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Emergent phonological representations: No need for autosegmental architecture

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Graduate Institute of Linguistics 30th Anniversary Celebration
2015 September 5



Introduction

What is the role of a phonological representation?

What is the structure of a phonological representation?

Introduction

What is the role of a phonological representation?

- a. Characterize the speaker's knowledge about the phonological form of items in the language
- b. Provide a means of showing relations between related forms, whether morphologically or phonologically related

What is the structure of a phonological representation?

Introduction

What is the role of a phonological representation?

What is the structure of a phonological representation?

- a. Prosodic representations – feet, syllables
- b. Segmental representations – features, autosegments, feature geometry
- c. Provided by an innate language faculty ('Universal Grammar', or UG) because it is too complex to be learned from the data)

Introduction

Goals

- a. Propose an alternative to autosegmental representations
- b. Case study: Tiv vowels
- c. Drawing on Emergent phonology (phonology without Universal Grammar)

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Diana Archangeli, Jeff Mielke, and Douglas Pulleyblank. "Greater than noise: Frequency effects in Bantu height harmony". In: *Phonological Explorations: Empirical, Theoretical and Diachronic Issues*. Ed. by Bert Botma and Roland Noske. Berlin: Mouton de Gruyter, 2012, pp. 191–222

Diana Archangeli and Douglas Pulleyblank. "Emergent Phonology: Evidence from English". In: *Issues in English Linguistics*. Ed. by Ik-Hwan Lee et al. Seoul: Hankookmunhwasa, 2012, pp. 1–26

Diana Archangeli and Douglas Pulleyblank. "Tonal allomorphy in Kinande". In: *Capturing Phonological Shades*. Ed. by Lian Hee Wee and Yuchau Hsiao. Newcastle upon Tyne: Cambridge Scholars Publishing, 2015, pp. 76–100

Diana Archangeli and Douglas Pulleyblank. "Emergent morphology". In: *Morphological Metatheory*. Ed. by Heidi Harley and Daniel Siddiqi. Amsterdam: John Benjamins Publishing, to appear

Diana Archangeli and Douglas Pulleyblank. "Phonology as an Emergent System". In: *The Routledge Handbook of Phonological Theory*. Ed. by Anna Bosch and S.J. Hannahs. London: Routledge, to appear

Autosegments in Tiv

Why Tiv?

- a. Tiv has ‘floating features’, ‘translaryngeal harmony’, ‘linking’, ‘spreading’
- b. These phenomena have been used to argue for autosegmental features
- c. Tiv tone also presents arguments for autosegmental representations. Here, we largely ignoring tone patterns; verbs fall into two tonal classes marked here by an initial High or initial Low tone
- d. Tiv: a Niger-Congo language of Nigeria

D.W. Arnott. “The Classification of Verbs in Tiv”. In: *Bulletin of the School of Oriental and African Studies* 21 (1958), pp. 111–133

Roy Clive Abraham. *A dictionary of the Tiv language*. England, originally published Nigeria, 1940: Gregg Revivals, 1968
 Douglas Pulleyblank. “Underspecification, the Feature Hierarchy, and Tiv Vowels”. In: *Phonology* 5 (1988), pp. 299–326
 Diana Archangeli and Douglas Pulleyblank. *Grounded Phonology*. Cambridge: MIT Press, 1994

Autosegmental representations & Tiv vowels

Floating features

Know the features, predict the vowel pattern

High, Low, Round combine in 8 logically possible ways resulting in 6 vowels (due to *High, Low)

	i	e	a	ɔ	o	u				
high	+					+	i	cìl	cover	16
low			+	+			e	tér	mention	267
round				+	+	+	a	yàv	lie down	323
							ɔ	gòr	pester	65
							o	kór	sew	121
							u	bùm	swear on	9

Floating features

Know the features, predict the vowel pattern

High, Low, Round combine in 8 logically possible ways resulting in 6 vowels (due to *High, Low)

	i	e	a	ɔ	o	u				
high	+					+	i	cìl	cover	16
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round				+	+	+	a	yàv	lie down	323
							ɔ	gòr	pester	65
							o	kór	sew	121
							u	bùm	swear on	9

Combinations of Low and High (& Round) in morphemes

Low, High	ìsa	shut off	yíra	call
Low, High, Round	kùma	suffice	yúma	help

Feature geometry

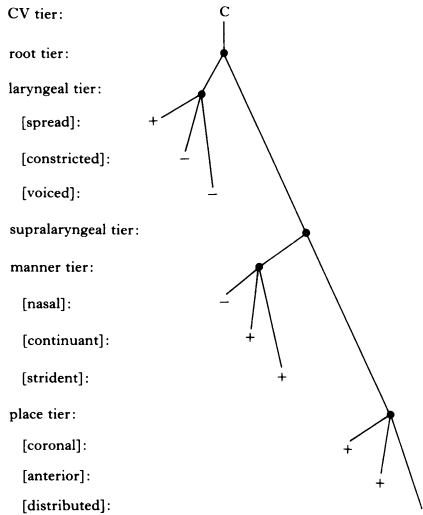
Translaryngeal harmony & feature geometry (n=733)

	i	e	a	ɔ	o	u
i	70	28	28			
e		201				
a			117			
ɔ				55	1	2
o					109	
u		9	24			89

