Morphosyntactic and lexical conditioning of vowel replacement in Guébie[*]

Hannah Sande

May 30, 2017

1 Introduction

Phenomenon: Root vowels in Guébie (Kru) [Côte d'Ivoire] are replaced with vowels of particular affixes[1]:

(1) /jɪla$^{3.3}$+ɔ^{2}/ → [jɔlɔ$^{3.2}$], *[jɪla-ɔ$^{3.3.2}$], *[jɪlɔ$^{3.2}$]
ask+3SG.HUM.OBJ → 'ask him'

This vowel replacement process is complex in two ways:

1. It only occurs in particular morphosyntactic environments.
2. It only occurs in 33% of Guébie roots.

Question: How do morphology and phonology interact such that both morphosyntactic and lexical information combine to trigger a phonological process?

Solution:

- Cophonologies, or morpheme-specific phonological grammars, drive vowel replacement only in particular contexts (Orgun 1996; Anttila 2002; Inkelas and Zoll 2005).
- Differences in phonological encoding strength of vowels condition different levels of input-output faithfulness, allowing some vowels to alternate where others do not (Smolensky et al. 2014; Inkelas 2015; Moore-Cantwell 2017; Pycha et al. 2017).

In this way, vowel replacement is driven by morpheme-specific constraint rankings and is limited by strong faithfulness to strongly encoded vowels.

Road map:

[*]Many thanks to the Guébie community, especially Sylvain Bodji, Olivier Agodio, and Serikpa Emil. Thanks also to Sharon Inkelas, Larry Hyman, Peter Jenks, and Dasha Kavitskaya for comments on various versions of this work.

[1]Guébie has four tone heights, marked with numbers 1-4, where 4 is high.

2 Morphosyntactic conditioning of vowel replacement

- Morphemes differ in whether they
  1. trigger vowel replacement of root vowels,
  2. undergo ATR harmony with the root.
- On monosyllabic roots, it is difficult to see the effect of vowel replacement, because all roots end in vowels, and when a vowel-initial suffix is added, the normal hiatus resolution process of the language is to delete to root-final vowel.
  - Ex: /ɓi^{2}-o^{2}/, *finish*-PASS, is pronounced [ɓo^{2}], *[ɓio$^{2.2}$].
  - For this reason, I use disyllabic examples throughout.
- **Nominalizer**: No harmony, no replacement

(2) **Nominalizer: no ATR harmony, no replacement**

	Verb	**Nominalized**	**Gloss**
a.	jeɓe$^{3.1}$	jeɓe-li$^{3.1.2}$	'knowing'
b.	sumu$^{2.2}$	sumo-li$^{2.2.2}$	'boiling'
c.	gbala$^{2.4}$	gbala-li$^{2.4.2}$	'climbing'
d.	bala$^{3.3}$	bala-li$^{3.3.2}$	'hitting'

- **Passive**: ATR harmony, no replacement

(3) **Passive: ATR harmony, no replacement**

	Verb	**Passive**	**Gloss**
a.	ɓi^{2}	ɓ-o^{2}	'be finished'
b.	sumu$^{2.2}$	sum-o$^{2.2}$	'be boiled'
c.	jili$^{2.3}$	jil-o$^{2.32}$	'be stolen'
d.	bala$^{3.3}$	bal-ɔ$^{3.2}$	'be hit'
e.	jɪla$^{3.3}$	jɪl-ɔ$^{3.2}$	'be asked'

- **Object enclitics**: No harmony, replacement
  - Here we see replacement, where the initial vowel of a root surfaces with the same features as the object enclitic.
    - This complete vowel replacement occurs regardless of the ATR quality of root vowels.

