar* hypothesis (UG), or are they simply the abilities that infants use to learn about all aspects of their world, the *Emergent Grammar* hypothesis (EG)?

We know that humans perceive gradient information categorically, and that we are good at categorizing in general (e.g., Rosch et al., 1976; Zacks and Tversky, 2001; Zacks et al., 2006; Seger and Miller, 2010). We know that humans make use of Bayesian probabilities (e.g., Tenenbaum and Griffiths, 2001). And we know that infants are very aware of skewed frequencies in language (Maye et al., 2002; Gerken and Bollt, 2008; Dawson and Gerken, 2011). We know that humans create symbolic systems to represent their knowledge (Deacon, 1997). Under the Emergent Grammar hypothesis (e.g., Hopper, 1987, 1998; MacWhinney and O'Grady, 2015) the infant language learner is expected to make use of these abilities in understanding the language environment in which s/he is immersed.

a. Ability to create categories
b. Ability to attend to frequency
c. Ability to generalize and create a symbolic system

As mentioned earlier, Archangeli & Pulleyblank (2015) argue for 'a largely Emergent Grammar in phonology' which competes with Universal Grammar (UG):

Do infants learn grammar 'due to an innate capability specific for language, the Universal Grammar hypothesis (UG), or are they simply the abilities that infants use to learn about all as- pects of their world, the Emergent Grammar hypothesis (EG)?'

Recall that they propose that language learners make use only of basic general cognitive principles:

Emergent Grammar versus Universal Grammar

a. Ability to create categories
b. Ability to attend to frequency
c. Ability to generalize and create a symbolic system

I have already observed that these principles fall woefully short of being capable of supporting the acquisition of phonology.

They cannot direct learners to any particular grammar, and certainly not to their EG analysis of Esimbi, as we shall see.

My concern now, however, is that they single out opacity as a problem that UG analyses have and that their EG analysis does not.

I will argue that this fact has no significance for the relative learnability of UG and EG analyses.

Test case: Esimbi

As their test case, they choose Esimbi, a Tivoid language of southwestern Cameroon, which has an unusual restriction on root vowels and an interesting set of prefix alternations.

Only 3 vowels can occur in Esimbi roots, and they are all high: /i, ɨ, u/.

Of course, Esimbi has more vowels than that; the prefixes show more variety:

i		u
e		o
ɛ		ɔ
	a	

The prefixes we will be looking at do not have fixed vowels, but rather have one of three different vowels depending on what root they attach to.

Esimbi prefix alternations (all tones omitted)

Consider the SG 9 prefix; it is:

[i] with 'goat':	i-bi
[e] with 'antelope':	e-kibi
[ɛ] with 'animal':	ɛ-nyimi

The SG 3 prefix has the forms:

[u] with 'end':	u-tili
[o] with 'tail':	o-ki
[ɔ] with 'grain':	ɔ-simi

The above roots have the vowel [i]. Similar patterns occur with [u]:

The SG 9 prefix is:

[i] with 'fish':	i-su
[e] with 'bird':	e-nunu
[ɛ] with 'hippo':	ɛ-fumu

The SG 3 prefix is:

[u] with 'fire':	u-wusu
[o] with 'ear':	o-tu
[ɔ] with 'hand':	ɔ-bu

Esimbi prefix alternations

This pattern is general: prefixes either alternate between [i, e, ɛ] or [u, o, ɔ]. (There is a third pattern [o, ɛ *or* ɔ, a], which we will look at later.)

We have seen that roots with [i] and [u] come in three types: those that occur with prefixes [i, u], those that occur with [e, o], and those that occur with [ɛ, ɔ].

There are also roots with [ɨ]. There are only two types; prefixes [i, u] are missing:

The SG 9 prefix has the forms:		The SG 3 prefix has the forms:	
[e] with 'cane rat':	e-bɨ	[o] with 'spear':	o-tɨ
[ɛ] with 'place':	ɛ-tlɨ	[ɔ] with 'broom':	ɔ-bɨ

Esimbi prefix alternations

The generalizations we have observed to here are:

- A given prefix is always front or always round

- The height of a prefix depends on the root it attaches to

What do you think is going on? Many languages have height harmony, where the height of a prefix vowel must match the height of the root vowel. But in Esimbi, all root vowels are high!

Any ideas?