VV		VhV	
tííl	press	víhi	spoil
kèèr	limp	téhe	cough
kàa	say	náha	stir
nòɔ	rain	lòhɔ	summon
tòol	boil	kóhor	collect
pùu	despise	njùhur	pucker up
hía	burn up	–	
yíe	feed	rìhe	be long
súe	support	wùhe	pull out
kùà	flow	wùha	adorn

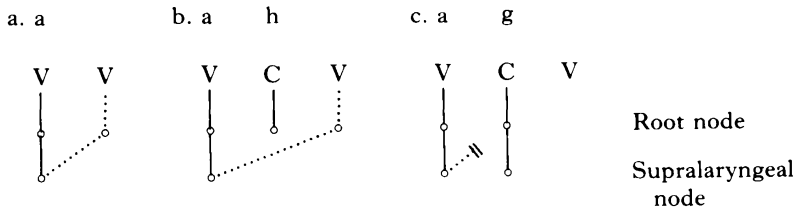
Feature geometry

Feature geometry, Clements (1985)



Feature geometry

Autosegmental spread of Supralaryngeal node in Tiv (Pulleyblank 1988)



Spreading of individual features

Autosegmental spreading (n = 1426)

	i	e	a	ɔ	o	u
i	143	40	6			
e		347	54			
a		277	3		3	
ɔ		3		3	96	2
o					179	15
u		46	42			160

a.	kìmbi	pay	112
	gèvel	belch	62
	pòso	untie	219
	rùmun	agree to	227
b.	ànem	melt	189
	nòndo	drip	202
c.	víne	dance	306
	kúve	embrace	147
d.	gèma	change	59
	mùsan	exchange	179
e.	óngur	stop crying	197

Spreading of individual features

Height-dependent round harmony (Pulleyblank 1988)

a. no round

a. kɪmbi pay
gɛ̀vɛl belch

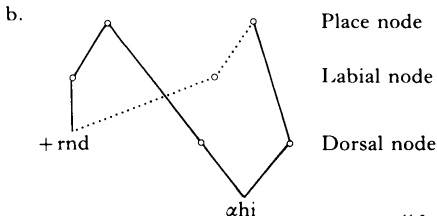
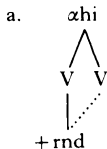
b. Round spreads on [αhigh]

b. pòso untie
rùmun agree to
nòndo drip

c. No round spread

c. kúve embrace
mùsan exchange

Round Harmony



Extrametricality

High links to V1 & may or may not spread

spread?	i-verbs			u-verbs		
yes	kìmbi	pay	112	rùmùn	agree to	227
no	gèma	change	59	mùsan	exchange	179
no	víne	dance	306	kúve	embrace	147

Extrametricality

- Final syllable is marked extrametrical wrt [high] spread
- Consequently does not undergo [high] spread

Special linking

High links to V1 & may or may not spread

spread?	i-verbs			u-verbs		
yes	kìmbi	pay	112	rùmun	agree to	227
no	gèma	change	59	mùsan	exchange	179
no	víne	dance	306	kúve	embrace	147

Special linking

- [round] and [high] link to the leftmost vowel
- [high] links *before* [low] links
- [low] links if [high] does not spread to V2
- if there is no [low], extrametrical vowel surfaces as 'default' [e]

Summary

Machinery invoked

- a. floating features
- b. articulated feature geometry
- c. spreading of different types
 - ① supralaryngeal node
 - ② [high]
 - ③ height-dependent [round]
- d. preferential linking
 - ① [high] before [low]
 - ② [high], [round] link leftmost

Summary

Machinery invoked

- a. floating features
- b. articulated feature geometry
- c. spreading of different types
 - ① supralaryngeal node
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- d. preferential linking
 - ① [high] before [low]
 - ② [high], [round] link leftmost

Is this all necessary? No!

- a. Consider Emergent grammar
 - bottom up
 - no innate phonological structure
- b. handles Tiv patterns
- c. no appeal to autosegmental representations

Emergent Grammar

Emergent Grammar

What is Emergent Grammar?

Why Emergent Grammar?

- Paul Hopper. "Emergent Grammar". In: *Berkeley Linguistics Society* 13 (1987), pp. 139–157
- Jeff Mielke. "The Emergence of Distinctive Features". PhD thesis. The Ohio State University, 2004
- Tore Nessel. *Abstract phonology in a concrete model. Cognitive linguistics and the morphology-phonology interface*. Berlin: Mouton de Gruyter, 2008
- Brian MacWhinney and William O'Grady, eds. *The Handbook of Language Emergence*. Chichester, UK: John Wiley & Sons, Inc, 2015

Emergent Grammar

What is Emergent Grammar?