(4) **Object enclitics: Vowel replacement, No Harmony**

	Verb	Object	Verb+Obj	Gloss
a.	jili$^{2.3}$	=ɔ^{2}	jɔl=ɔ$^{2.32}$, *jil=ɔ$^{2.32}$	'steal him'
b.	jili$^{2.3}$	=ɛ^{2}	jɛl=ɛ$^{2.32}$, *jil=ɛ$^{2.32}$	'steal it'
c.	jili$^{2.3}$	=ɪ^{2}	jɪl=ɪ$^{2.32}$, *jil=ɪ$^{2.32}$	'steal them'
d.	jɪla$^{3.3}$	=ɔ^{2}	jɔl=ɔ$^{3.2}$, *jɪl=ɔ$^{3.2}$	'ask him'
e.	jɪla$^{3.3}$	=ɛ^{2}	jɛl=ɛ$^{3.2}$, *jɪl=ɛ$^{3.2}$	'ask it'
f.	jɪla$^{3.3}$	=ɪ^{2}	jɪl=ɪ$^{3.2}$	'ask them'
g.	bala$^{3.3}$	=ɔ^{2}	bɔl=ɔ$^{3.2}$, *bal=ɔ$^{3.2}$	'hit him'
h.	bala$^{3.3}$	=ɛ^{2}	bɛl=ɛ$^{3.2}$, *bal=ɛ$^{3.2}$	'hit it'
i.	bala$^{3.3}$	=ɪ^{2}	bɪl=ɪ$^{3.2}$, *bal=ɪ$^{3.2}$	'hit them'

- **Plural morphemes**: Harmony, replacement

(5) **Plural: Vowel replacement, Harmony**

	Noun	Plural	Plural noun	Gloss
a.	ɓuli$^{3.3}$	/-I/	ɓil-i$^{3.3}$	'cow'
b.	wʊlɪ$^{4.4}$	/-I/	wɪl-ɪ$^{4.4}$	'goat'

- **Summary**:
  - Vowel replacement occurs in object enclitic and plural contexts, but not elsewhere.
  - Vowel harmony occurs in passive and plural contexts, but not in all contexts.

(6) **Morphemes by phonological property**

	Harmony	No Harmony
No replacement	SG	DEF
	CAUS	1/2.ACC
	PASS	NMLZ
	APPL	
	RECIP	
Replacement	PL	3.ACC

  - The shaded cells are morphemes that occur in nominal domains, while the other morphemes occur on verb roots.

- To account for the fact that vowel replacement and ATR harmony occur in some contexts but not others, I propose modeling the data in Cophonology Theory (Orgun 1996; Inkelas et al. 1997; Anttila 2002; Inkelas and Zoll 2005, 2007).
  - Cophonology Theory allows for distinct constraint rankings triggered by different morphosyntactic constructions in the same language.
  - In section 4 I present the constraint rankings necessary to derive the different levels of replacement in Guébie.

3 Lexical specificity of vowel replacement

- In this section I address the lexical conditioning of vowel replacement.
- The vowel replacement facts described in section 2 only occur in 33% of roots.
  - This number is based on a corpus of 3577 distinct morphemes, and over 5000 utterances, collected primarily in Gnagbodougnoa, Côte d'Ivoire between 2013 and 2017.
- Note that in non-replaceable roots, object enclitics retain their underlying ATR quality (no harmony), while plural suffixes take the ATR quality of the root they attach to (harmony).

(7) **Non-replaceable roots in object contexts (No harmony)**

	Root	**Root=ɔ**^{2}	**Gloss**
a.	sumu$^{2.2}$	sum=ɔ$^{2.2}$, *sɔmɔ$^{2.2}$	'boil him'
b.	ɟʊla$^{3.2}$	ɟʊl=ɔ$^{3.2.2}$, *ɟɔlɔ$^{3.2}$	'take him'

(8) **Non-replaceable roots in plural contexts (Harmony)**

	Noun	**Plural noun**	**Gloss**
a.	nunə$^{3.3}$	nun-i$^{3.3}$	'story'
b.	tɛlɛ$^{3.3}$	tɛl-ɪ$^{3.3}$	'snake'