The ‘UG analysis’: Hyman (1988)

Hyman (1988) proposes that the restriction of roots to high vowels at the surface masks the fact that in underlying representations there is a wider variety of vowels that trigger height harmony in the prefixes. The ingredients of his analysis:

- [i, e, ɛ] prefixes are specified [–back], [u, o, ɔ] prefixes are [+round].
- [i] roots derive from /i/, /e/, or /ɛ/; [u] roots derive from /u/, /o/, or /ɔ/; [ɨ] roots derive from /ə/ or /a/.
- Prefix height assimilation (PHA): Prefixes assimilate to the height features of the roots.
- Root vowel raising (RVR): Following PHA, all root vowels become [+high].

Sample derivations

Here are some sample derivations that illustrate this analysis. For now I do not try to assign features to the root vowels.

Note that Raising makes assimilation opaque: after the root vowels raise, we cannot see the rationale for why the prefixes have the height that they do.

Gloss	'a goat'	'a bird'	'a spear'	'a grain'
Morphology	SG 9 + *bi*	SG 9 + *nunu*	SG 3 + *tɨ*	SG 3 + *simi*
Underlying	/[−bk] + bi/	/[−bk] + nono/	/[+rnd] + tə/	/[+rnd] + sɛmɛ/
Assim. (PHA)	i-bi	e-nono	o-tə	ɔ-sɛmɛ
Raising (RVR)	—	e-nunu	o-tɨ	ɔ-simi
Surface	[i-bi]	[e-nunu]	[o-tɨ]	[ɔ-simi]

Critique of the UG analysis

Archangeli & Pulleyblank (2015: 10–1) are critical of this analysis [my emphasis]:

> Assuming that a phonological difference in the roots is the source of the difference in prefix height requires that height distinctions be encoded in roots even though there is no surface evidence—in the roots—for the required distinction.

The suggestion here—not stated explicitly—is that learners may not have evidence for positing height distinctions in the lexical forms of the roots.

Moreover, they observe that the analysis results in surface opacity and propose alternative generalizations that 'resolve the opacity problem'. They don't say what the problem is, but they do claim that their analysis is more likely to be learned.

The Emergent Grammar (EG) analysis

Archangeli & Pulleyblank (2015) present an analysis with no opacity and no abstract underlying vowels that are different from the surface vowels.

In their analysis, the words for ‘goat’, ‘antelope’, and ‘animal’ all have the same high vowel in their lexical representations: /bi/, /kibi/, and /nyimi/, and similarly for the other root vowels [u] and [ɨ].

So how do they account for the fact that they take prefixes of different heights: [i-bi], [e-kibi], [ɛ-nyimi] ?

Here is how they do it: in the lexical entry of each root, they indicate—in terms of features—what sort of prefix it prefers.

The Emergent Grammar (EG) analysis

For example, Set A roots /bi/ and /sumu/ prefer a prefix that is high and ATR.

Set C roots /simi/, /bɨ/, and /zu/ prefer low and RTR prefixes.

Set B roots have no specified preference; Archangeli & Pulleyblank propose that they take the unmarked prefixes, [e-] and [o-].

The reason they do it this way has to do with the impossibility of stating the preferences of this set positively, as I will show later.

Root lexical representations (Archangeli & Pulleyblank 2015: 7–9)

a. Set A		b. Set B		c. Set C	
{bi$_{\text{HI, ATR}}$}	‘goat’	{ki}	‘tail’	{simi$_{\text{LO, RTR}}$}	‘grain’
		{tɨ}	‘spear’	{bɨ$_{\text{LO, RTR}}$}	‘broom’
{sumu$_{\text{HI, ATR}}$}	‘thorn’	{tu}	‘ear’	{zu$_{\text{LO, RTR}}$}	‘snake’

The Emergent Grammar (EG) analysis

A & P (2015:10–11): The issue of surface opacity … is a non-issue under this analysis. The problem derives from assuming that patterns such as these are entirely phonological [...]

Emergent Grammar recognizes all types of generalizations that the learner might make. Among these are generalizations over sets of lexical items that are arbitrary based on their surface forms … It is the recognition of such lexical generalizations co-existing with phonological generalizations that eliminates opacity as an issue in Esimbi prefix selection.

Root lexical representations (Archangeli & Pulleyblank 2015: 7–9)

a. Set A		b. Set B		c. Set C	
{bi$_{\text{HI, ATR}}$}	'goat'	{ki}	'tail'	{simi$_{\text{LO, RTR}}$}	'grain'
		{tɨ}	'spear'	{bɨ$_{\text{LO, RTR}}$}	'broom'
{sumu$_{\text{HI, ATR}}$}	'thorn'	{tu}	'ear'	{zu$_{\text{LO, RTR}}$}	'snake'

Some questions

A & P (2015:10–11): It is the recognition of such lexical generalizations co-existing with phonological generalizations that eliminates opacity as an issue in Esimbi prefix selection.