- 1 Using general cognitive learning mechanisms (not ones that are specific to language)
- 2 Bottom-up learning based on generalising over perceived forms

Why Emergent Grammar?

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Emergent Grammar

What is Emergent Grammar?

Why Emergent Grammar?

- ① Null hypothesis: cannot adopt innate language capacity until we have rejected emergent hypothesis
- ② Early results suggest Emergence explains
 - a. acquisition
 - b. lexical access
 - c. regular phonological patterns
 - d. idiosyncratic phonological patterns

Paul Hopper. "Emergent Grammar". In: *Berkeley Linguistics Society* 13 (1987), pp. 139–157

Jeff Mielke. "The Emergence of Distinctive Features". PhD thesis. The Ohio State University, 2004

Tore Nessel. *Abstract phonology in a concrete model*. Cognitive linguistics and the morphology-phonology interface. Berlin: Mouton de Gruyter, 2008

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Principles of Emergence

Human cognition Primitives (a non-exhaustive list)

- a. **Memory**
- b. **Similarity**: Humans note similarity between remembered and encountered items (faces, sounds, words).
- c. **Frequency**: Humans keep track of frequency, or how many times something is encountered, giving greater weight to more frequently occurring experiences.
- d. **Generalising** (& generalising over generalisations): Humans build a symbolic system, starting with categories of similar items then finding similarities among categories and so building an increasingly abstract set of relations within the symbolic system.

Emergent Grammar illustrated

Acquiring a phonological system

What the learner has to learn

- a. segments
- b. segment phonotactics
- c. segment sequence phonotactics
- d. prosody
- e. prosodic shapes of words
- f. verb vs. noun
- g. meanings
- h. morphological relations
- i. etc. etc.

Our focus & simplifying assumptions

What the learner has to learn

- a. ✓ segments [i e a ɔ o u]
- b. ✓ segment phonotactics *[High, Low]
- c. **segment sequence phonotactics**
- d. ✓ prosody
- e. ✓ prosodic shapes of words
- f. ✓ verb vs. noun
- g. ✓ meanings
- h. **morphological relations**
- i. ✓ etc. etc.

Acquiring a phonological system

What is easy to identify?

- a. Initially, item has to be heard to be learned
- b. Adult humans pay attention to frequency
- c. Young language learners pay attention to frequency
- d. Kids generalize over a types of the same pattern – even over a small number of items

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Joshua B. Tenenbaum and Thomas L. Griffiths. “Generalization, similarity, and Bayesian inference”. In: *Behavioral and Brain Sciences* 24.4 (2001), pp. 629–640

Acquiring a phonological system

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- Jessica Maye, Janet Werker, and LouAnn Gerken. “Infant Sensitivity to Distributional Information can affect Phonetic Discrimination”. In: *Cognition* 82.3 (2002), pp. 101–111
- C. Dawson and L.A. Gerken. “When global structure “Explains Away” local grammar: A Bayesian account of rule-induction in tone sequences”. In: *Cognition* 120.3 (2011), pp. 350–359

Acquiring a phonological system

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LouAnn Gerken and Alex Bollt. “Three Exemplars Allow at Least Some Linguistic Generalizations: Implications for Generalization Mechanisms and Constraints”. In: *Language Learning and Development* 4 (2008), pp. 228–248

LouAnn Gerken et al. “Surprise! Infants consider possible bases of generalization for a single input example”. In: *Developmental science* 18.1 (2015), pp. 80–89

What is critical? Segments

Contrast 6 vowels: [i, e, a, ɔ, o, u]

- a. Hear items with vowels in them
- b. Notice sounds
- c. Notice similarities between sounds
- d. Group similar items as members of the same class

What is critical? Identify segments

Similarities converge on 6 vowel groups

	Groupings	phonetics	Tiv phonology	call them...
a.	{ i e a }	lip position	co-occur	[nonround]
b.	{ ɔ o u }	lip position	co-occur	[round]
c.	{ i u }	tongue/F1	following V	[high]
d.	{ e a ɔ o }	tongue/F1	co-occur	[nonhigh]
e.	{ ɔ a }	tongue/F1	asymmetric	[low]
f.	{ e o }	tongue	most regular	[mid]