- I propose that the difference between roots that undergo replacement (4, 5) and those that do not (7, 8) is due to a difference in phonological encoding strength.
- Namely, roots that undergo replacement have a weakly phonologically encoded initial vowel (see Smolensky et al. 2014; Inkelas 2015; Rosen 2016; Moore-Cantwell 2017 and Pycha et al. 2017 for recent analyses of alternations depending on encoding strength).
  - Weakly encoded vowels have also been also called *latent, floating,* or *defective* vowels (cf. Zoll 1996).
  - Here I follow the Kru literature in notating weakly encoded vowels as superscripted (Marchese 1979; Zogbo 2016): *b*^{a}*la*$^{3.3}$, 'hit'.
  - By contrast, those segments which are not written as superscripts are considered to be *strongly encoded.*
- Support for an encoding strength analysis comes from the fact that the same set of roots that undergo vowel replacement also undergo vowel reduction.

(9) **CVCV reduced to CCV** (syl_20161207)

	CVCV	**CCV**	**Gloss**
a.	bala$^{3.3}$	bra^{3}	'hit'
b.	kala$^{3.3}$	kra^{3}	'cut down'
c.	tulu$^{4.4}$	tru^{4}	'chase'
d.	jɪla$^{3.3}$	jra^{3}	'ask'
e.	zala$^{2.2}$	zra^{2}	'tobacco pipe'
f.	wʊlʊ$^{3.3}$	wrʊ^{3}	'granary'
i.	ɟʊla$^{3.2}$	*ɟra^{32}	'take, borrow'
j.	ɓolo$^{2.2}$	*ɓro$^{2.2}$	'one'

  - Those roots in (9i,j) do not undergo vowel replacement, nor are they reducible to CCV.
  - All other roots in (9) undergo both vowel replacement in object/plural contexts and reduction to CCV.
  - Unlike replacement, vowel reduction is not morphosyntactically conditioned.
  - Reduction is conditioned by speech rate and social factors.

- Roots that undergo reduction/replacement tend to share certain phonological properties:
  - C2 (consonant) is /l/ (or /m/ in a nasal root)
  - V1 (vowel) and V2 are identical
  - T1 (tone) and T2 are identical

- Not every root with these features is reducible, and not every reducible root has (some subset of) these features; however, the more of the above features a given root shows, the more likely it is to be reducible.

(10) **Factors influencing reducibility**

	T1=T2	**C2=l**	**V1=V2**	**T&C2**	**T&V**	**C2&V**	**All**	**None**
Reducible	269	287	328	145	208	199	127	157
Total	614	536	611	244	339	244	154	751
Percent	43.8	53.5	53.7	59.4	61.4	81.6	82.5	20.9

- Phonological features like those in (10) tend to cue which roots have weak versus strong initial vowels; however, the effect is not categorical, thus some information about strength of encoding must be present lexically.

- I notate this difference in encoding strength on lexical items with superscripts, as described above.

- Using the encoding strength terminology, we see the patterns in (11).

(11) **Distribution of replacement and ATR harmony by encoding strength**

	Strong vowels	**Weak vowels**
Object	No replacement, No harmony	Replacement, No harmony
Plural	No replacement, Harmony	Replacement, Harmony
Passive (and others)	No replacement, Harmony	No replacement, Harmony
Nominalizer (and others)	No replacement, No harmony	No replacement, No harmony

4 A multiple-grammar constraint-based analysis

- There are two obvious approaches to the vowel replacement facts:
  1. suppletive allomorphy
  2. multiple phonological grammars sensitive to lexical class and morphosyntactic construction

- I argue for the latter.

4.1 Morphosyntactically conditioned cophonologies

- This section accounts for the morphosyntactic conditioning of vowel replacement, using a multiple-grammar model of phonology (Lightner 1965; Kiparsky 1982; Orgun 1996; Inkelas et al. 1997; Itô and Mester 1999; Bermúdez-Otero 1999; Kiparsky 2000; Anttila 2002; Inkelas and Zoll 2005, 2007; Kiparsky 2008).
- I propose that there are distinct phonological grammars, Cophonologies, triggered in the environment of
  - Object enclitics (vowel replacement, no harmony),
  - Plural (vowel replacement, harmony),
  - Passives (no replacement, harmony),
  - and Nominalizers (no replacement, no harmony).
- Within each cophonology, the ranking of encoding-strength-sensitive faithfulness constraints determines whether replacement occurs for a given root.