- Why is opacity an issue? What is the issue? What is gained by eliminating it?
- Where do we draw the line between 'phonological generalizations' and 'lexical generalizations' when the latter are stated in terms of phonological features?
- Are features easier to learn if they are represented as small cap subscripts?

a.	Set A		b.	Set B		c.	Set C	
	$\{bi_{\text{HI, ATR}}\}$	'goat'		{ki}	'tail'		$\{simi_{\text{LO, RTR}}\}$	'grain'
				{tɨ}	'spear'		$\{bɨ_{\text{LO, RTR}}\}$	'broom'
	$\{sumu_{\text{HI, ATR}}\}$	'thorn'		{tu}	'ear'		$\{zu_{\text{LO, RTR}}\}$	'snake'

Comparing the analyses

I mention the notation because I think it obscures some similarities between the UG and the EG analysis.

The UG Analysis of a word like simi 'grain', which takes [ɛ, ɔ] prefixes, attributes to the root vowel two different feature specifications: one is underlying, whose height feature is spread to the prefix, and the other is for the root after raising.

The EG Analysis of this word also attributes to the root vowel two different feature specifications: one is for the root vowel and the other is for the prefix.

UG Analysis	/sɛmɛ/ → [simi]
Lexical features	[front, RTR]
Surface features	[front, high, ATR]

EG Analysis	/simi/$_{\text{LO, RTR}}$
Prefix features	[low] and/or [RTR]
Lexical features	[front, high, ATR]

Comparing the analyses

Learnability question: What does the learner have to discover in order to arrive at either the UG or the EG analysis?

The challenge for the learner is to recognize that, though the vowel in [simi] appears as a high ATR vowel, it carries (somewhere, in some fashion) low and RTR specifications.

What sort of UC will enable Esimbi learners to discover (learn) this?

UG Analysis	/sɛmɛ/ → [simi]
Lexical features	[front, RTR]
Surface features	[front, high, ATR]

EG Analysis	$/simi/_{LO,\ RTR}$
Prefix features	[low] and/or [RTR]
Lexical features	[front, high, ATR]

Comparing the analyses

- ➢ They must have a UC that directs them to look for a solution in terms of features associated with the roots to account for the height of the prefixes.

Consider first the UG analysis: Do we have a learning theory that does this?

Yes, we do! Recall the learning theory for abstract underlying phonemes that I outlined earlier:

UG Analysis	/sɛmɛ/ → [simi]
Lexical features	[front, RTR]
Surface features	[front, high, ATR]

EG Analysis	/simi/$_{\text{LO, RTR}}$
Prefix features	[low] and/or [RTR]
Lexical features	[front, high, ATR]

A UG learning theory for abstract phonology

Recall in particular the first two assumptions that segments are analyzed into features and that segments interact via features.

- Learners analyze segments into features.
- Interactions between segments involve features.
- Learners have access to the morphological make-up and paradigmatic membership of lexical items.
- Learners attempt to arrive at a single underlying form for each lexical item.
- Where possible, rules and representations formulated in phonological terms are preferred to those that mention non-phonological terms (e.g., diacritics or morphosyntactic terms).

A UG learning theory for abstract phonology

Recall also our template for a highly-valued rule:

(2) Template for a highly-valued rule

$$\begin{bmatrix} \beta G \\ \cdot \\ \varphi P \end{bmatrix} \longrightarrow [\alpha F] \;/\; \begin{matrix} \underline{\quad\quad} X\ [\alpha F] \\ \\ [\alpha F]\ X \underline{\quad\quad} \end{matrix}$$

If a segment S takes on a feature [αF] in the presence of another segment T, the learner will suppose that T also bears [αF].

Applied to our case:

If learners see the form [ɔ-simi], where the height features (but not backness/roundness) are determined by the root, they will attribute those features to the root.

That is, like Inuit weak *i*, root vowels are sending conflicting signals:

A UG learning theory for abstract phonology

In the example below, the surface form of the root vowel [ɨ] in [otɨ] signals that it is [+high], but the prefix vowel [o] signals that it is [−high].

The conflict is resolved by assigning both [+high] and [−high] to the root vowel ɨ.

UC tells the learner how to accommodate these contradictory specifications.

	‘SG3+spear’
UR	/[+rd]+t$ə_{[-hi]}$/
PHA (harmony)	ot$ə_{[-hi]}$
RVR (raising)	ot$ɨ_{[+hi]}$
SR	[otɨ]

In UG (derivational generative phonology), the accommodation takes the form of a derivation with ordered rules.