What is critical? Identify words

fɪar₁

njùhur₁

dìnde₁

kóse₁

nèe₁

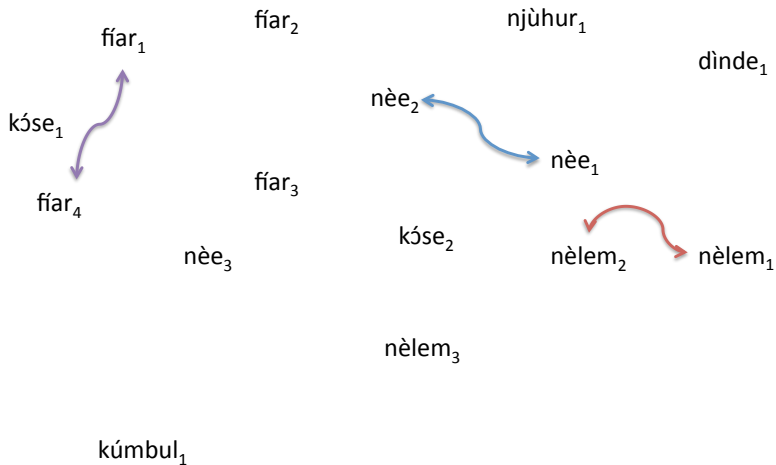
nèlem₁

kúmbul₁

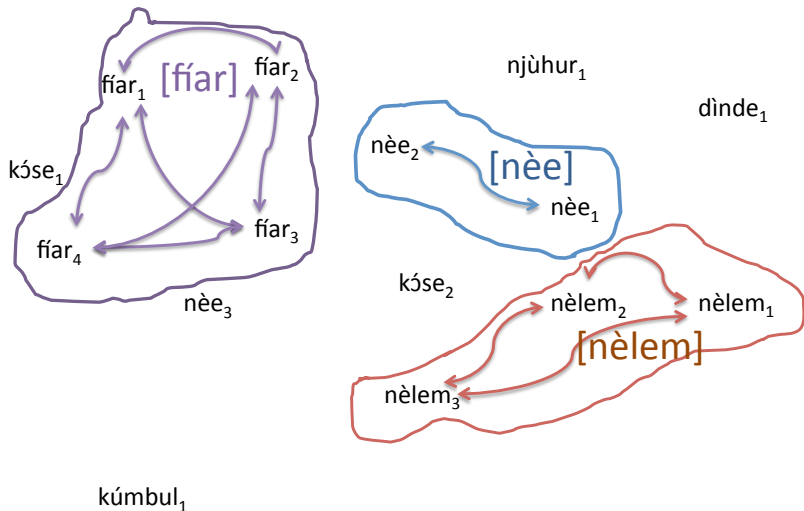
What is critical? Identify words

fíar₁ fíar₂ njùhur₁ dìnde₁
 kóse₁ nèe₂
 fíar₃ nèe₁
 nèlem₂ nèlem₁
 kúmbul₁

What is critical? Identify words – note similar sequences



What is critical? Identify words – identify similar sequences as ‘the same’