4.1.1 Object enclitic cophonology

- **Vowel replacement**: In order to ensure replacement of root input vowels with a vowel identical to the object enclitic, I propose the use of Agreement by Projection (ABP) (proposed by Hansson 2014, and illustrated in Lionnet 2016; Walker 2016).
  - ABP constraints conflate the work of Agreement-by-Correspondence constraints Corr and CC-Ident[F] (Hansson 2001; Rose and Walker 2004) into a single constraint.
  - Only those segments with a particular feature (here +syllabic), are evaluated, on a separate tier from the rest of the word or phrase under consideration.

(12) ***[**α**F][**β**F]**$_{[+syllabic]}$
A segment with some feature value may not directly precede another segment with a different feature value in the ordered set of output segments that are [+syllabic] (i.e. vowels). Assign one violation for each pair of neighboring segments that meet the criteria.

- The above constraint will penalize candidates whose vowels do not agree in phonological features.
- This constraint must dominate an input-output identity constraint, (13).

(13) **Ident-IO** (McCarthy and Prince 1995)
Assign one violation for each output segment whose features differ from the corresponding input segment.

- **Object enclitic faithfulness**: To ensure that the output vowels have the same features as the object enclitic vowel and not the features of the root vowels, I propose using the Ident-Phase, (14) (McPherson and Heath 2016).

(14) **IDENT-PHASE(DP)** (adapted from (McPherson and Heath 2016, 613))
Assign one violation if the phonological content of a DP phase is distinct in the output from the input.

- **Tone**: Tone does not play a role in vowel replacement, so I leave it out of the tableaux below. Subscripts on vowels represent input-output correspondence relationships.

(15) **ID-PHASE, *[αF][βF]$_{[+syllabic]}$ $\gg$ ID-IO**

/b^{a_i}la$_j$=ɔ$_k$/	ID-PHASE	*[αF][βF]$_{[+syllabic]}$	ID-IO
a. ba$_i$la$_k$	*!		*
b. ba$_i$lɔ$_k$		*!	
c. ☞bɔ$_i$lɔ$_k$			*

- **No vowel hiatus**: In addition to ensuring correspondence between output root and enclitic vowels, we need a constraint that prevents two vowels from surfacing next to each other across a morpheme boundary.

(16) ***V+V**
Assign one violation for every instance of two consecutive output vowels that correspond to two distinct input morphemes.

- A candidate could satisfy *V+V in two ways, either by failing to realize the final root vowel (which is the correct output), or the enclitic vowel.

- To avoid the latter repair, we need another constraint to ensure that if an input vowel is the only exponent of some morpheme, it has some output realization.

(17) **REALIZEMORPHEME** (Samek-Lodovici 1993; Rose 1997; Walker 2000; Kurisu 2001)
Assign one violation for each input morpheme that is not phonologically realized in the output.

(18) **Weak vowels in object contexts**
REALIZE, *V+V, ID-PHASE, *[αF][βF] $\gg$ ID-IO

/b^{a_i}la$_j$=ɔ$_k$/	REALIZE	*V+V	ID-PHASE	*[αF][βF]	ID-IO
a. ba$_i$la$_j$	*!				
b. ba$_i$la$_j$ɔ$_k$		*!		*	
c. ba$_i$la$_k$			*!		
d. ba$_i$lɔ$_k$				*!	
e. ☞bɔ$_i$lɔ$_k$					*

- While the tableau in (18) ensures vowel replacement in the context of a third-person object enclitic, it will incorrectly predict vowel replacement in *all* roots, (19).

- The root in (19), ɟʊla$^{3.2}$, 'take, borrow', is not reducible to CCV, nor does it undergo vowel replacement.