[−high] is assigned to the UR, spreads to the prefix by PHA, then raises to [+high] by RVR.

An EG learning theory for phonology?

So there is a UG learning theory that can get us (at least part of the way) to Hyman's (1988) abstract analysis.

What about A&P's EG? It needs much more than the abilities to create categories, attend to frequency, and generalize and create a symbolic system.

It must somehow direct the learner to attach the prefix height features to the root.

UG Analysis	/sɛmɛ/ → [simi]
Lexical features	[front, RTR]
Surface features	[front, high, ATR]

EG Analysis	/simi/$_{\text{LO, RTR}}$
Prefix features	[low] and/or [RTR]
Lexical features	[front, high, ATR]

Comparing the analyses

However one implements the EG analysis, both it and the UG analysis require assigning conflicting vowel features to roots.

The conflict is resolved differently: in UG by a derivation that creates opacity, in EG by some sort of co-existing sets of specifications.

The differences between these analyses have nothing to do with learnability—there is no opacity 'issue' that the EG analysis resolves.

UG Analysis	/sɛmɛ/ → [simi]
Lexical features	[front, RTR]
Surface features	[front, high, ATR]

EG Analysis	/simi/$_{\text{LO, RTR}}$
Prefix features	[low and/or [RTR]
Lexical features	[front, high, ATR]

Interim conclusions

We have discussed two Esimbi prefixes: the [i, e, ɛ] prefix, specified [–back], which Hyman (1988) calls the I- prefix; and the U- prefix [u, o, ɔ], specified [+round].

Based on these, I believe I have shown that Archangeli & Pulleyblank's (2015) EG analysis of Esimbi is not easier to learn than Hyman's (1988) UG analysis.

Moreover, I have argued that there does exist a plausible learning theory for UG abstract phonemes and opaque rules (or at least some important ingredients of such a theory), whereas the principles of EG are much too weak.

Some questions left to resolve

Nevertheless, there are some questions about the analysis that I have left hanging:

- Why do A&P write that Set A 'prefers' prefixes that are [high] and [ATR], and that Set C prefers [low] and [RTR] prefixes? Why not 'selects' or 'assigns'?

- And why are the Set B prefix preferences left unmarked?

- Finally, what exactly are the phonological features of Esimbi vowels?

Root lexical representations (Archangeli & Pulleyblank 2015: 7–9)

a. Set A		b. Set B		c. Set C	
{bi$_{\text{HI, ATR}}$}	'goat'	{ki}	'tail'	{simi$_{\text{LO, RTR}}$}	'grain'
		{tɨ}	'spear'	{bɨ$_{\text{LO, RTR}}$}	'broom'
{sumu$_{\text{HI, ATR}}$}	'thorn'	{tu}	'ear'	{zu$_{\text{LO, RTR}}$}	'snake'

Some questions left to resolve

To answer these questions, we have to look at a third Esimbi prefix, what Hyman (1988) calls the A- prefix.

This prefix considerably complicates the analysis of Esimbi vowel phonology!

Here we will see a considerable difference in the adequacy of the UG analysis compared to the EG analysis.

8. Further Complications: The A-Prefix in Esimbi

Esimbi A-prefix alternations (all tones omitted)

As Hyman (1988) observes, the A- prefix appears one height degree lower than the vowels of the I- and U- prefixes which occur with the same root vowel.

For example, the singular 3 U- prefix on the left has the allophones shown. On the right are the same roots with the plural 6 A- prefix.

[u] on the left corresponds to [o] on the right, [o] corresponds to [ɔ], and [ɔ] corresponds to [a].

The SG 3 prefix U-	
[u] with 'end':	u-tili
[o] with 'spear':	o-tɨ
[ɔ] with 'hand':	ɔ-bu

The PL 6 prefix A-	
[o] with 'end':	o-tili
[ɔ] with 'spear':	ɔ-tɨ
[a] with 'hand':	a-bu

Esimbi A-prefix alternations (all tones omitted)

By Hyman's hypothesis, the I- and U- prefixes get their height by harmony, and so show the underlying height of the root vowels they co-occur with.

With respect to non-height features (frontness and rounding), the A- prefix shows no consistent pattern. According to Hyman (1988: 259):

Hyman assumes that frontness and rounding are assigned to the A- prefix by a secondary process, and I will not be concerned with these features further.