What is critical? Identify sequences

fár

njúhur

dínde

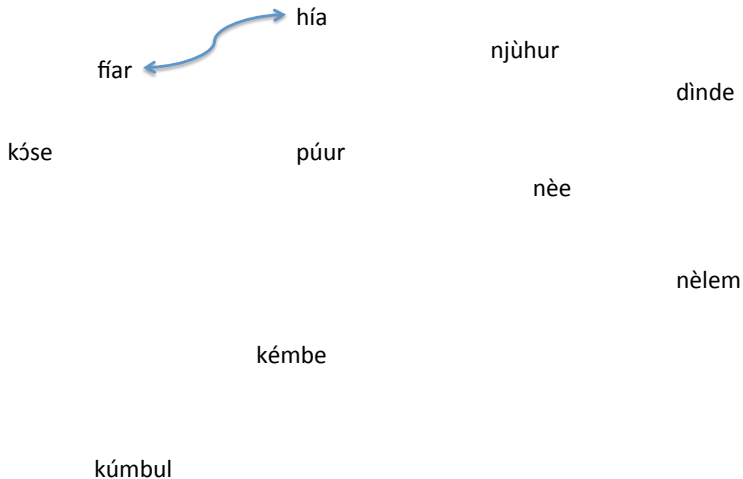
kóse

nèe

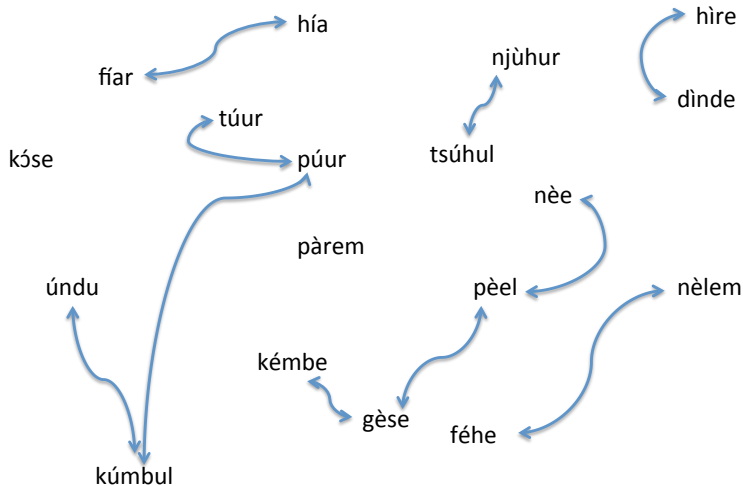
nèlem

kúmbul

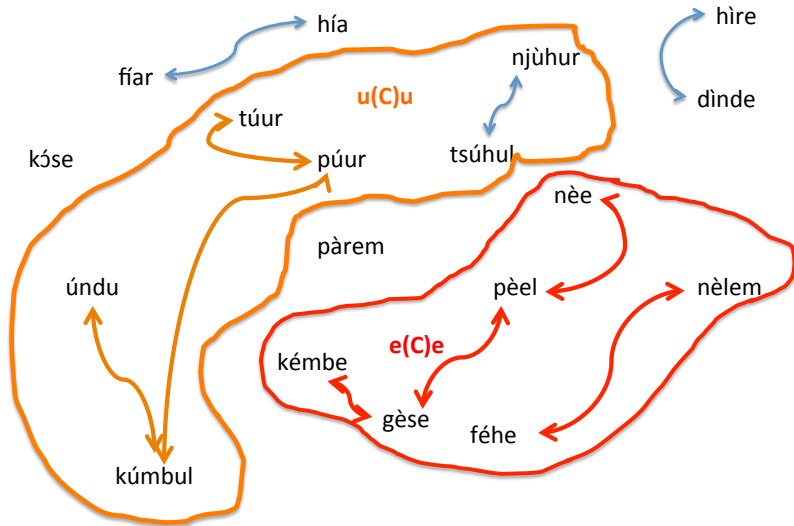
What is critical? Identify similar sequences



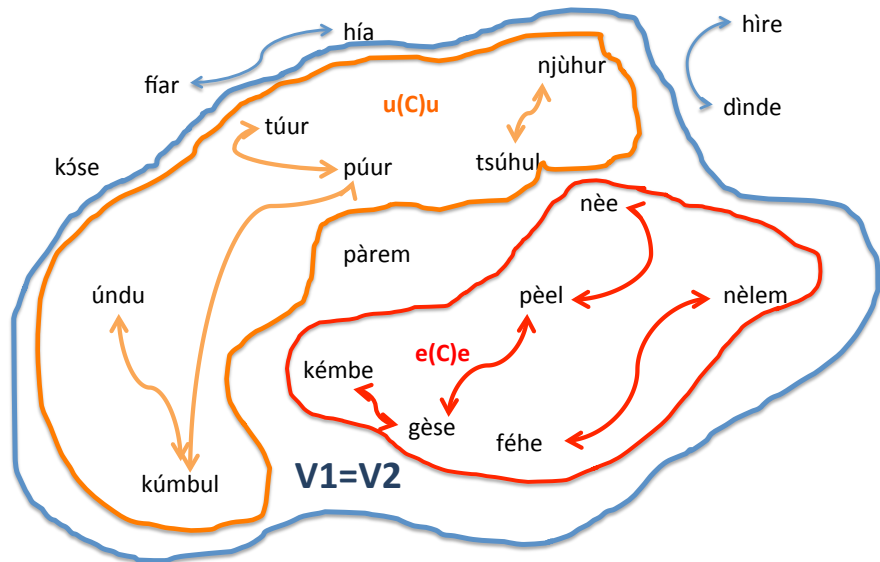
What is critical? Identify more similar sequences



What is critical? Identify similar sequences as 'the same'



Recursion: Generalisations over generalisations



Distribution of vowels in Tiv

Acquiring Tiv verbal phonology

Frequency of vowel sequences in Tiv: VV, VhV, VCV (n=2159)

a. Most sequences are rare (negative value) or non-occurring (blank cell).

Log2 of Observed/Expected of all V...V verbs

	i	e	a	ɔ	o	u
i	2.78	-1.03	-0.23			
e		1.05	-.05			
a		0.65	1.24		-4.58	
ɔ		-4.63		3.68	1.68	-0.97
o					2.4	-1.36
u		-1.57	0.5			2.4

Interpreting Log2

2	4 times as frequent
1.58	3 times as frequent
1	twice as frequent
0	as expected
-1	half as frequent
-1.58	one third as frequent
-2	one fourth as frequent

Acquiring Tiv verbal phonology

Frequency of vowel sequences in Tiv: VV, VhV, VCV (n=2159)

- Most sequences are rare or non-occurring (blank cell).
- Identical vowels occur at least twice as often as expected.

$V_1 \dots V_2, V_1 = V_2$

	i	e	a	ɔ	o	u
i	2.78	-1.03	-0.23			
e		1.05	-.05			
a		0.65	1.24		-4.58	
ɔ		-4.63		3.68	1.68	-0.97
o					2.4	-1.36
u		-1.57	0.5			2.4

Most verb forms are in the General Class

Acquiring Tiv verbal phonology

Frequency of vowel sequences in Tiv: VV, VhV, VCV (n=2159)

- Most sequences are rare or non-occurring (blank cell).
- Identical vowels occur at least twice as often as expected.
- Skewed frequencies lead to generalisations about sequences.