(19) **Realize, *V+V, Id-Phase, *[αF][βF] ≫ Id-IO**

/ɟʊ$_i$la$_j$=ɔ$_k$/	Realize	*V+V	Id-Phase	*[αF][βF]	Id-IO
a. ɟʊ$_i$la$_j$	*!			*	
b. ɟʊ$_i$la$_j$ɔ$_k$		*!		**	
c. ɟʊ$_i$lʊ$_k$			*!		*
d. ɟʊ$_i$lɔ$_k$				*!	
e. ☹ ɟɔ$_i$lɔ$_k$					*

- The tableau in (19) predicts (19e), where vowel replacement has occurred, to be the winner.
- Instead, the output candidate is (19d), where the final vowel of the root fails to surface, satisfying *V+V, but the strongly encoded initial vowel of the root retains its input features.
- **Faithfulness sensitive to degree of encoding strength**: I propose an encoding-strength-sensitive constraint, (20), to ensure identity to strongly encoded input vowels (cf. Inkelas 2015).

(20) **Ident-Strong**
Assign one violation for each output segment that corresponds to a strongly encoded input segment, and whose features differ from that corresponding input segment.

(21) **Strong vowels in object contexts**
Id-Strong, Realize, *V+V, Id-Phase, *[αF][βF] ≫ Id-IO

/ɟʊ$_i$la$_j$=ɔ$_k$/	Id-Strong	Realize	*V+V	Id-Phase	*[αF][βF]	Id-IO
a. ɟʊ$_i$la$_j$		*!			*	
b. ɟʊ$_i$la$_j$ɔ$_k$			*!		**	
c. ɟʊ$_i$lʊ$_k$				*!		*
d. ☞ɟʊ$_i$lɔ$_k$					*	
e. ɟɔ$_i$lɔ$_k$	*!					*

- The ranking in (21) gets us the correct output for roots with strongly and weakly encoded vowels in the environment of a third-person object enclitic.
- The same Ident-Strong constraint can be used to prevent CVCV reduction to CCV in roots with strongly encoded vowels.

4.1.2 Reranking in other cophonologies

- The same constraints, with the addition of an ABP constraint specific to ATR harmony, (22), derive (no) replacement in other morphosyntactic contexts.

  (22) ***[αATR][βATR]**$_{[+syllabic]}$
  A segment with some value of the feature ATR may not directly precede another segment with a different ATR value in the ordered set of output segments that are [+syllabic] (i.e. vowels). Assign one violation for each pair of neighboring segments that meets the criteria.

- In plural contexts, where we see both replacement and ATR harmony, both the ATR harmony and general vowel agreement constraints are highly ranked:

  (23) **Plural ranking**
  Id-Strong, *[αATR][βATR] $\gg$ Realize, *V+V, *[αF][βF] $\gg$ Id-IO

- In passive contexts, where we see ATR harmony but no replacement, the ATR constraint must be ranked high, but the general vowel agreement constraint low.

  (24) **Passive ranking**
  Id-Strong, *[αATR][βATR], Realize, *V+V $\gg$ Id-IO $\gg$ *[αF][βF]

- In nominalizing contexts, where we see neither ATR harmony nor replacement, both ABP constraints must be ranked below the faithfulness constraints Id-Strong, Id-IO.

  (25) **Nominalizing ranking**
  Id-Strong, Realize, *V+V, Id-IO $\gg$ *[αF][βF], *[αATR][βATR]

4.1.3 Summary of (non-)replacement cophonologies in Guébie

- We saw that RealizeMorph and *V+V are ranked highly across the cophonologies discussed here.

- Reranking the faithfulness constraints Id-Strong, Id-IO differently with respect to the Agreement-by-Projection constraints *[αATR][βATR]$_{[+syllabic]}$, *[αF][βF]$_{[+syllabic]}$, results in four surface possibilities all found in Guébie morphophonology:

  (26) **The distribution of harmony and replacement in Guébie**

	Harmony	**No harmony**
Replacement	Plural	Objects
No replacement	Passive	Nominalizer

4.2 Against a suppletive allomorphy approach

- The alternative to a multiple-grammar approach to Guébie vowel replacement would be to list multiple lexical items for each root that undergoes vowel replacement.
- Two such frameworks are
  1. Distributed Morphology suppletive vocabulary insertion (Halle and Marantz 1993, 1994; Harley 2014)
  2. Emergent Phonology (Archangeli and Pulleyblank 2012, 2015a,b)
- Such an analysis would require listing up to twelve distinct forms of each verb that undergoes vowel replacement in Guébie.