When the root vowel is	/i, u/	the A- prefix is	[o-]
When the root vowel is	/o, ə/	the A- prefix is	[ɔ-]
When the root vowel is	/e/	the A- prefix is	[ɛ-]
When the root vowel is	/ɛ, ɔ, a/	the A- prefix is	[a-]

Esimbi A-prefix alternations (all tones omitted)

We will be concerned with the A- prefix specifications that have the effect of lowering the height assigned by the root vowels by one step.

This is not a trivial problem! Let's first look at Archangeli & Pulleyblank's approach.

In this respect, their EG analysis is indeed very different from any UG account.

When the root vowel is	/i, u/	the A- prefix is	[o-]
When the root vowel is	/o, ə/	the A- prefix is	[ɔ-]
When the root vowel is	/e/	the A- prefix is	[ɛ-]
When the root vowel is	/ɛ, ɔ, a/	the A- prefix is	[a-]

Archangeli & Pulleyblank's analysis of the A- prefix

A&P do not characterize the three prefixes in terms of features, but rather as sets of allomorphs.

The I-, or Front, prefixes are {i, e, ɛ}; the U-, or Round, prefixes are {u, o, ɔ}; The A-, or Nonhigh, prefixes are {o, ɛ or ɔ, a}.

TABLE 8 | Esimbi prefix descriptive summary.

Prefix → / Root ↓	Prefix Class: Front	Round	Nonhigh
Set A	i	u	o
Set B	e	o	ɛ or ɔ
Set C	ɛ	ɔ	a

Archangeli & Pulleyblank's analysis of the A- prefix

Recall that A&P specify the Set A roots, what Hyman considers to be underlyingly high, as preferring prefixes that are [high] and [ATR] (e.g. 'goat' bi$_{\text{HI, ATR}}$).

Front and Round prefixes are [high] and [ATR]; Nonhigh [o] is [ATR], not [high].

That's why prefix selection is framed as preferences: Set A prefers prefixes that are [high] and [ATR] but will accept only one of these if necessary.

TABLE 8 | Esimbi prefix descriptive summary.

Prefix → / Root ↓	Prefix Class: Front	Round	Nonhigh
Set A	i	u	o
Set B	e	o	ε or ɔ
Set C	ε	ɔ	a

In A&P's analysis, [o] is the only Nonhigh prefix that is [ATR]; [ε, ɔ, a] are all [RTR].

[e, o] in Front and Round prefixes are also [ATR] but not [high], so lose to [i, u].

Archangeli & Pulleyblank's analysis of the A- prefix

The Set C roots, what Hyman considers to be underlyingly /ɛ, ɔ, a/, prefer prefixes that are [low] and [RTR] (e.g. 'snake' $zu_{LO,\ RTR}$).

In A&P's analysis, [ɛ, ɔ] are the only Front and Round prefixes that are [RTR].

In the Nonhigh prefix, [ɛ, ɔ] are [RTR] but lose to [a] which is also [low].

TABLE 8 | Esimbi prefix descriptive summary.

Prefix → / Root ↓	Prefix Class		
	Front	Round	Nonhigh
Set A	i	u	o
Set B	e	o	ɛ or ɔ
Set C	ɛ	ɔ	a

Archangeli & Pulleyblank's analysis of the A- prefix

Now consider the Set B roots, what Hyman considers to be underlyingly /e, o, ə/.

In A&P's analysis these roots have no specified preferences (e.g. 'tail' ki) but take the 'unmarked' member of each prefix, stipulated to be the middle member.

Now we can see why they are forced to this solution!

TABLE 8 | Esimbi prefix descriptive summary.

Prefix → / Root ↓	Prefix Class: Front	Prefix Class: Round	Prefix Class: Nonhigh
Set A	i	u	o
Set B	e	o	ɛ or ɔ
Set C	ɛ	ɔ	a

Archangeli & Pulleyblank's analysis of the A- prefix

They need to say that Set B prefers [nonhigh] and [ATR] to account for the Front and Round prefixes; but this selects the wrong vowel [o] in the Nonhigh prefix.

The Nonhigh allomorphs that need to be selected are [ɛ, ɔ], which are [RTR]; but then the other prefixes will select the wrong vowels [ɛ, ɔ].

TABLE 8 | Esimbi prefix descriptive summary.

Prefix → / Root ↓	Prefix Class		
	Front	Round	Nonhigh
Set A	i	u	o
Set B	e	o	ɛ or ɔ
Set C	ɛ	ɔ	a

That is, there is no way to state the Set B preferences in a positive way.