$V_1 \dots V_2, V_1 = V_2$

	i	e	a	ɔ	o	u
i	2.78	-1.03	-0.23			
e		1.05	-.05			
a		0.65	1.24		-4.58	
ɔ		-4.63		3.68	1.68	-0.97
o					2.4	-1.36
u		-1.57	0.5			2.4

General verb class

$V_1 = V_2$

Most verb forms are in the General Class

Acquiring Tiv verbal phonology: mid vowels

Implications for forms with initial [mid] vowels

V...V sequences, V_1 is [mid]

	i	e	a	o	u
eV		165			
ehV		36			
eCV		347	54		
oV				89	
ohV				20	
oCV				179	15

The General Class

$$V_1 = V_2$$

Acquiring Tiv verbal phonology: mid vowels

Implications for forms with initial [mid] vowels

V...V sequences, V_1 is [mid]

	i	e	a	o	u
eV		165			
ehV		36			
eCV		347	54		
oV				89	
ohV				20	
oCV				179	15

The General Class

$$V_1 = V_2$$

The Nonround Mid-Low Class

$$V_1 = [\text{mid}] \rightarrow V_2 = [\text{low}]$$

(nonround vowels only)

Acquiring Tiv verbal phonology: mid vowels

Implications for forms with initial [mid] vowels

V...V sequences, V_1 is [mid]

	i	e	a	o	u
eV		165			
ehV		36			
eCV		347	54		
oV				89	
ohV				20	
oCV				179	15

The General Class

$$V_1 = V_2$$

The Nonround Mid-Low Class

$$V_1 = [\text{mid}] \rightarrow V_2 = [\text{low}]$$

(nonround vowels only)

Residual o...u class

Five CVCVC verbs with the sequence o...u in all 3 morphological forms.

Acquiring Tiv verbal phonology: Low vowels

Frequency of all vowel sequences in Tiv (n=2159)

- [ɔ...o], [a...e] are fairly robust classes.
- Both begin with a [low] vowel.

V1 = Low, V2 ≠ V1

	i	e	a	ɔ	o	u
i	2.78	-1.03	-0.23			
e		1.05	-.05			
a		0.65	1.24		-4.58	
ɔ		-4.63		3.68	1.68	-0.97
o					2.4	-1.36
u		-1.57	0.5			2.4

Class: Low-Mid

V₁ = [low]

V₂ = [mid]

V₁, V₂ have same [round]

Some verbs are marked for Low-Mid membership

- Some verbs with [low] V1 are in the General Verb Class.
- Some verbs with [low] V1 are in the Low-Mid Class.
- Class membership is part of what is learned.

Acquiring Tiv verbal phonology: Low vowels

Distribution of sequences with low vowels

VV & VhV sequences

	e	a	ɔ	o	u
aV		90			
ahV		27			
ɔV			40		2
ɔhV			15	1	

VCV sequences, C ≠ [h]

	e	a	ɔ	o	u
aCV	277	3		3	
ɔCV	3		3	96	9

V(h)V sequences

Class: V(h)V

$$V_1 = V_2$$

The General Class!

Acquiring Tiv verbal phonology: Low vowels

Distribution of sequences with low vowels

VV & VhV sequences

	e	a	ɔ	o	u
aV		90			
ahV		27			
ɔV			40		2
ɔhV			15	1	

VCV sequences, C ≠ [h]

	e	a	ɔ	o	u
aCV	277	3		3	
ɔCV	3		3	96	9

V(h)V sequences

Class: V(h)V

$$V_1 = V_2$$

The General Class!

VCV sequences, C ≠ [h]

Class: Low-Mid

VCV, C ≠ [h] & V₁ = [low]

→ V₂ = [mid]

V₁, V₂ have same [round]

Acquiring Tiv verbal phonology: high vowels

Implications for forms with initial [high] vowels

V...V sequences, V₁ is [high]

	i	e	a	u
iV	59	24	28	
ihV	11	4		
iCV	143	40	6	
uV		8	20	81
uhV		1	4	8
uCV		46	42	160

The General Class

$$V_1 = V_2$$

Acquiring Tiv verbal phonology: high vowels

Implications for forms with initial [high] vowels

V...V sequences, V_1 is [high]

	i	e	a	u
iV	59	24	28	
ihV	11	4		
iCV	143	40	6	
uV		8	20	81
uhV		1	4	8
uCV		46	42	160

The General Class

$$V_1 = V_2$$

The High...Nonhigh Class

$$V_1 = [\text{high}] \rightarrow \\ V_2 \neq [\text{round}], [\text{high}]$$

Is [e] or [a] in the second syllable? It's in part random

$$V_1 = [\text{high}] \ \& \ \exists V_2 \rightarrow V_2 \text{ is either [a], [e], or [high]}$$

Basic Tiv verbal phonology summary

Classes

- a. Tiv sequential frequencies lead to generalisations: sequential phonotactics.
- b. Generalisations over items define verb classes.
- c. Robust class: Identity between vowels.
- d. A few large but less robust classes (Mid-low; Low-mid; High-nonhigh)
- e. A few small classes (oCu)
- f. Some “one offs”, e.g. [nyóho] ‘be sweet’