(27) **Lexically listed forms in an allomorphy approach**

	Unreduced	**Reduced**
Default	jɪla	jra
3sg.hum.obj	jɔlɔ	jrɔ
3sg.obj	jɛlɛ	jrɛ
3sg.obj	jʊlʊ	jrʊ
3sg.obj	jala	jra
3pl.obj	jɪlɪ	jrɪ

- The listed forms are predictable given the default form of that verb, so a phonological approach seems preferable.
- Additionally, listing all allomorphs for each replaceable verb fails to make any phonological connection among the set of verbs that undergo replacement.
  - Verbs that undergo replacement also undergo reduction to CCV.
  - Verbs that undergo replacement tend to share a set of phonological properties.
- Unlike a strength-of-encoding analysis where there is a phonological feature (weak encoding of V1) that unites replaceable roots, a suppletive analysis does not predict that replaceable roots should form a natural class, nor that the replacement should show the same pattern across roots.

5 Conclusion

- Vowel replacement of root vowels in Guébie is both lexically and morphosyntactically conditioned.
  - It only occurs in the context of a third-person object enclitic or plural suffix.
  - It only occurs roots containing weakly phonologically encoded initial vowels.
- **Cophonology Theory** allows us to model the morphosyntactic conditioning of vowel replacement by reranking constraints based on morphosyntactic environment.

- Faithfulness constraints sensitive to **encoding strength**, where weak encoding correlates with weak faithfulness, allow us to model the lexical conditioning.
    - This constraint is also used to model vowel reduction from CVCV to CCV, which occurs in the same set of roots.
- **Take away**: A model of the morphology/phonology interface must allow for both lexically and morphosyntactically conditioned phonological phenomena.
- Cophonology Theory and encoding strength work together to do just that.

References

Anttila, Arto. 2002. Morphologically conditioned phonological alternations. *Natural Language & Linguistic Theory* 20:1–42.

Archangeli, DB, and DG Pulleyblank. 2012. Emergent phonology: evidence from English. *Issues in English linguistics* .

Archangeli, Diana, and Douglas Pulleyblank. 2015a. Phonology without universal grammar. *Frontiers in psychology* 6.

Archangeli, Diana, and Douglas Pulleyblank. 2015b. Tonal allomorphy in Kinande. In *Capturing phonological shades within and across languages*, ed. Yuchao Hsiao and Lian-Hee Wee. Cambridge Scholars Publishing.

Bermúdez-Otero, Ricardo. 1999. *Constraint interaction in language change: quantity in English and Germanic*. University of Manchester.

Halle, Morris, and Alec Marantz. 1993. Distributed Morphology and the pieces of inflection. In *The view from building 20*, ed. Kenneth Hale and Samuel Jay Keyser, 111–176. Cambridge, Massachusetts: MIT Press.

Halle, Morris, and Alec Marantz. 1994. Some key features of Distributed Morphology. *MIT working papers in linguistics* 21:88.

Hansson, Gunnar Ólafur. 2001. Theoretical and typological issues in consonant harmony. Doctoral Dissertation, University of California, Berkeley.

Hansson, Gunnar Olafur. 2014. (dis)agreement by (non)correspondence: Inspecting the foundations. *ABC Conference, UC Berkeley* .

Harley, Heidi. 2014. On the identity of roots. *Theoretical linguistics* 40:225–276.

Inkelas, Sharon. 2015. Confidence scales: A new approach to derived environment effects .