Archangeli & Pulleyblank's analysis of the A- prefix

Before leaving A&P's analysis, let's reflect for a moment on how they specify the variants of each prefix.

Each prefix consists of a list of allomorphs. Why these particular allomorphs?

In A & P's analysis, there is no reason why the heights of the Front and Round allomorphs correspond to each other.

TABLE 8 | Esimbi prefix descriptive summary.

Prefix → / Root ↓	Prefix Class		
	Front	Round	Nonhigh
Set A	i	u	o
Set B	e	o	ɛ or ɔ
Set C	ɛ	ɔ	a

And it appears to be a coincidence that the Nonhigh allomorphs are exactly one step below them.

A UG learning theory for abstract phonology

Recall again the following assumptions of our UG learning theory:

A&P's EG analysis violates each of these assumptions.

Of course, this UG learning theory might not be correct. But the EG analysis has no explanation for why the prefix allomorphs are the way they are.

- Interactions between segments involve features.
- Learners attempt to arrive at a single underlying form for each lexical item.
- Where possible, rules and representations formulated in phonological terms are preferred to those that mention non-phonological terms (e.g., diacritics or morphosyntactic terms).

A UG learning theory for abstract phonology

By contrast, here is what Hyman (1988: 260) considered to be the criterion for a successful analysis of the Esimbi prefixes [emphasis added]:

> To repeat our aim, an analysis must be sought that correctly and insightfully captures the vowel height relations between the prefixes I- and U- *vs.* those of the prefix A-, which are one step lower. Hyman (1988)

TABLE 8 | Esimbi prefix descriptive summary.

Prefix → / Root ↓	Prefix Class: Front	Round	Nonhigh
Set A	i	u	o
Set B	e	o	ɛ or ɔ
Set C	ɛ	ɔ	a

A&P's analysis abandons this aim: they simply stipulate the vowel heights of each prefix.

So let's look at a UG analysis.

9. A UG Analysis of the A-Prefix in Esimbi

The Esimbi A-prefix in terms of features

As I mentioned, it is not trivial to deduce what features the A- prefix might have that could produce a vowel that is one step lower than the root vowel.

There are theories which can do this very elegantly; for example, the Particle Phonology of Schane (1984), or versions of Element Theory (Kaye, Lowenstamm, & Vergnaud 1985; Backley 2011).

The PL 6 prefix A-			
'death':	/A - ku/	→	[o-ku]
'spear':	/A – tə/	→	[ɔ-tɨ]
'hand':	/A – bɔ/	→	[a-bu]

The Esimbi A-prefix in terms of features

In such theories, we could say that the A- prefix literally consists of an A element; adding one A to the root vowel lowers it by one step.

Maybe this approach is right! But here I will continue to pursue a more conventional approach to features.

Vowel system with particles						
i	I			U	u
e	IA	ə	A	UA	o
ɛ	IAA			UAA	ɔ
		a	AAA		

The PL 6 prefix A-			
‘death’:	/A - ku/	→	[o-ku]
‘spear’:	/A – tə/	→	[ɔ-tɨ]
‘hand’:	/A – bɔ/	→	[a-bu]

The Esimbi A-prefix in terms of features

Although Hyman (1988) could posit an underlying inventory for the Esimbi root vowels based on how they affect the prefixes, determining what their distinctive features are is a more complicated matter.

One common way of representing an eight-vowel system is represented schematically below.

There are 3 heights plus ATR/RTR to distinguish the mid vowels /e, ə, o/and /ɛ, ɔ/.

/ɛ, ɔ/ are mid and RTR			
i		u	*high (ATR)*
e	ə	o	*mid ATR*
ɛ		ɔ	*mid RTR*
	a		*low (RTR)*

The Esimbi A-prefix in terms of features

Another common analysis, on the right, also posits three heights, but /ɛ, ɔ/ are low together with /a/. Analyses vary as to what role if any ATR/RTR plays.

Neither of these analyses, however, gives a good account of the A- prefix.

If we specify the A- prefix as [+low], then combining [+low] with the height features of the root might be expected to always yield a [+low] vowel.

/ɛ, ɔ/ are mid and RTR			
i		u	*high (ATR)*
e	ə	o	*mid ATR*
ɛ		ɔ	*mid RTR*
	a		*low (RTR)*

/ɛ, ɔ/ are low (and/or RTR)			
i		u	*high (ATR)*
e	ə	o	*mid (ATR)*
ɛ	a	ɔ	*low/RTR*

The Esimbi A-prefix in terms of features

Hyman (1988) proposes instead that /a/ is [–ATR] (which I consider the same as [+RTR]); all the other vowels, including /ɛ, ɔ/, are [+ATR].