Basic Tiv verbal phonology summary

Classes

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- f. Some “one offs”, e.g. [nyóho] ‘be sweet’

All without appeal to autosegmental representations

Tiv phonological classes for verbs

	Condition	Condition	Emergent effect
a.	General	$V_1 = V_2$	Spread
b.	Mid-Low	$V_1 = [\text{mid}] \rightarrow V_2 = [\text{low}]$ (nonround vowels only)	Special linking
c.	Low-Mid	VCV, $C \neq [h]$ & $V_1 = [\text{low}] \rightarrow V_2 = [\text{mid}]$ (V_1, V_2 have same [round])	Extrametricity, Spread
d.	High-Nonhigh	$V_1 = [\text{high}] \rightarrow V_2 \neq [\text{round}], [\text{high}]$	Linking priority, extrametricality

What about feature geometry?

Consider translaryngeal harmony & the supralaryngeal node

VV, VhV & V?V vs. VCV cases

- A not uncommon pattern cross-linguistically (Steriade 1999).
- 'No feature geometry' predicts VV and VCV vs. VhV, V?V!

Consider translaryngeal harmony & the supralaryngeal node

VV, VhV & V?V vs. VCV cases

- A not uncommon pattern cross-linguistically (Steriade 1999).
- 'No feature geometry' predicts VV and VCV vs. VhV, V?V!

Emergent prediction: no need for special representations

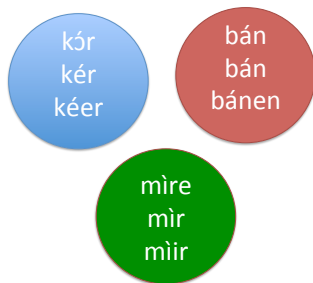
- Proximity: The closer two sounds are to each other, the more likely they are to interact (Suzuki 1998)
- VV is closer than any VCV
- VhV, V?V are closer than VCV for articulation
- In principle, VV, VCV vs. VhV is possible
- It is unlikely to arise in a language but could be learned if it did occur (Blevins 2004)

An Emergent Tiv Morphology

Word learning 1: a few items

“Morph sets”

- Sets of morphs with some similarity, here meaning & function
- Sets learned by principles of similarity/generalisation
- As more sets are learned, learner generalises over properties of sets
- Our focus here: what are the generalisations relating members of a morph set?



Is ‘no autosegmental representations’ a problem?

General properties of Tiv verb system

- a. 3 tenses General past, Recent past, Habitual
- b. tones Different patterns for each tense
 → ignoring tonal alternations
- c. prosody Sometimes the same throughout, sometimes not.
 → Common alternations: V/0; 0/Vn; V/VV

Extending analysis to morphological alternations

Prosodic alternations in Tiv verbs

	General Past	Recent Past	Habitual	gloss
a.	<i>Same prosody throughout</i>			
	náha	náha	náha	stir, 182
	tèse	tèse	tèse	show, 268
	tìmbir	tìmbir	tìmbir	delay, 270
b.	<i>Habitual has different prosody in one of 2 ways: VV or Vn</i>			
	mèm	mèm	mèem	rest, 166
	kór	kór	kóron	sew, 121
c.	<i>Three distinct prosodic forms</i>			
	kíne	kín	kíin	groan, 113
	túme	túm	túum	kick, 289
	súe	súgh	súugh	support, 257
	bé	bée	béen	finish, 3

Question 1: What vowel accompanies [n]?

Examples of Vn in the Habitual

	General Past	Recent Past	Habitual	gloss
[i]	cíl	cíl	cílin	cover, 16
[e]	kér	kér	kéren	seek, 109
[a]	ár	ár	áren	chop, 222
[o]	kór	kór	kóron	sew, 121
[u]	búr	búr	búrun	be bald, 132

NOTES:

- ① All verbs with -n in the Habitual are H-toned
- ② No verbs with [ɔ] take -n in the Habitual

Suffixation: CVC roots and Habitual [Vn]

Tiv verb wellformedness conditions govern RP & H

Class: Low-Mid, C ≠ [h]

$V_1 = [\text{low}], V_2 = [\text{mid}]$
 V_1, V_2 have same [round]

The General Class

$V_1 = V_2$

		General Past	Recent Past	Habitual	gloss
[high]-[high]	[i]	cíl	cíl	cílin	cover, 16
	[u]	búr	búr	búrun	be bald, 132
[mid]-[mid]	[e]	kér	kér	kéren	seek, 109
	[o]	kór	kór	kóron	sew, 121
[low]-[mid]	[a]	ár	ár	áren	chop, 222

Setting aside VV, VhV cases, where typically $V_1 = V_2$

General properties of Tiv verb system

- a. 3 tenses General past, Recent past, Habitual
- b. tones Different patterns for each tense
→ ignoring tonal alternations
- c. prosody Sometimes the same throughout, sometimes not.
→ Common alternations: V/0; 0/Vn; V/VV
- d. “ablaut” Vowel quality alternations
Recent Past/Habitual: most common patterns
→ No [ɔ] in Recent Past or Habitual
→ aCe, C≠[h]
V₁=V₂

Tiv ablaut

Vowel quality alternations

	General Past	Recent Past	Habitual	gloss
a. $V_2 = V_1$	témba hìde	témbe hìdi	témbe hìdi	thread, 267 return, 76
b. no [ɔ]	tsòr nòndo	tsèr nènde	tsèer nènde	select, 284 drip, 202
c. no high-low	yíra kùma dzùà	yér kòm dzògh	yéer kòom dzòogh	call, 327 suffice, 139 collect, 37

Question 2: What are the vowel quality relations?