Inkelas, Sharon, Orhan Orgun, and Cheryl Zoll. 1997. The implications of lexical exceptions for the nature of grammar. In *Optimality theory in phonology: A reader*, ed. J. J. McCarthy, 542–551. Oxford: Blackwell.

Inkelas, Sharon, and Cheryl Zoll. 2005. *Reduplication: Doubling in morphology*, volume 106. Cambridge University Press.

Inkelas, Sharon, and Cheryl Zoll. 2007. Is grammar dependence real? a comparison between cophonological and indexed constraint approaches to morphologically conditioned phonology. *Linguistics* 45.1:133–171.

Itô, Junko, and Armin Mester. 1999. Realignment. *The prosody-morphology interface* 188–217.

Kiparsky, Paul. 1982. From cyclic phonology to lexical phonology. *The structure of phonological representations* 1:131–175.

Kiparsky, Paul. 2000. Opacity and cyclicity. *The linguistic review* 17:351–367.

Kiparsky, Paul. 2008. Fenno-Swedish quantity: Contrast in Stratal OT. In *Rules, constraints, and phonological phenomena*, ed. Bert Vaux and Andrew Nevins. Oxford: Oxford University Press.

Kurisu, Kazutaka. 2001. The phonology of morpheme realization. Doctoral Dissertation, University of California Santa Cruz.

Lightner, Theodore McGraw. 1965. Segmental phonology of modern standard Russian. Doctoral Dissertation, Massachusetts Institute of Technology.

Lionnet, Florian. 2016. Subphonemic teamwork: A typology and theory of cumulative coarticulatory effects in phonology. Dissertation, UC Berkeley.

Marchese, Lynell. 1979. *Atlas linguistique kru.* Abidjan: ILA.

McCarthy, John, and Alan Prince. 1995. Faithfulness and reduplicative identity. In *University of massachusetts occasional papers in linguistics 18: Papers in Optimality Theory*, ed. Jill Beckman, Laura Dickey, and Suzanne Urbanczyk, 249–384. Amherst, MA: GLSA.

McPherson, Laura, and Jeffrey Heath. 2016. Phrasal grammatical tone in the Dogon languages. *Natural Language & Linguistic Theory* 34:593–639.

Moore-Cantwell, Claire. 2017. Concurrent learning of the lexicon and phonology. *LSA annual meeting presentation* .

Orgun, Cemil. 1996. Sign-based morphology and phonology with special attention to Optimality Theory. Unpublished dissertation, UC Berkeley.

Pycha, Anne, Sharon Inkelas, and Sarah Bakst. 2017. Why do morpheme-internal segments resist alternations? a word-learning experiment. *Berkeley Phonology Forum presentation* .

Rose, Sharon. 1997. Theoretical issues in comparative Ethio-Semitic phonology and morphology. Phd dissertation, McGill University.

Rose, Sharon, and Rachel Walker. 2004. A typology of consonant agreement as correspondence. *Language* 80:475–31.

Rosen, Eric. 2016. Predicting the unpredictable: Capturing the apparent semi-regularity of rendaku voicing in Japanese through harmonic grammar. *Proceedings of the 42nd Berkeley Linguistics Society* 235–249.

Samek-Lodovici, Vieri. 1993. Morphological gemination crosslinguistically. *Rutgers Optimality Workshop* .

Smolensky, Paul, Matthew Goldrick, and Donald Mathis. 2014. Optimization and quantization in gradient systems: A framework for integrating the continuous and the discrete in cognition. *Cognitive Science* 38:1102–⊠⊠1138.

Walker, Rachel. 2000. Nasalization, neutralization, and opacity effects. Doctoral Dissertation, Ph. D. thesis, University of California, Santa Cruz. Published from Garland Press.

Walker, Rachel. 2016. Surface correspondence and discrete harmony triggers. In *Proceedings of the Annual Meetings on Phonology*, volume 2.

Zogbo, Lynell. 2016. Central vowels in the Kru language family: Innovation and areal spreading. *ACAL* .

Zoll, Cheryl. 1996. Parsing below the segment in a constraint based framework. Doctoral Dissertation, UC Berkeley.