The idea is that [+RTR] can interact with height features in particle phonology style, lowering each height by one step (in a way to soon be explained).

I like this idea, but want to modify the specifications slightly.

/ɛ, ɔ/ are mid and RTR			
i		u	*high*
e	ə	o	*mid*
ɛ		ɔ	*low*
	a		*RTR*

The Esimbi A-prefix in terms of features

I adhere to a theory that generates contrastive features by a hierarchy.

For reasons of contrast, I would like /ɛ, ɔ/ to also be [+RTR].

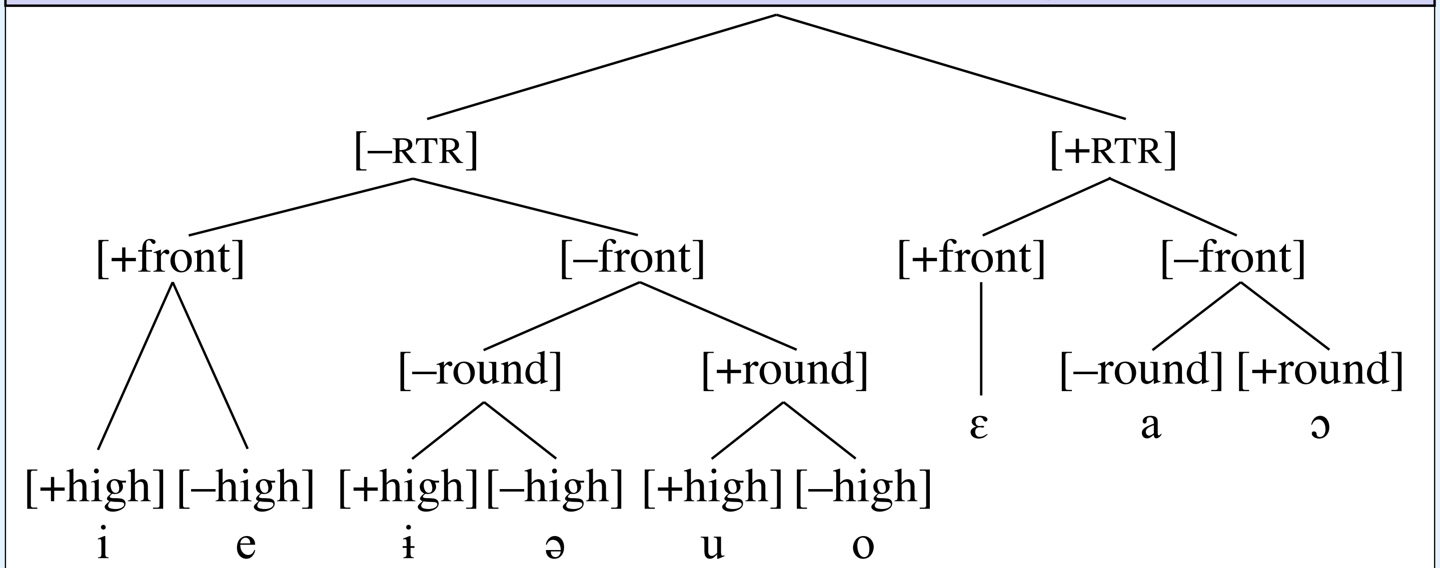
I would also like to include /ɨ/; though it is a derived vowel, it consists entirely of contrastive features, so is part of the contrastive inventory at some point.

/ɛ, ɔ/ are RTR			
i	(ɨ)	u	*ATR, high*
e	ə	o	*ATR, mid*
ɛ	a	ɔ	*RTR*

Esimbi vowel feature hierarchy

Here is a proposed contrative feature hierarchy for Esimbi vowels:

[RTR] > [front] > [round] > [high]



The Esimbi A-prefix in terms of features

Here are the generated specifications in the form of a feature matrix.

Following Hyman (1988), I assume that the A- prefix is specified only [+RTR] and that backness and rounding are assigned by other rules.

Therefore, the height of the A- prefix is derived from combining the height features of the root vowel with [+RTR], with one important proviso:

	i	e	ɛ	ɨ	ə	a	u	o	ɔ
[RTR]	–	–	+	–	–	+	–	–	+
[front]	+	+	+	–	–	–	–	–	–
[round]				–	–	–	+	+	+
[high]	+	–		+	–		+	–	

Esimbi A-prefix alternations (all tones omitted)

Structure preservation: When [+RTR] is assigned to a vowel specified [+high], the derived specification is changed to the phonetically nearest [−RTR] vowel.