Examples of ablaut

	General Past	Recent Past	Habitual	gloss
[i...e]	hìde	hìdi	hìdi	return, 76
[u...e]	númbe	númbu	númbu	play, 204
[u...a]	tsúmba	tsómbo	tsómbo	abrade, 286
[e...a]	kémba	kémbe	kémbe	clutch, 107
[ɔ...ɔ]	còhɔ	cèhe	cèhe	plaster, 19
[ɔ...o]	tóngo	téngge	téngge	blow, 274

NOTES:

- Recent Past and Habitual show [aCe], $C \neq [h]$; else $V_1 = V_2$
- Identical vowels tend to show no vowel quality alternations.

Vowel quality relations

	GP	RP/H
same	(a...e)	a...e
	(a(h)a)	a(h)a
	(o...o)	o...o
V ₁ =[high]	(i...i)	i...i
	i...e	
	(u...u)	u...u
	u...e	
	u...a	o...o
V ₁ =[e]	(e...e)	e...e
	e...a	
V ₁ =[ɔ]	ɔ...o	

Generalisations

- No alternations = (...).
- No [ɔ] in RP & H.
- In V₁ ≠ [low], V₂ = V₁

Vowel quality relations

	GP	RP/H
same	(a...e)	a...e
	(a(h)a)	a(h)a
	(o...o)	o...o
V ₁ =[high]	(i...i)	i...i
	i...e	
	(u...u)	u...u
	u...e	
	u...a	o...o
V ₁ =[e]	(e...e)	
	e...a	e...e
V ₁ =[ɔ]	ɔ...o	

Identity Relation

GP RP, H
 V₁ ≠ [low] → V₂ = V₁

Vowel quality relations

	GP	RP/H
same	(a...e)	a...e
	(a(h)a)	a(h)a
	(o...o)	o...o
V ₁ =[high]	(i...i)	i...i
	i...e	
	(u...u)	u...u
	u...e	
	u...a	o...o
V ₁ =[e]	(e...e)	
	e...a	e...e
V ₁ =[ɔ]	ɔ...o	

[low, round] Relation

GP		RP, H
V ₁	→	V ₁ ≠
[low, round]		[low, round]

Vowel quality relations

	GP	RP/H
same	(a...e)	a...e
	(a(h)a)	a(h)a
	(o...o)	o...o
V ₁ =[high]	(i...i)	i...i
	i...e	
	(u...u)	u...u
	u...e	
	u...a	o...o
V ₁ =[e]	(e...e)	
	e...a	e...e
V ₁ =[ɔ]	ɔ...o	

[high, round, low] Relation

	GP			RP, H
high	C	low	→	nonhigh
round				round

Summary: Vowel quality alternations

Relations: highly similar to conditions on verb classes

Relation	General Past	→	Recent Past/Habitual
a. Identity	$V_1 \neq [\text{low}]$		$V_2 = V_1$
b. [low, round]	V_1 [low, round]		$V_1 \neq$ [low,round]
c. [high, round, low]	high C low round		nonhigh

Conclusion

The essence of our analysis

Phonological restrictions on lexical verb classes

- a. Identity
- b. Low-Mid, same rounding
- c. High-Nonhigh, Nonround

Phonological restrictions on relations between lexical verb classes

- a. Relate General Past to Recent Past and Habitual
- b. Identity
- c. No Low-Round
- d. High-Low-Round relates to Mid-Round

The Emergent advantage

Results

- a. Tiv verb phonotactics characterised as simple generalisations each holding over a fraction of the lexicon
- b. Tiv verb morphotactics hold over whole lexicon generalisations
- c. No need for richness of autosegmental representations

The Emergent advantage

Results

- a. Tiv verb phonotactics characterised as simple generalisations each holding over a fraction of the lexicon
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- c. No need for richness of autosegmental representations

Why does Emergence give these results?

- Starting point is the language learner, not the adult language
- What is accessible without UG?

The Emergent advantage

Comparisons: Emergence vs. UG models

Emergence generalisations are straightforward
 must learn which class a verb belongs to

UG models express verb classes by phonological features
 requires extrametricality or similar for [i...e], [u....e] cases
 requires feature geometry
 requires special linking and spreading rules/parochial constraints

Thank you!

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