We have the following outcome:

Hyman writes that [+RTR, +high] is quite close to [−RTR, −high] in many languages.

Prefix A-	*Root vowel*	*features*	*Result*	*Predict*	*Actual*	*features*
[+RTR]	i, u	[−RTR, +high]	[+RTR, +high]	*[ʊ, ʊ]	[o, o]	[−RTR, −high]

Esimbi A-prefix alternations (all tones omitted)

Assigning [+RTR] to the other vowels works more simply:

Prefix A-	*Root vowel*	*features*	*Result*	*Predict*	*Actual*	*features*
[+RTR]	i, u	[−RTR, +high]	[+RTR, +high]	*[ʊ, ʊ]	[o, o]	[−RTR, −high]
[+RTR]	e, ə, o	[−RTR, −high]	[+RTR, −high, ...]	[ɛ, ɔ, ɔ]	[ɛ, ɔ, ɔ]	[+RTR, ...]
[+RTR]	a	[+RTR]	[+RTR]	[a]	[a]	[+RTR]

The learning problem for the Esimbi A-prefix

As we saw for Inuit weak i and the Esimbi I- and U- prefixes, when the A- prefix combines with a root, learners receive conflicting signals; in this case, the conflict is compounded:

- In a root like tu 'ear', the root vowel signals that it is [+high];
- the U- prefix o-tu signals that the root vowel is [–high, -RTR];
- the A- prefix ɔ-tu signals yet a different vowel height, [+RTR].

The simplest solution is that the I- and U- prefixes show the underlying height of the root, and that the A- prefix lowers it.

10. Conclusion

Conclusion and connection to pertinacity

To conclude, I think there are two ways that this talk connects to the workshop theme of pertinacity.

The first way is that it demonstrates my own persistence in continuing to believe in abstractness in phonology.

But more importantly, I think it advocates for the pertinacity of phonology itself, in a sense I will try to make clear.

If we imagine an Inuit dialect in which weak i was overtly a schwa on the surface, very few phonologists would object to saying that palatalization by i is an entirely phonological process.

Conclusion and connection to pertinacity

Similarly, if you imagine a dialect of Esimbi in which the root vowels did not all become high but spread their height features transparently to the prefixes, most would agree that this height harmony was purely phonological.

The controversy starts when a phonological process is made opaque; then there is a question whether a purely phonological analysis should persist, or if it should change into something fundamentally different.

Of course, if the opacity is so drastic that no learner could reasonably reconstruct the old underlying forms, then something has to give.

But I have in mind some of the quotations that I read that seem to suggest that any amount of opacity should cause us to abandon a phonological analysis.

Conclusion and connection to pertinacity

Recall the quote that I started with, which was part of a critique of Compton & Dresher's (2011) analysis of Inuit vowel systems :

> an underlying featural contrast is used to condition phonological behavior, despite corresponding to no observable phonetic differences *in the conditioning segments themselves* [...] These analyses therefore make strong claims [...] *that there is some learning mechanism* that leads to such a representation. Mayer, Major, & Yakup (2022)

The suggestion is that evidence from neighbouring segments, no matter how copious, does not suffice to make an underlying contrast learnable.

By the way, this quote is from a paper on Uyghur, a language about which I have never written a word, so the critique is entirely gratuitous.

Conclusion and connection to pertinacity

And remember this one, which has the same position:

> Assuming that a phonological difference in the roots is the source of the difference in prefix height requires that height distinctions be encoded in roots even though there is no surface evidence—*in the roots*—for the required distinction. Archangeli & Pulleyblank (2015)

This view is reminiscent of the strict constraints on abstractness that characterized some American Structuralist approaches, that were critiqued by Chomsky and Halle in the early years of generative phonology.

And I could cite other efforts to do away with opacity in one way or another.

Conclusion and connection to pertinacity

But I think opacity and conflicting signals are the very nature of phonology, which is all about how segments interact and affect each other.

Opacity effects, like the rest of phonology, are bound up with problems of the poverty of the stimulus, and the phenomena that manifest them are valuable as probes into the structure of the learning theory that learners are endowed with.

Efforts to do away with opacity on learnability grounds are therefore misguided, because opacity is not a learning problem, but a solution to a problem posed by conflicting signals in the data.

The conflicting signals will still be there, however we choose to analyze them!

Pertinacious Phonology & Morphology

Ettington Park, Stratford-upon-Avon, UK

September 23, 24, 25

THANK YOU!

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